IFIP AICT 408

Luis M. Camarinha-Matos
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(Eds.)

Collaborative Systems for Reindustrialization

14th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2013
Dresden, Germany, September/October 2013
Proceedings

Springer

IFIP Advances in Information and Communication Technology 408

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ISSN 1868-4238 e-ISSN 1868-422X
ISBN 978-3-642-40542-6 e-ISBN 978-3-642-40543-3
DOI 10.1007/978-3-642-40543-3
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013945876

CR Subject Classification (1998): K.6, C.2, H.4, H.5, J.1, D.2, H.3

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Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Collaborative Systems for Reindustrialization

The ongoing economic crisis, which is affecting many world regions, especially Europe, has led to an intensification of discussions around the needs for reindustrialization. After decades of industrial decline, due to deliberate policies that advocated an exclusive move toward a service-oriented society while neglecting the production of tradable goods, many countries are struggling with public and private belt-tightening measures that only accelerate the crisis spiral. Reindustrialization is the economic, social, and political process of organizing resources for the purpose of re-establishing / revitalizing industries in order to reinvigorate the economy.

What is the role of collaborative networks in this process? Collaboration is essential especially to small and medium enterprises in order to acquire critical mass, reach new markets, and leverage skills. But reindustrialization cannot simply follow the steps of the last century. New perspectives of industry are needed, as exemplified by current trends such as:

- Focusing on service-enhanced products
- Addressing the full life cycle of products, including refurbishing / retrofitting and recycling
- Taking on board the serious concerns of energy saving and reduction of ecological footprint
- Having a *glocal* perspective, and relying on co-innovation and co-evolution

Sustainability issues are clearly in the front row of these trends. Any effective solution in such direction imposes collaboration of multiple stakeholders organized in combinations of dynamic value chain networks. New collaborative systems need to be developed under a well-integrated sociotechnical perspective.

The extensive body of empiric knowledge and the size of the involved research community in collaborative networks provide the basis for leveraging the potential of new concepts and mechanisms in addressing big societal challenges and consolidating the scientific discipline on "collaborative networks." This discipline is strongly multidisciplinary and thus the PRO-VE Working Conference is designed to offer a major opportunity to mix contributions from computer science, manufacturing, engineering, economics, management, or sociohuman communities. The selected theme for PRO-VE 2013 thus focused on crucial aspects to empower collaborative networks – an important contributor to a new generation of industrial systems.

PRO-VE 2013, held in Dresden, Germany, was the 14th event in a series of successful conferences, including PRO-VE 1999 (Porto, Portugal), PRO-VE 2000 (Florianopolis, Brazil), PRO-VE 2002 (Sesimbra, Portugal), PRO-VE 2003 (Lugano, Switzerland), PRO-VE 2004 (Toulouse, France), PRO-VE 2005

(Valencia, Spain), PRO-VE 2006 (Helsinki, Finland), PRO-VE 2007 (Guimarães, Portugal), PRO-VE 2008 (Poznan, Poland), PRO-VE 2009 (Thessaloniki, Greece), PRO-VE 2010 (St. Etienne, France), PRO-VE 2011 (São Paulo, Brazil), and PRO-VE 2012 (Bournemouth, UK).

This book includes a number of selected papers from the PRO-VE 2013 Conference, providing a comprehensive overview of identified challenges and recent advances in various collaborative network domains and their applications, with a particular focus on the support for reindustrialization. With this focus, this edition of the conference specifically emphasized collaborative network topics related to:

- Product-service ecosystems
- Innovation in networks
- Strategies to build collaborative networks
- Collaboration related processes and performance
- Models and meta-models of collaboration
- Cloud-based support to collaborative networks
- Collaboration platforms
- Services and service design
- Sustainable collaborative networks
- Event-driven collaborative networks
- Social-semantic enterprise
- Risks and trust

We would like to thank all the authors both from academia/research and industry for their contributions. We hope this collection of papers represents a valuable tool for those interested in research advances, emerging applications, and future challenges for R&D in collaborative networks. We also appreciate the dedication of the PRO-VE Program Committee members who helped with the selection of articles and contributed with their valuable comments to help authors in improving the quality of their work.

July 2013

Luis M. Camarinha-Matos
Raimar J. Scherer

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Introduction

Collaborative Systems in Support of Reindustrialization

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Abstract. The establishment of collaborative business ecosystems is widely accepted as a key strategy in the reindustrialization processes. This is clearly present in the ongoing policy discussions and industry-oriented research roadmaps. A brief analysis of recent contributions to the PRO-VE conference shows the active role already played by the collaborative networks community in this process. Focusing on areas such as service orientation and service-enhanced products, sustainability issues, collaboration stimulation strategies, co-innovation, and improvement of distributed processes, the area is contributing with valuable models, organizational structures, infrastructures and tools to enable a new generation of sustainable industrial systems.

Keywords: Reindustrialization, Collaborative Networks, Sustainability.

1 Introduction

The term *reindustrialization* has appeared to represent the economic, social, and political process of organizing resources for the purpose of re-establishing / revitalizing industries in order to reinvigorate the economy. After decades of industrial decline, due to deliberate policies that advocated an exclusive move towards a service-oriented society, while neglecting the production of tradable goods, many countries are struggling with hard public and private belt-tightening measures which only accelerate the crisis spiral. While the urgent need for growth and job creation are getting attention in the policy agendas, technical discussions more and more focus on new approaches for manufacturing, value creation, operational excellence in distributed contexts, agility, and collaborative networks.

Sustainability issues, considering the three pillars of environment protection, economic growth, and social progress, are clearly upfront in these trends. Any effective solution in the direction of sustainable industrial approaches imposes collaboration of multiple stakeholders organized in mixes of dynamic value chain networks. New collaborative systems need to be developed under a well-integrated socio-technical perspective.

This introductory chapter intends to briefly highlight the relevant contribution that collaborative networks can have in the development of a new generation of industrial systems able to address major societal challenges. For this purpose, a brief analysis of relevant literature and research roadmaps is made.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 3–10, 2013.

2 Some Literature Trends

The first wave of literature on reindustrialization appeared in the 1980s, particularly in Europe and the USA. In the case of Europe, most discussions were associated to the political changes in Central and East Europe and were focusing on the creation of new, innovative industries, activities and products, with high priority for environmental protection industry [1]. The transformation processes were associated to the crisis and decline of state-owned industries, leading to some de-industrialization [2]. By the same time, considerable discussions on reindustrialization, productivity, and competitiveness were also taking place in the USA [3], [4]. The need for collaborative strategies among various stakeholders for effective reversal of stagnant or declining economies was already recognized in this period [5].

More recently, in the sequel of the ongoing economic crisis, the subject became again on top of the political agenda. For instance, a manifesto for growth and employment in Europe [6] advocates the need:

"*To organize technological and industrial cooperation in all sectors and all regions: building new industries, European players of international dimensions, and creating ecosystems for innovation and investment call for sustainable partnerships*".

The Foundation Robert Schuman also points out the importance of cluster networks in the strategy to reduce disparities between regions and overcoming innovation gaps [7]. At the European Commission level it is particularly relevant the new target for 2020 to counter the decline of Europe's industrial base and increase the share of manufacturing in EU's GDP to 20% [8], [9]. Many discussions around reindustrialization and economic revitalization appear associated to transformations along the lines of a green economy.

A recent manufacturing outlook report by KPMG [10] also highlights the importance of collaboration:

"*While the lean manufacturing revolution was focused on getting businesses' own houses in order, the challenge now is to improve supply chain performance through genuinely closer working relationships and* ***collaboration across the network***".

Improved end-to-end visibility of the supply chain is also pointed out as key for optimization, which is synonymous of more effective collaboration. ICT collaboration platforms and tools are fundamental enablers in this process. According to the same report [10], when asked "what are the major challenges your company faces in its ability to innovate?", manufacturing companies identified top 5 challenges:

1. Aligning innovation to company strategy;
2. Complexities in collaborating with suppliers and partners;
3. Executing innovation – on time and on budget;
4. Shortage of ideas to drive innovation;
5. Incomplete view of / difficulty understanding the needs of customers.

Besides the second challenge, which clearly requires collaborative networks contribution, also concepts such as co-innovation, open innovation, or *glocal* enterprise, which are addressed in current research by the collaborative networks community, can bring significant inputs to challenges 4 and 5.

3 Industry-Oriented Research Roadmaps

Realizing the importance of manufacturing in “growth and jobs”, a prerequisite for societal sustainability, EFFRA has elaborated a multiannual roadmap [11] with research and innovation priorities for Factories of the Future under the Horizon 2020 program of the European Commission. The roadmap is designed with the aim of having a significant impact in the following major long-term objectives:

- Maintain and create new jobs in manufacturing.
- Increase value added by manufacturing.
- Address environmental concerns, by reducing emission of gases, energy consumption, waste generation, and consumption of materials.
- Enhance attractiveness of jobs in manufacturing.
- Increase the number of manufacturing enterprises engaged in innovation and R&D.

The roadmap identifies 6 main research and innovation priorities (Fig. 1). When observing the details of each priority and the proposed research actions, the role of collaborative networks becomes evident. This role is most obvious in the priority “Collaborative and mobile enterprise”, in which the proposed actions are clearly aligned with research topics in collaborative networks. But relevant contributions of collaborative networks and collaborative systems are also identifiable in all the other priority domains, as summarized in Fig. 1.

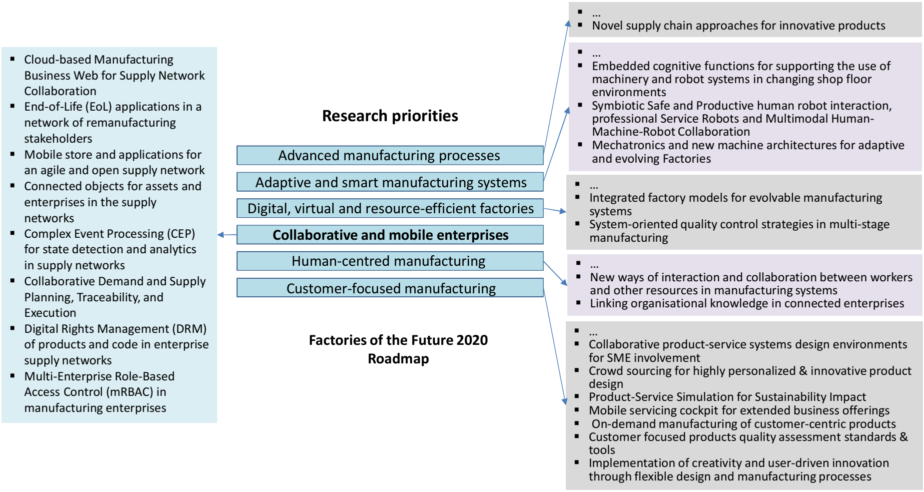
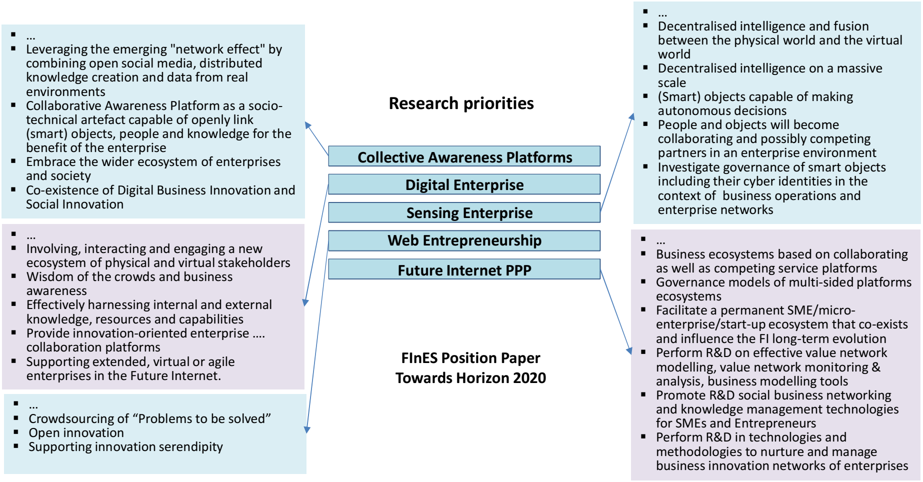


Fig. 1. Role of collaborative systems in the FoF 2020 roadmap

A complementary roadmapping initiative is represented by the position paper towards Horizon 2020, elaborated by the FInES (Future Internet Enterprise Systems) cluster [12]. This document is organized around 5 research priorities aimed at supporting Internet-based disruptive enterprise innovation towards competitive advantage development and sustainable growth.

As illustrated in Fig. 2, in all these priority areas collaborative networks is a major contributing discipline.



Research priorities

Collective Awareness Platforms

Digital Enterprise

Sensing Enterprise

Web Entrepreneurship

Future Internet PPP

FInES Position Paper
Towards Horizon 2020

- ...
- Leveraging the emerging "network effect" by combining open social media, distributed knowledge creation and data from real environments
- Collaborative Awareness Platform as a socio-technical artefact capable of openly link (smart) objects, people and knowledge for the benefit of the enterprise
- Embrace the wider ecosystem of enterprises and society
- Co-existence of Digital Business Innovation and Social Innovation

- ...
- Involving, interacting and engaging a new ecosystem of physical and virtual stakeholders
- Wisdom of the crowds and business awareness
- Effectively harnessing internal and external knowledge, resources and capabilities
- Provide innovation-oriented enterprise .... collaboration platforms
- Supporting extended, virtual or agile enterprises in the Future Internet.

- ...
- Crowdsourcing of “Problems to be solved”
- Open innovation
- Supporting innovation serendipity

- ...
- Decentralised intelligence and fusion between the physical world and the virtual world
- Decentralised intelligence on a massive scale
- (Smart) objects capable of making autonomous decisions
- People and objects will become collaborating and possibly competing partners in an enterprise environment
- Investigate governance of smart objects including their cyber identities in the context of business operations and enterprise networks

- ...
- Business ecosystems based on collaborating as well as competing service platforms
- Governance models of multi-sided platforms ecosystems
- Facilitate a permanent SME/micro-enterprise/start-up ecosystem that co-exists and influence the FI long-term evolution
- Perform R&D on effective value network modelling, value network monitoring & analysis, business modelling tools
- Promote R&D social business networking and knowledge management technologies for SMEs and Entrepreneurs
- Perform R&D in technologies and methodologies to nurture and manage business innovation networks of enterprises

Fig. 2. Role of collaborative systems in the FInES position paper towards Horizon 2020

4 Examples of Contributions from Collaborative Networks

The 2013 edition of PRO-VE was specifically focused on the contribution of collaborative systems for reindustrialization and, as such, it presents a good overview of current contributions [13]. Furthermore, many other important contributions can also be found in other recent editions, with particular relevance to the ones devoted to sustainability [14], value creation [15], and Internet of services [16].

Fig. 3 gives an overview of the main areas covered by the selected papers. It shall be noted that some papers address more than one area.

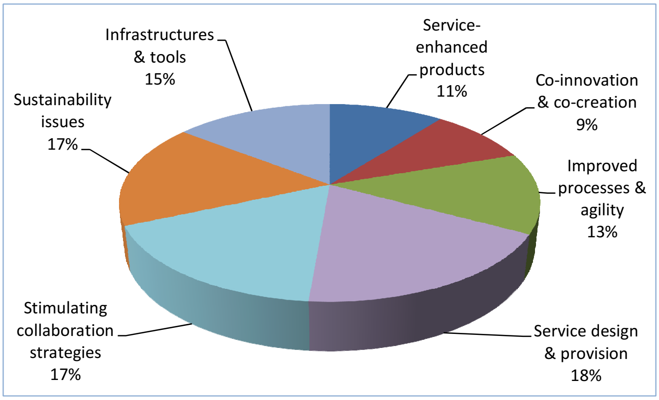


Fig. 3. Main covered areas in PRO-VE'13

Focusing on Service-Enhanced Products. The notion of service-enhanced product, also known as product-service, represents the association of business services to the physical product, adding value to the product along its life-cycle through better satisfaction of customer needs. The term product-service system (PSS) is also used, including the product, the associated services, the involved enterprises network, and the needed infrastructure. Examples of significant research topics under this item:

- Notion of "*servitization*" and "service-dominant strategy" to represent a mindset shift from goods-dominant logic to service-dominant logic;
- Role of service enhancement in sustainability and methods to assess that sustainability;
- Organization of collaborative ecosystems to provide the services, introducing the perspectives of multi-stakeholders collaborative value creation and co-creation through the involvement of the customer;
- Identification and characterization of the interplay among various collaborative networks along the product life-cycle such as product manufacturing network, service co-creation network, product servicing network, and the long-term ecosystem or manufacturers VBE;
- The notion of *glocal* enterprise in the product-enhanced services, highlighting the role of the customer and its related "community" (local suppliers, regulators, other local stakeholders) and the interplay of this "community" with the manufacturers network;
- Understanding and modeling the contribution of the various stakeholders in value proposition to form a PSS;
- Identification of critical decision processes and decision centers in the transition to PSS;
- Specification and configuration of customized complex products;
- Assessment of (industrial) service procurement processes;
- Value systems alignment in the creation of product servicing networks;
- Cloud-based collaboration platforms and tools to support service-enhanced product ecosystems.

Focusing on Co-innovation. The notion of co-innovation refers to a collaborative process involving not only industry stakeholders but also the customer in the design of new solutions. Examples of relevant research topics include:

- Strategies and mechanisms to promote the creation of innovation networks;
- Key roles and processes in co-creation of intellectual property;
- Service co-creation networks and processes;
- Mechanisms to assess knowledge circulation in co-innovation networks;
- Co-creation support platforms and collaboration spaces.

Improving Processes and Agility. Various research activities continue focused on the improvement of distributed business processes, redesign of processes towards more optimized operation, and configuration and reconfiguration of networks. Examples include:

- Incentives, sanction mechanisms, and fair distribution of benefits;
- Transportation logistics optimization;

- Sensor networks in large-scale monitoring;
- Collaborative cyber-physical systems in process monitoring;
- Identification and characterization of collaborative processes;
- Context-aware process modeling methods;
- Representation of behavior related processes;
- Consortia formation and reconfiguration of collaborative networks to support better coordination and control.

Focusing on Service Design and Provision. The growing importance of (business) services and the need to better "engineer" them led to the emergence of new research streams such as *services science* and *services design*. Services science is a *movement* trying to clarify the notion of service in all its dimensions and provide a sound conceptual framework for the area. Service design aims at providing effective approaches and tools for service design, addressing the functionality and form of the services. In particular, it aims to ensure that service interfaces are useful, usable, and desirable from the client's perspective, while being also effective, efficient, and distinctive from the supplier's perspective. Examples of relevant research topics:

- Modeling services life-cycle;
- Methods for services discovery and selection based on non-functional properties:
- Role of mobile and location-based services in dynamic value chains;
- Dynamic negotiation and contracting of services to support agile manufacturing networks;
- Handling uncertainties associated with partnerships in provision of sustainable services, e.g. dealing with variability of governance structures, climate of relationships, behavioral uncertainty, performance variations, etc.;
- Methods to support service co-design, with particular focus on visual thinking approaches;
- Cost prediction for service systems, namely in co-creation contexts;
- Approaches to "industrialize" the service design and service innovation processes;
- Interaction patterns in NFC interfaces for services;
- Service level agreements in cloud-based environments;
- Adaptation of service design tools to different industries;
- Identification and characterization of services in fashionable products;
- Development of energy-control services for smart homes based on multi-stakeholders collaboration;
- Collaboration in effective service recovery in incidents management.

Stimulating Collaborative Strategies. A substantial group of diversified contributions are focusing on strategic and managerial approaches to promote collaboration. Examples of addressed topics include:

- Trends in global economy and facilitators for intercontinental collaboration;
- Dynamic networks and employment structure;
- Approaches to enhance collaboration strategies and anything relationships management;
- Legal and regulatory frameworks to promote enterprise networks;

- Collaborative approaches in revitalizing rural communities;
- Promotion of public-private collaboration;
- Evolution of business models in networks;
- Collaboration forms in the tourism and healthcare sectors;
- Risk analysis and trust promotion methods;
- Exploiting the value of social networks, namely in terms of information fusion and knowledge extraction.

Addressing Sustainability in Its Various Perspectives. The role of collaborative networks in sustainability has deserved considerable attention in the last years [14] and is likely to continue a major topic of research. Examples of current issues include:

- Models to promote sustainable packaging and transportation logistics, aiming at reducing environmental impacts;
- Collaborative networks in reverse logistics and end-of-life manufacturing challenges;
- Enterprise networking in support of remanufacturing and recycling;
- Role of intangible assets in business sustainability;
- Power distribution and sustainability of the networks;
- Sustainability issues in networked mass customization, namely addressing variability rationalization.

Developing Infrastructures and Tools. In addition to the various technological components and systems included in previous sections, the developments of collaboration platforms and generic collaboration support tools offers important enablers for the actual establishment of collaborative networks. Examples of developments include:

- Collaboration spaces – models and support functionalities;
- Knowledge-based architectures to support co-creation;
- Collaboration platforms for learning environments;
- Cloud-based collaboration platforms;
- Collaborative planning support tools;
- Event-driven architectures and event marketplaces;
- Support for dynamic composition of processes.

The above examples do not constitute an exhaustive representation of research in this domain but provide a comprehensive set of examples of issues being tackled by a large variety of research groups [13], and which are likely to contribute to effective reindustrialization.

5 Concluding Remarks

The perspective of collaboration and enterprise networks has become a central issue in the ongoing policy agendas and initiatives to revitalize industry. As such, collaborative networks play a relevant enabling role in the reindustrialization processes. This is well recognized in recent literature and strategic research roadmaps for future manufacturing and enterprise systems. A survey of current research in the collaborative networks area, as represented by the contributions to recent PRO-VE conferences, illustrates well how collaborative systems and models are being developed and evaluated in support of a new industrial landscape.

Acknowledgements. This work was funded in part by the European Commission through the GloNet project (FP7 programme).

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Product-Service Ecosystems

Product-Service Sustainability Assessment in Virtual Manufacturing Enterprises

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Abstract. New directions in modern industry are creating distributed virtual enterprises and pushing companies towards service-enhanced products. Both trends converge when a Virtual Manufacturing Enterprise (VME) is created to provide product-service solutions. At the same time, sustainability is a crucial aspect for industrial networks. This paper proposes a methodology to assess the sustainability of Product-Service Systems (PSS) in a VME by modelling an integrated lifecycle, defining impact categories and KPIs, and evaluating all the partners' contributions. The method allows easily comparing PSS design alternatives to each other or with traditional products. The industrial case study is represented by a "washing as a service" solution proposed by a worldwide VME. Sustainability assessment is useful to highlight the service benefits as well as the critical phases, and to support VME decision-making.

Keywords: Service-enhanced products, Sustainable manufacturing networks, Product-Service Systems (PSS), Virtual Manufacturing Enterprise (VME), Sustainability.

1 Introduction

Nowadays manufacturing enterprises are involved in the transition from products to Product-Service Systems (PSS). This trend mainly consists of adding a wide range of services to increase the value perceived by the customers and better satisfy their needs over time [1]. Furthermore, service-enhanced products (e.g. maintenance, user training, retrofitting and product monitoring, etc.) can significantly influence product performances and improve PSS sustainability.

Anyhow creating a PSS implies two main important changes in company's processes: firstly, the traditional product lifecycle has to be enhanced by including also service management; secondly, the product-oriented company model must be extended to realize a service-oriented ecosystem [2]. Indeed, interrelations between products and non-physical services are complex to model and they require managing new relationships between different stakeholders by creating a Virtual Manufacturing Enterprise (VME). Managing such complex scenario can add value with low impact and realize more sustainable processes thanks to the exploitation of the whole ecosystem capabilities [3]. In this context, sustainability assessment can be useful to

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 13–21, 2013.

understand the benefits connected to PSS and the effective advantages in respect with traditional products and to support strategic decision-making in the VME. However, a reliable analysis can be achieved only by considering a new integrated lifecycle and the ecosystem as a whole.

The research proposes a methodology to carry out a holistic sustainability assessment of PSS in complex manufacturing ecosystems. It defines an integrated lifecycle and, for each phase, indicates the sustainability objectives (economic, ecological or social) to be achieved. Objectives are than concretized by a set of KPIs that can be measured by specific assessment techniques (i.e. LifeCycle Assessment LCA, LifeCycle Cost Assessment LCCA, Social LifeCycle Assessment SLCA) and normalized to obtain a unique Sustainability Assessment value (SA). Finally, the impacts are mapped in the VME by eliciting the specific contributions of the ecosystem partners. It can be adopted until the preliminary design stages to envisage the global impacts of different PSS design solutions and highlight the most critical phases and objectives in danger. The methodology is validated by an industrial case study focusing on the "EasyWash service", which offers a set of washing services instead of the traditional product (washing machine). Analyses allow investigating the benefits of he proposed PSS and understanding how to optimize the sustainability within the VME.

2 Product-Service Sustainability Assessment

A product-service consists of a mix of tangible core products and intangible services designed and combined to increase the value for customers [4]. Value creation can be provided through an extended business network involving different stakeholders, which concur to create the services. The term PSS includes the product-service itself, the enterprise network and the infrastructures needed [5].

Services can provide great advantages on sustainability according to all the three dimensions considered by the modern sustainability thinking: environment, economics and social wellbeing [6]. From the economic viewpoint, services create new market potentials and higher profit margins, and can contribute to higher productivity by means of reduced investment costs along the lifetime as well as reduced operating costs for the final users. From an ecological viewpoint, product-services can be more efficient thanks to a more conscious product usage, an increased resource productivity and a close loop-chain manufacturing as reported by some examples [7-8]. Finally, services are able to support the building up and securing of knowledge intensive jobs, and can contribute to a more geographically balanced wellbeing distribution [9].

In industry, product sustainability can be achieved by adopting lifecycle design approaches: they allow quantifying product impacts and providing tangible commercial values in terms of efficiency and costs [10]. They are based on the definition of key parameters and indicators as metrics to assess the lifecycle performance (e.g. functionality, manufacturability, serviceability, environmental impact) and support comparative analysis [11]. Some techniques representing the basis for lifecycle assessment analysis are LifeCycle Assessment (LCA) [12] and LifeCycle Costing (LCC) [13]. Recently, also the social dimension has been included by the so-called Social LifeCycle Assessment (SLCA) [14]. However, the application of lifecycle techniques generally refers to physical products and adopts the single company perspectives. Only few recent studies try to apply lifecycle methods for PSS assessment [3]. However, the ecosystem has never been considered nor the partners' impact investigated.

Creating product-services implies the involvement of organizations, public bodies, tertiary service providers and customers to create a new business framework that is organized to support both product and service lifecycles. It entails moving from the traditional concept of virtual enterprise to the new idea of VME: a virtual enterprise is an aggregation of several business partners sharing costs and resources for the purpose of producing a product [15], while a VME focuses on PSS and contemporarily involves manufacturing agents (internal or external) producing and supplying products and services, and sales agents negotiating with customer agents [16]. In this context, considering the sustainability of PSS in the VME by understanding the impacts on the three sustainability dimensions can be particularly interesting and represents a novelty in research and in industry.

3 Product-Service Sustainability Assessment in the VME

A product-service sustainability assessment in complex ecosystems can be achieved by a structured methodology that considers the different aspects of sustainability and extends the analysis to the involved VME. The main novelties are:

- the approach, as it considers an integrated lifecycle considering both product and service phases and additional stages about the product-service system management;
- the service evaluation, as it applies sustainability analysis techniques not only for product abut also for service assessment;
- the VME perspective, as it analyses the involved partners of the virtual enterprise and their roles, and it determines the specific impact for each of them.

The proposed method consists of the following steps (Fig.1):

1. Definition of an integrated Product-Service Lifecycle: it considers all the activities related to product and service realization, from PSS ideation and design until PSS disposal. Lifecycle modelling considers the product as well as the technological infrastructure and the services;
2. Identification of the sustainability objectives: it includes environmental, economic and social objectives for each lifecycle phase;
3. Definition of the relevant KPIs: for each objective, a set of key indicators is defined according to sustainability purposes and manufacturing service-enhanced products;
4. Definition of reliable measuring techniques to assess the KPIs: a combination of suitable lifecycle design techniques is defined to assess PSS sustainability. In particular, LCA focusing on environmental resources and ecosystem, LCCA estimating the lifecycle total costs, and SLCA estimating impacts on human resources and human health;

5. Ecosystem analysis and correlation between the lifecycle phases and the VME partners involved: objectives are related to a specific ecosystem actor in order to separate the sustainability impacts;
6. Measurement of the global sustainability assessment for the VME: for each relevant lifecycle phase and for each identified ecosystem actor, KPIs are separately measured by combining the selected techniques and normalizing the single indexes to have a unique sustainability assessment value (SA), as expressed by Eq. (1):

$$LCA + LCCA + SLCA = SA \tag{1}$$

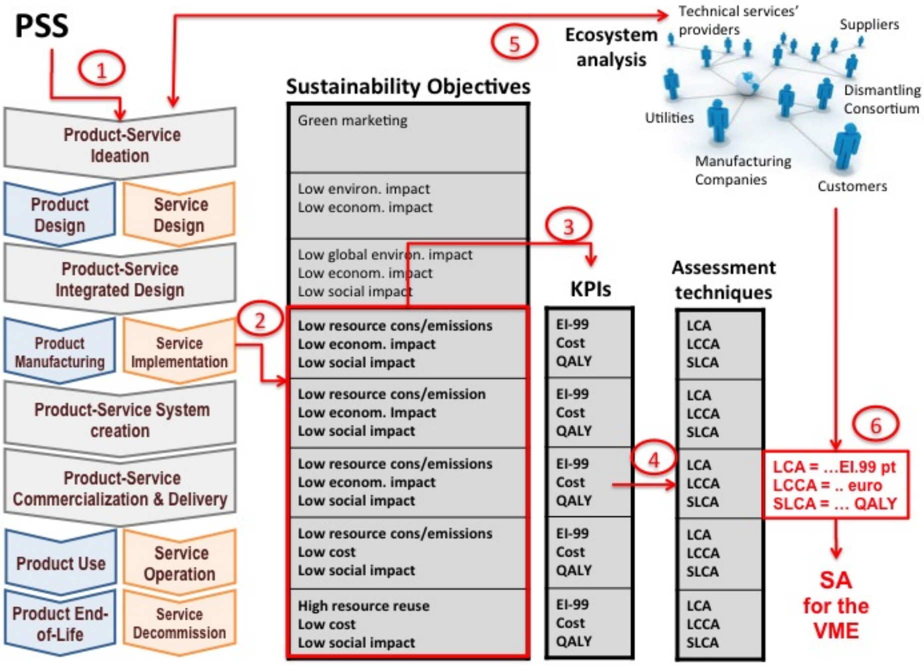

Fig. 1. Methodology steps for Product-Service sustainability assessment in the VME

Sustainability assessment focuses on the operative phases, from the end of the design stage until the end-of-life. Indeed, ideation and design slightly affect sustainability and in a similar way for different solutions, so these phases are neglected for the research purposes.

The lifecycle analysis considers all significant data referring to the analysed phases for product (manufacturing, use, end-of-life), service (implementation, operation, decommission) and product-service system (creation, commercialization and delivery). Environmental impact is measured by Eco-Indicator99 (EI-99) considering Ecosystem Quality impact and Resources consumption. The unit of measurement is EI-99 point (Pt). Economic impact relates to the material use and transformation cost (MegaJoule or euro/dollars) as well as the lifecycle resources consumption cost (MegaJoule) within the entire ecosystem. It adopts the Equivalent Annual Cash Flow technique (EA) to transform a generic cash flow distribution into an equivalent annual distribution by cost actualization according to Eq. (2):

$$EA = P\frac{(i+1)^n * i}{(i+1)^n - 1} \tag{2}$$

where n is the lifetime years' number, i is the generic discount rate (e.g. 3%), and P is the value during the entire lifetime. The impact is expressed in Euro. Finally, social impact considers separately Human Health contributions according to EI-99 methodology as before. Impact is expressed into QALYs (Quality Adjusted Life Years). Such values can be calculated by LCA and LCCA software tools (i.e. SimaPro, Gabi). For each lifecycle phase LCA, LCCA and SLCA are coupled to obtain a unique sustainability index via proper data normalization. The environmental impact, originally expressed in EI-99 pt., can be translated into PDFm^{2}yr (Potentially Disappeared Fraction of species per square meter per year) and MJ (MegaJoule), and normalized by Eq. (3) and Eq. (4). The social impact, originally expressed in QALYs, can be multiplied for the estimate cost for year according to recent European data, be Eq. (5).

$$Pt = PDFm^2yr \text{ and } (PDFm^2yr) * 1{,}4 = euro \tag{3}$$

$$Pt = MJ \text{ and } MJ * \frac{0{,}00411}{lifetime} = euro \tag{4}$$

$$1\ QALYs * 74.000 = euro \tag{5}$$

The three monetary values (in euro) are summed to obtain a unique SA value.

Such a method has two main implications to practices: it is general and can be carried out for assessing PSS as well as product since the lifecycle will be simplified by considering only product-oriented activities. It has three main advantages: providing a global overview according to a lifecycle approach; anticipating the sustainability impact analysis and supporting early decision-making as it can be adopted until the preliminary design stage; and carrying out comparative analyses since it well addresses product-services as well as traditional products. Such a method applies a metric-based approach, which can be usefully adopted in design to compare investigate specific aspects of VMEs (e.g. collaboration, knowledge management, etc.) [17-18].

4 The Product-Service Case Study

The case study has been realized in collaboration with Indesit Company, a world leader in household appliances. The company actually designs, produces and sells product and leads a vertical supply-chain. The case study aims to investigate the idea of proposing no more products but services for Indesit Company and its ecosystem. In particular, it focuses on washing machines and analyses the so-called "EasyWash service": it provides the washing machine rent for free, a supply agreement comprising the washing energy and the detergent supply by paying an annual fee, and a web/mobile application for machine monitoring and customer training. The "EasyWash service" aims at creating a direct relationship with the customers by facilitating the product use in two ways: providing a turnkey solution able to make the machine ready to use and educating the customers in a correct use and energy/cost saving practices.

Such service requires realizing a PSS that comprehends the product, the service and the infrastructure. The case study product is a new prototype derived for the commercial Hotpoint Aqualtis model, the service is realize by an advanced on-board display and a mobile application as the local and remote user interface, and the infrastructure is composed mainly by an embedded Zigbee module that allows data to be sent by a local gateway, and an Internet Wi-Fi router to make data available for the"EasyWash service" application.

The research questions are: which is the global impact on sustainability of the new PSS solution? How do they change for different use scenarios? Which are the achievable benefits in respect with the traditional product? How are they distributed within the VME? And how to optimize the sustainability for each ecosystem actor?

4.1 The Virtual Manufacturing Enterprise

The case study considers a real VME, which is actually working together for the development of some research projects. The VME members and their correlation with the PSS lifecycle phases are briefly described. *Indesit Company*: it is the product (washing machine) manufacturing company and it participates by involving different departments (R&D, marketing, service, IT). Its role is crucial in product manufacturing and service implementation, and it also participates in PSS creation, commercialization and delivery. *Bticino*: it is a leader in electrical installations distribution and it supplies high innovation electronics for the implementation of the "EasyWash service". It is involved in product manufacturing and in service implementation by providing the necessary electronic components and sensors. *Softeco*: it is an Italian software company that cares about the software infrastructure of the "EasyWash service" and the development of its application and user interfaces. It is mainly involved in the PSS creation. *Energy Utility (reserved)*: it provides a customized service for the "EasyWash service" energy consumption. It is involved in the PSS use and operation phases and it cares about the environmental and economic impacts for energy. *Detergent producer (reserved)*: it supplies the detergent for the service use and provides marketing offers to consumers. It participates in the PSS use and operation phases. *Dismantling Consortium*: it cares about the PSS end-of-life and decommission. *Customers*: they are the main actors during the PSS use and operation phases and they charge of the service agreement costs and water consumption.

4.2 The Use Scenarios

The use scenarios investigate the user profiles representing different lifestyles. They differ for the average number of cycle executed in a fix time period (week): *House Manager (HM)* (4,3 cycles/weeks), *Efficiency Seeker (ES)* (5,8 cycles/week), and *Delegator (D)* (3,9 cycles/week). Data derive from a European investigation carried out by Indesit Marketing. The service agreement is assumed as the same for each scenario: customers pay an annual fee (e.g. 120 euro/year) to have the “Easy Wash Service” comprehending the machine, the energy and the detergent supply, and the mobile app. So energy and detergent consumptions and costs are in charged of the VME. Contrarily, water consumption is in charge of the user as traditionally. The analyzed impact will vary according to the considered lifetime: for washing machine the average lifetime is 10 years.

4.3 Results and Discussion

In order to answer the research questions presented in section 4, the proposed method has been applied to each use scenario. As a result, the impacts have been separately calculated and then normalized and summed. The analysis has been repeated for the traditional product by considering different lifetimes. Table 1 shows the comparative analysis values for 10-year lifetime. Results demonstrate that PSS is globally more advantageous (lower impact) for all the points of view (environmental, economic and social) and for all the analyzed use scenarios. Benefits are almost proportional to the washing use (more intensive is the use, greater are the benefits). Subsequently, the PSS impacts have been investigated along the lifecycle and in relation to the VME members’ contributions.

Table 1. Sustainability assessment of PSS and traditional product for the use scenarios

10-year lifetime	**House Manager (HM)**		**Efficiency Seeker (ES)**		**Delegator (D)**	
	Product	**PSS**	**Product**	**PSS**	**Product**	**PSS**
Environmental Impact LCA (Pt)	365,96	339,60	419,20	382,84	376,60	350,24
Economic Impact LCCA (euro)	€ 488,03	€ 413,35	€ 565,99	€ 464,12	€ 496,71	€ 410,31
Social Impact SLCA (QALY)	8,9 E-04	7,58 E-04	1,21 E-03	1,01 E-03	9,41 E-04	8,07 E-04
Sustainability Assessment SA (euro)	**€ 565,94**	**€ 480,67**	**€ 669,47**	**€ 551,86**	**€ 578,56**	**€ 481,58**

Table 2 shows the detailed data for the House Manager scenario and a 10-year lifetime. Expressing the single impact by percentage allows highlighting the most critical phases, where the VME should work to optimize the global sustainability. Results from Table 2 reveal that the product manufacturing company has the highest environmental impact due to product manufacturing, but the economic impact is limited. Diversely, the Detergent producer has the greatest cost while the environmental impact is limited. The dismantling Consortium has negative environmental impact as it allows recycling and reusing some items. In this case the VME should work to reduce the costs associated to detergents and improve product sustainability. Analysis of the other scenarios showed that the VME impact distribution does not vary. Such an investigation can be carried put also over the years to provide an overview of the PSS advantages along the lifetime and compare different business models for the VME. Such results could be further exploit to realize a sustainable VME able to efficiently manage a specific PSS solution. It can be a new evaluation metric to be inserted in novel collaborative design systems [19].

Table 2. PSS impacts distribution in the VME

House Manager PSS scenario *10-year lifetime*							
VME	**PSS lifecycle phases**	**Environmental Impact**		**Economic Impact**		**Social Impact**	
		Pt.	**%**	**euro**	**%**	**QALY**	**%**
Indesit Company	PRODUCT manufacturing	230,52	67,7 %	€ 25,79	6,3 %	1,33 E-04	17,54 %
	SERVICE implementation	6,13	1,8 %	€ 23,45	5,7 %	9,42 E-05	12,43 %
	PSS creation	14,77	4,3 %	€ 11,72	2,8 %	4 E-06	0,53 %
	PSS comm. & delivery	0,23	0,2 %	€ 111,37	26,9 %	-	
Bticino	PRODUCT manufacturing	18,66	5,5 %	€ 7,03	1,7 %	1,09 E-04	14,38 %
	SERVICE implementation	28,87	8,5 %	€ 5,86	1,4 %		
Softeco	PSS creation	23,35	6,8 %	€ 11,72	2,8 %	4,38 E-05	5,78 %
Energy Utility	PSS use/operation	54,95	16,2 %	€ 29,31	7,1 %	3,35 E-04	44,19 %
Detergent producer	PSS use/operation	48,65	14,3 %	€ 170,92	41,3 %	2,24 E-04	29,55 %
Consumer	PSS use/operation	2,99	1 %	€ 15,47	3,7 %	2,11 E-05	2,78 %
Dismantling Consortium	PSS EoL/decommission	- 89,52	- 26,3 %	€ 0,70	0,3 %	- 2,06 E-04	- 27,17 %
TOTAL IMPACT		**339,60**	**100%**	**€ 413,35**	**100%**	**7,58 E-04**	**100%**

5 Conclusions

The paper proposes a methodology to support PSS ideation and VME configuration by assessing PSS sustainability. It allows investigating the impacts of PSS as well as products along the lifecycle phases with respect to three impact categories: environment, economics and social wellbeing. Its validity is demonstrated by an industrial case study proposing an "EasyWash service" in comparison with traditional washing machine selling and use. The impacts are investigated in relation to the involved VME to identify the necessary optimization to improve the global sustainability. The method can be extended to other services and application scenario.

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The Service-Dominant Ecosystem: Mapping a Service Dominant Strategy to a Product-Service Ecosystem

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Abstract. Nowadays product-oriented companies are facing the need to focus on the service rather than the product alone. By following a Service-Dominant Strategy, we need to focus on the ecosystem embodying the collaboration to provide such a service. This collaborative perspective on value creation and value sharing is the foundation for designing new business models within the ecosystem. We take the lessons learned in the car-leasing domain on the development of a Service-Dominant Strategy to design a tool supporting the transition from product focus to Product-Service ecosystems.

Keywords: service dominant strategy, service dominant logic, servitization, product, service, ecosystem, value.

1 Introduction

Nowadays, it is widely assumed that manufacturing firms need to offer services and solutions delivered through their products to survive in developed countries [1]. Moreover, the shift from goods to service has been in process since the early 1990s as the role of manufacturers producing and selling products in value chain has become less remunerative [2]. This shift has been driven by external and internal factors. Examples of external factors are new possibilities of business growth in mature industries by extending the range of manufacturers towards services and customer demands on solutions. Example of internal factors are financial savings and revenues, where companies such as Xerox shift from producing and selling copy machines to document management systems solutions, perceiving service-orientation as a survival strategy [3].

The *Servitization* of manufacturing is a term first mentioned as a competitive manufacturing strategy by adding services to products to create value [4]. Manufacturers have been going downstream the value chain by focusing on activities (such as financing, maintenance and spare-parts) by looking on how the product is being used by the customers at the end of value chain [2]. This results in an integrated product-service offering by the manufacturer. However, this product-service integration by manufacturers is just seen as a linear production process where the manufacturer adds value to its products through services [5].

The organizational shift from goods-centric towards a service-centric organization is highly relevant for the development of the so-called “Service Science”. “Service Science

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 22–30, 2013.

is an emerging interdisciplinary field of inquiry that focuses on fundamental science, models, theories and applications to drive service innovation, competition, and well-being through co-creation of value" [6]. The change from goods towards solutions is recognized as an academic research priority for the science of services [6].

The challenges of developing value propositions for service-goods offerings is being recognized as a tremendous opportunity for practitioners and researchers in the service arena. This owes to Goods-Dominant organizations rarely recognizing the need to develop goods-service value propositions. Furthermore, research and management tools development has been focusing on the goods-dominant mindset within the value chain. Service-focused tools built under a service-dominant mindset are however needed by the service science research field to foster adoption by practitioners [6]. Hence, we see a research opportunity for a management tool constructed on the service-dominant mindset with a focus on the service-product ecosystem as a whole rather than the traditional value chain.

We found especially interesting the shift from product to service in the asset-finance domain, particularly in car leasing where lessors rely on vendor assets to offer their service. Moreover, the pure focus on the assets lifecycle as a revenue source seems to be no longer enough to sustain the business in a Service-Dominant business landscape.

In this paper we build on our previous work on Service-Dominant strategy definition [7]. We devise a tool to map a Service-Dominant strategy into a complex ecosystem able to support the above-mentioned manufacturers' transformation from products to service solutions providers. We built our tool using our experience on such a transition in the car-leasing domain. Our tool overcomes the typical value chain-based view on servitization by allowing the identification of complex networks of actors, activities, and value propositions constituting the product-service ecosystem.

The paper is structured as follows: In Section 2, we introduce the Service-Dominant Strategy. In section 3, we establish a transition to the ecosystem concept. In Section 4, we visualize the Service Dominant Ecosystems. In Section 5, we discuss the results our lessons with the car-leasing domain. Finally, we draw our conclusions and briefly outline future work.

2 Background the Service-Dominant Strategy

In this section we focus on the Service-Dominant Strategy as a plan to acquire and deploy the service-dominant mindset within the organization and as a new way of doing business [7], [8].

Nowadays, the shift from product to service is being conceptualized as a mindset shift from Goods-Dominant (G-D) Logic towards Service-Dominant (S-D) Logic. The G-D Logic is the traditional manufacturing logic that focuses on the value chain: a product is produced and then value is added through services. The S-D logic focuses on the benefits of adding services, where products are just a mechanism for service provision. This mindset focuses on the value networks and value propositions [9].

The mandate of the S-D Strategy is to focus on operant resources and service flows, to find innovative ways to integrate them for service provision. These service flows can be part of the organization or outside the organization, involving other actors of the ecosystem. Furthermore, Information Technologies (IT) can support this service-orientation by the management and integration of service flows within the service ecosystem.

Our strategic focus is on the value-in-use, where the value is seen as a benefit for the customer and not on the product or services. For instance, when a customer purchases a driller the value is on the job of making holes by using the driller for the buyer and the value for the seller derived from selling the driller. This is known in the S-D Strategy as value co-creation.

Flexible organizational boundaries are required to foster the collaboration within the ecosystem. Moreover, the interactions of actors within the network are bidirectional, i.e. a consumer and a producer at the same time can contribute to value creation within the ecosystem. This co-production is achieved by empowering the actors with the right tools to participate actively in the ecosystem.

The ecosystem orchestrator integrates the service flows from different actors resulting from their co-production activities by offering the integrated value proposition at a price that includes the risk of their collaborators. Furthermore, the benefits should be ethically shared among the participants. This does not include only financial benefits, but other forms of benefit such as knowledge acquisition.

Once this strategic view is embraced, we need to take the steps to facilitate the design and communicate businesses following a Service-Dominant strategy.

3 Transitioning from Service-Dominant Strategy towards an Ecosystem

A S-D Strategy sets the plan and the perspective on doing business. Moreover, strategy is a set of choices on how the business is being conceptualized. However, to operationalize the strategy we need to reflect these choices into business models.

The business model concept is used to describe value creation and value appropriation. Current business model conceptualizations are focused at the value chain level rather than the network level. This follows the G-D Logic foundation on the manufacturing industry, from raw material, to production of goods and then value added services. By following a S-D Strategy, we need to look at the collaborations between actors to co-create value. This view requires focusing on the value network and the company ecosystem rather than the internal perspective on the value chain. Hence, we start the operationalization of the Service-Dominant Strategy towards business models at the ecosystem level.

We can think on the ecosystem as a collaborative business model tool, where we focus on value creation and appropriation at the network level, beyond the boundaries of one organization. Furthermore, we can view the ecosystem as the operationalization of the S-D strategy by establishing our value network of value propositions as a product-service system [10].

Servitization is also linked to the Product-Service System (PSS) literature [5]. The PSS concept arises as the embracement of a service-led strategy to differentiate from companies that offer low cost products. A PSS is defined as ‘an integrated combination of products and services that deliver value in use’ [11]. Furthermore, these integrated solutions can be viewed as integrated service-product combinations, tailored to create desired outcomes for the customer [12]. A PSS emphasizes the value in use as a solution, rather than the sale of a product [11]. For instance, the value in use can be seen in companies like Rolls-Royce, which deliver power-by-the-hour to airlines as a combination of jet engines (products) with monitoring (services) [12].

In contrast with manufacturing companies, service-based companies are more flexible towards a multivendor system tailored to customers' need. [12]. However, multivendor companies that rely on adding value form vendor's assets with services could easily face disruption on their business if the ecosystem is not defined and managed properly. Hence, we need to establish an ecosystem to see how a company should collaborate with different actors within a value network.

4 The Service-Dominant Ecosystem

In this section, we present a tool to design and communicate ecosystems derived from a S-D Strategy. This strategic view suggests focusing on collaborations at the network level of actors. We conceptualize the ecosystem as follows: Firstly, an ecosystem comprises heterogeneous entities such as businesses, firms, and customers, i.e. the ecosystem *actors*. Secondly, these entities interact with each other to achieve shared goals, i.e. *value co-creation*. Thirdly, these entities can be viewed as socio-economic actors, connected through *value propositions*. Finally, entities perform *actions* aimed at reaching desired outcomes, such as mutual value creation through co-produced solutions and experiences [13].

We further elaborate the service ecosystem concept by developing an artifact to describe and communicate the ecosystem level driven by a S-D strategy, that is, the Service-Dominant Ecosystem. The resulting ecosystem is presented in Figure 1 as concentric circles and slices. Each actor of the ecosystem is represented as a slice of the concentric circles connected to the inner circle that represents the common co-creation goal of the ecosystem. From outside in, the concentric circles are used to represent the ecosystem collaboration of each actor as follows: firstly, the cost and benefits of each actor; secondly, the co-production activities of performed by each actor and thirdly, each actor's value proposition.

As shown in Figure 1, we describe the Service-Dominant Ecosystem as a networked perspective requiring an Actor-to-Actor perspective focused on value co-creation by integrating each actor's value propositions. Moreover, each actor has an active role in the ecosystem by performing activities that are reflected as costs and benefits for each one. We first exemplify the elements using the Spotify ecosystem to describe each element of the S-D ecosystem as follows.

Value Co-creation. The ecosystem goal is value co-creation defined in terms of value-in-use. We define the core of the ecosystem as the experience or solution that we want to co-create with the ecosystem actors. For instance, the Spotify ecosystem co-creates a music listening experience.

Ecosystem Actors. The S-D Logic aims at overcoming the producer and consumer divide by pointing out an Actor-to-Actor (A2A) perspective emphasizing the heterogeneity of business entities. Such an A2A focus drives away the traditional manufacturing logic based on the liner process of value creation driven by the value chain [13], [14]. For instance, in the Spotify ecosystem, besides the company we can distinguish free users, paying users, record labels, original equipment manufacturers (OEMs) and application developers.

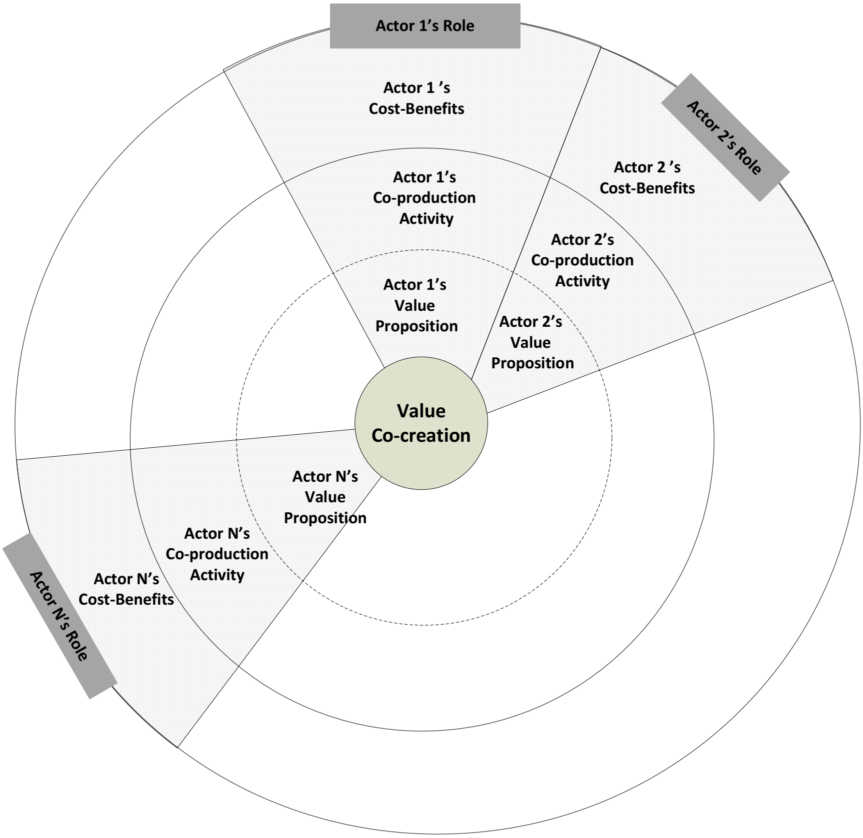

Fig. 1. The Service-Dominant Ecosystem

Actors Value Propositions. The value propositions is what each actor delivers to the ecosystem. This can be thought as a network effect, where the value proposition of one actor enhances the overall value for the same or other group of actors. These are known as *same-side* and *cross-side* network effects, respectively. For instance, in the Spotify ecosystem a same-side network effect is achieved when more users bring more content to other users into the ecosystem and a cross-side network effect is achieved when music content generated by application developers creates value for the users by improving listening choices [15].

Co-production Activities. Each actor performs activities in the ecosystem to deliver value propositions. For instance, in the Spotify ecosystem, users participate in the ecosystem by creating and sharing playlists, developers participate by creating music applications, and record labels participate by providing their music libraries.

Costs-Benefit Sharing. The actors incurs in costs and obtains benefits by participating into the ecosystem. These costs and benefits are driven by the need to share benefits and establish the cost of the actors in the collaboration. For instance, in the Spotify ecosystem the record labels incur in cost of signing artists and get the benefits of monetary license fees.

In Figure 2, we analyze the ecosystem of Spotify to illustrate how our tool works. The goal of the ecosystem as value-in-use is represented at the center of the figure, in this case the music listening ecosystem. The actors are identified as a slice of the circle, where we can identify the *orchestrator* as Spotify, *partners* such as record labels and advertisers, *complementors* such as original equipment manufacturers (OEMs) and application developers. At last we have *prosumers* like free and premium users. Each actor performs a co-production activity, for instance the free premium users create and share playlists, and OEMs provide connected hardware. The value propositions are presented as increased value on the ecosystems, for instance the value proposition at ecosystem level is to provide more access points to listen music.

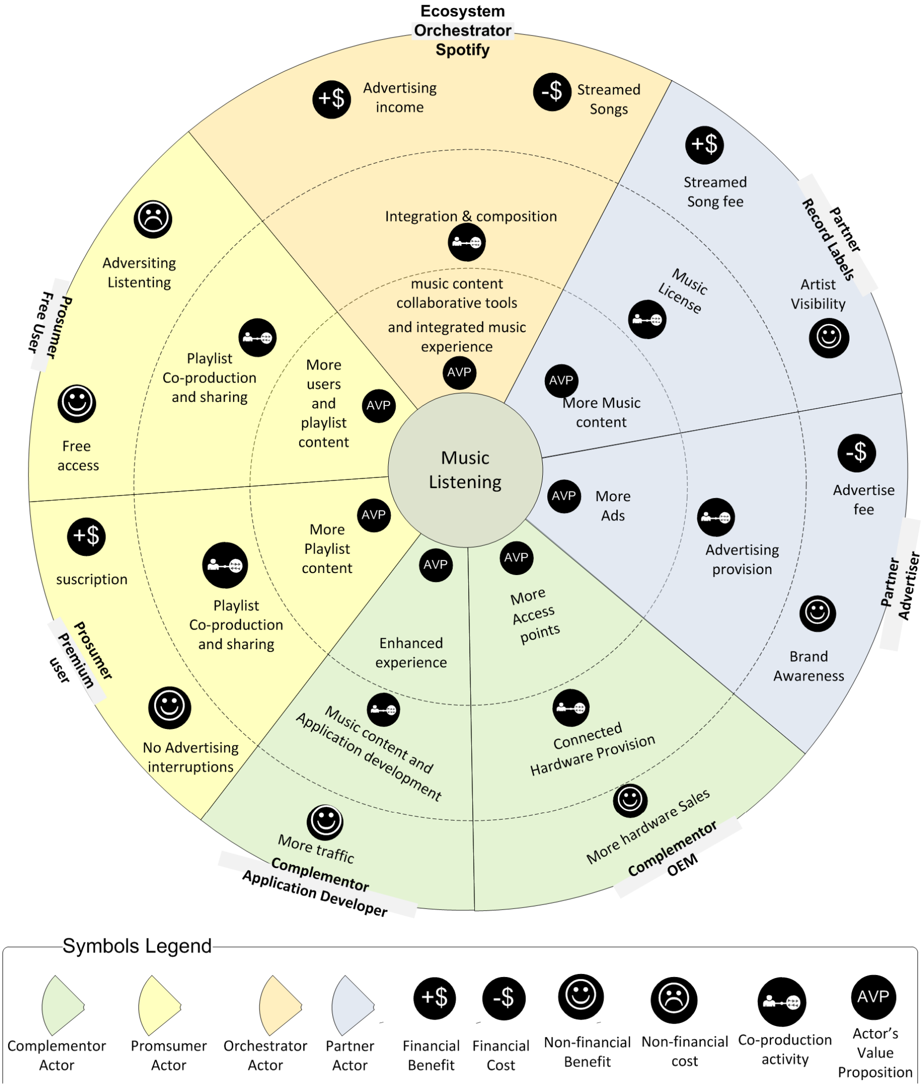

Fig. 2. The Service-Dominant Ecosystem of Spotify

In the next section we discuss the lesson learned by applying our artifact to a more complex case in the mobility scenario (car leasing).

5 Defining the Service Ecosystem in Mobility

We have been collaborating with the biggest car leasing company in the Netherlands to support their transition from the product focus, e.g. leasing cars, towards a service focus,

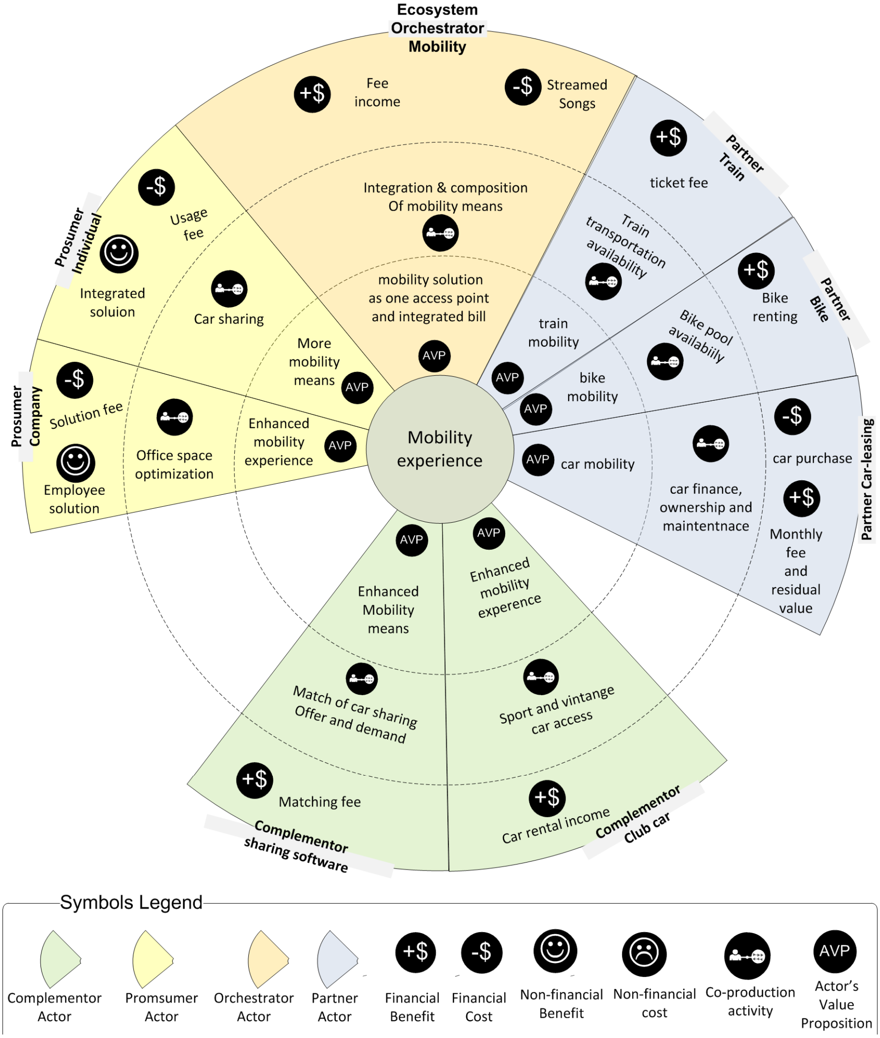

Fig. 3. The Service-Dominant Ecosystem in Mobility

i.e. provide a mobility solution. This transition is needed to satisfy the needs of contemporary customers requiring flexibility in their mobility needs. The Dutch company has more than fifty years of experience and currently operating in Belgium, France, Germany, Luxembourg, the Netherlands, Poland, Portugal and Spain. The company belongs to a Dutch asset-finance group present in 35 countries with a lease portfolio of €23.3 billion and 4,965 employees.

In Figure 3, we show the mobility ecosystem derived from a Service-Dominant strategy applied with the mobility transformation team of the company. The inner circle shows the co-creation goal of ecosystem: mobility experience. The actors of the ecosystem include the mobility orchestrator as the new role of the company. Partners provide different mobility means in form of bikes, train trips and cars. The prosumers are individuals participate actively by sharing cars and companies that participate by optimizing the location of the employees according to their mobility needs. The complementors sharing software and car club participate respectively by offering extended mobility means and enhancing the mobility experience.

The tool let us to identify the power of network effects within the ecosystem. For instance, the sharing mechanism acts as a same-side effect by bringing more mobility means to other individuals. An example of a cross-side network effect is the benefit by the car club to individuals thanks to an enhanced mobility experience. Nowadays, the car-leasing company understands the need of other ecosystem actors to achieve their mobility goal. Moreover, the company understands that the value is no longer in the car, but in the mobility experience driven by the ecosystem.

6 Conclusions and Future Work

In this paper we discussed the Service-Dominant Ecosystem as a tool to design an ecosystem around the value-in-use concept. In a nutshell, the Service Dominant Ecosystem facilitates the understanding of the collaboration of different actors by brining different value propositions to form a product-service system. This system integrates value propositions form different kinds of actors. We applied our tool to the well-known example of Spotify and then we discussed the lesson we learned by using our tool in the car-leasing domain, supporting a company in the transition from product- to service-focus.

The Service-Dominant ecosystem brings a holistic perspective on the business by visualizing it at the network level in which the company participates. This holistic view enables focusing on the collaboration and the different value propositions of each actor, rather than just the internal value chain. Hence, the service-dominant ecosystem leads to new business opportunities in collaboration with others business actors to co-create value. Moreover, the tool facilitates the identification of the network effects. These are usually harder to realize when focusing solely on the internal value chain of a company.

As future work, we are further testing the ecosystem tool with practitioners and use the ecosystem to identify new business models. Moreover, we will further elaborate the mobility ecosystem and identify new business models to help the car-leasing company transitioning towards mobility. We will also focus on the mapping between the ecosystem and the technological landscape to execute the service orchestrations identified within the ecosystem.

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Industrial Transition through Product-Service Systems: Proposal of a Decision-Process Modeling Framework

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Abstract. In this paper, we attempt to explain that Product Service Systems (PSS) are not based solely on technical and functional aspects, but that organizational and collaborative aspects are also involved. Thus, we propose a servitization analyzing approach that highlights the need to manage the complexity of the iconic functional and decisional areas related to this strategy. We propose a transition process conceptual model adapted from a modeling framework for business decision-making processes (GRAI framework and tools).

Keywords: servitization, transition, decision, ecosystem.

1 Introduction

Current trends of economic and population growth have been exerting pressure on the environment. The actual business environment overview is characterized by market volatility and instability. Increased competition is about to weaken the sustainability of classic differentiation strategies based on product innovation, technological empowerment or lower prices [1]. Since then, differentiation based on product and prices are presently less significant factors, while service competencies are becoming core differentiators in business relations [2]. Therefore, during the last decades, we have witnessed a paradigm shift through the development and spread of servitization and Product Service System (PSS) concepts. A product-services system (PSS) is implemented as an innovation strategy that shifts the focus of a business from developing and selling physical products to developing and selling a system of products and services capable of fulfilling specific demands of clients [1]. But also, turning to this new paradigm requires questioning business interaction within a defined ecosystem and, organization' roles and goals.

We develop in this paper three main parts. First, we introduce the basic concepts of the servitization process. The objective of the second part is to illustrate our approach of servitization modeling, for which we propose a generic decision model construction. In the third part, we apply and validate this approach through a case study of a manufacturing company in a servitization process.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 31–39, 2013.

2 Servitization: Transformation of the Economic Relationships within Business Ecosystem

The main objective of this section is to present servitisation from a decisional point of view: servitization can be understood and formalized as a complex decision process of enterprise transformation, which changes several aspects of its economic relationships within a business ecosystem. We present below key dimensions of this decision process. To extend a systematic approach to strategy, we adopt Moore's vision of a company viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries [3].

In this paper, we express an analytical vision of servitization through focusing on a specific focal company interacting with its ecosystem. This transitioning focal company is considered as the central network productive node and as the main driver of the PSS offer. This transformation affects the company on different levels: through its strategy, its internal processes and competencies, as well as its external network relationships. In fact, servitization leads to rethink the enterprise positioning within its ecosystem, the various parties involved with it and the different relationships between parties. This research work aims at modeling and controlling the decision-making process deployed by the company along the servitization transformation project.

Transitioning to servitization is defined as a decision-making process, which generates information and knowledge progressively through temporal sequences according to each specific context. This is the system adopted by an organization to move from a current economic model (product-oriented offer) towards a servitized economic model (integrated product and service offer). A PSS business model is often accompanied by new types of partnerships among stakeholders such as producers, retailers, customers and end-of-life managers with connected economic interests and shared vision of desirable outcomes for 'system resource optimization' [4]. Broadening PSS thinking beyond focusing on an individual product to a wider social-technological system that incorporates multiple actors, perspectives, and approaches may simultaneously increase customer satisfaction, profits and eco-efficiency [5].

We propose to decompose the global servitization process in 3 decisional issues which cover key dimensions of the business transformation:

1. The product service system (PSS) technical design;
2. The PSS business model transformation;
3. The organizational changes, required to support the PSS implementation.

Each of these decisional issues contributes to redesign the positioning of the focal company in its ecosystem with different interaction levels. Indeed, the first decision issue represented emphasizes the services' intangible nature, service delivery requires then a delicate process of value proposition [1]. The second issue encountered in the servitization process is to predict the market behavior vis-à-vis this new offering. Therefore, servitization leads to consider a new form of competition outside the usual expected rivals within an ecosystem [6]. In addition, the third issue considers the adaptation of organizational structures and processes necessary to ensure congruence between their resources and capabilities implementing this new strategy [7].

Thus, the transformation of a manufacturing company to a product service organization confronts a set of challenges that we summarize in the three problematic domains underlined. These domains are also included as areas having different functional characteristics of complementarity. In addition, they can play a role of catalyst in the dynamics of the transition process: the company often initiates the transition by using one of the domains as an entry point.

In the following sections, we present a way to model this complex decision process and to provide diagnosis tools dedicated to a better management of servitization.

3 A Modeling Framework for the Servitization Decision-Process

In reference to a state of the art in Enterprise decision-making modeling [8], we have selected the formalized modeling proposed in GRAI method as the most appropriate to our research problem. GRAI method is a decision-making modeling framework that focuses on businesses in general and specifically on production systems [9]. Additionally to the decision-making orientation, the contribution of GRAI is also due to its ability to represent the complexity of servitization process, through a systemic view of the process. To represent the complexity of a decision process, GRAI grid considers simultaneously distinct functions of the system through functional areas, and, a notion of decision-making levels characterized by the concept of decisional horizons. Additionally, interacting among decisions is represented with coordination mechanisms among the different decision centers considered in the GRAI grid. GRAI modeling framework can then be applied to represent the servitization decision-making process in a systemic multi perspective approach.

We model this decision making process through three basic concepts:

- Macro-Process (MP): corresponds to a functional decisional domain, and comprises a coherent set of decisions on an overall goal. In addition, each MP includes specific types of actors within an ecosystem.
- Critical Decision Process (CDP): represents all decision-making processes involved within a macro process, whose output is likely to have a significant impact / importance on the overall transition process.
- Decision Activity (DA): represents a basic/elementary decision. In a decision-making process of transition, a set of decision-making activities (DA) represents the finest decomposition level of each critical decision making process (CDP).

These concepts will be used later in the servitization modeling process. We specify below the servitization decision model using 2 formalisms proposed by the GRAI method: the decision-making grid system and the decision-making networks. In this paper we illustrate only the decision-making grid.

3.1 Constructing the GRAI Grid for Servitization

An overview of this decision model is provided by a GRAI grid adapted to servitization process. This grid allows classifying specific functional transition areas, and decisional horizons: it requires specifying two axes (vertical and horizontal) of the GRAI grid.

3.1.1 Vertical Axis: Three Decisional Horizons

The vertical axis in the GRAI grid is linked to the decision's horizon: long, medium and short term. This aspect of the decision clarifies crossing from high strategic-decisional level to tactical and operational ones. This distinction allows:

- To define the strategic objectives considered by the manufacturer through the servitization transition on a long-term horizon ensuring the sustainability of the firm and minimizing the harmful effects on the environment.
- To establish the necessary resources to make the transition on a medium-term horizon for achieving the above objectives. Essential resources relate to capabilities, business networks and internal and external skills necessary to achieve this strategic change.
- To perform processing operations on a short-term horizon to achieve the strategic servitization objectives. Here, the target is about to define the specific action plan in terms of operational decisions, guided by performance indicators that can ensure a good consistency between the strategic objectives and the available resources.

This characterization of the decision-making process sheds light on the transition process advancement in time and the strategic objectives decomposition into operational objectives.

3.1.2 Horizontal Axis: Three Macro-processes

According to GRAI approach, this axis is related to the decision's specific functional domains. We identify functional areas in the decomposition of servitization on three Macro-processes (MP) representing the three problematic issues in a manufacturer servitization process introduced above. These MP comprise the horizontal axis in the GRAI grid:

1. MP1: the product service system (PSS) technical design;
2. MP2: the PSS business model construction;
3. MP3: the Organizational changes, required to support PSS implementation

These MP aim at explaining the problematic complexity of a servitisation transitioning planning. They are also included as areas having different functional characteristics of complementarity and which involve different linkages to the ecosystem's actors. In fact, servitization requires an effort that moves beyond the capabilities of the only transitioning business, it involves complex coopetitive links between different actors; it involves an entire business ecosystem. Planning the PSS value design, the production forces and the commercializing requires understanding its firm's ecosystem ability and capacities to maintain sustainable working flows. In order to achieve its goals, a transitioning company should accommodate to its ecosystems' specificities, they are larger, more diverse, and more fluid than a traditional set of bilateral partnerships. By leveraging ecosystems, companies can deliver complex solutions while maintaining corporate focus [10].

3.1.3 Critical Decision Processes and Decision Centers

In the GRAI modeling framework, decision-centers represent the intersection between a functional decision area and a decision's horizon. To identify servitization DC, we consider that they are directly linked to the concept of critical decision-making processes (CDP) introduced above.

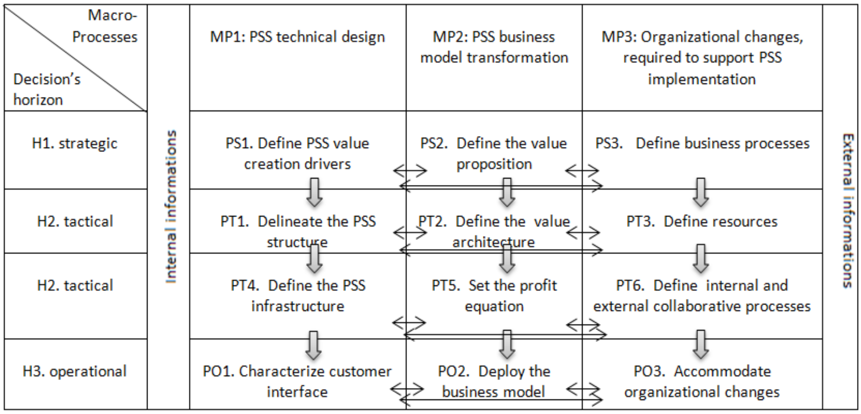
We have made a specific literature review on each MP to identify the critical decision-making processes nested within it. For clarity, in this paper, we limit our explanation to the MP2: Business-model transformation, and the associated DC (the approach is the same for the 2 others MP).

To decompose MP2 into several CDP, we adopt the following Business Model definition [11] articulated through three dimensions:

1. The value proposition: it describes the "what?" and reflects the offer attractiveness to the customer. It includes the target market segment, and the proposed offer.
2. The value architecture: it describes the "How?" and is defined as the set of the implemented tasks by the company to achieve delivering the value proposition to the customer. It includes the internal value chain definition of the company and its value network.
3. The profit equation which explains the origin of profitability by combining the revenues, costs and capital employed. It reflects the economic viability of the BM.

These 3 BM dimensions induce the creation of 3 CDP, which will also correspond to decision centers. Then, we decided to add a fourth dimension in the above definition, which is the deployment of the BM, describing the implementation of the BM on the market in terms of operational decisions.

Finally we thus consider four critical decision-making processes; each of them corresponds to a specific DC. Within the structure of the GRAI grid (see Figure 1), the first dimension corresponds to a long-term horizon, and embodies strategic decisions while the second and third correspond to a medium-term horizon, they embody tactical decisions. Finally, the fourth dimension corresponds to a short or very short term that embodies operational decisions.



Macro-Processes / Decision's horizon	Internal informations	MP1: PSS technical design	MP2: PSS business model transformation	MP3: Organizational changes, required to support PSS implementation	External informations
H1. strategic		PS1. Define PSS value creation drivers	PS2. Define the value proposition	PS3. Define business processes	
H2. tactical		PT1. Delineate the PSS structure	PT2. Define the value architecture	PT3. Define resources	
H2. tactical		PT4. Define the PSS infrastructure	PT5. Set the profit equation	PT6. Define internal and external collaborative processes	
H3. operational		PO1. Characterize customer interface	PO2. Deploy the business model	PO3. Accommodate organizational changes	

Fig. 1. Generic servitization transition decisional model

3.2 Illustrating the Servitization GRAI Grid

From the foregoing, we explained the followed process to build the framework in analogy with the GRAI modeling logic and to reflect the evolution of the servitization decision-making process.

The construction of the GRAI grid (Figure.1) allows visualizing the flows trade between different decision centers vertically and horizontally. These trade flows are primarily informational (thin arrows) and decisional (thick arrows). This model allows understanding the complexity of the overall transition process, identifying different backgrounds decision attached to them and delineating the functional areas in MP. In addition, the GRAI grid differentiates the granularity level of the decision-making process from strategic to operational objective level and from general to particular within each DC.

Moreover, analyzing the sevitization GRAI grid situates inherently the ecosystem's importance in the approach. Indeed, the focal enterprise linkages with its ecosystem appear at two levels: the first level concerns the informational domains (internal and external) and its influence on the collaborative mechanisms of the transitioning firm. The second level concerns more specifically the composition of each CD, from this point of view, we consider the importance of taking into account the main actors of an ecosystem. In that sense ecosystem plays a relevant role in orienting the global orientation of a servitization trajectory.

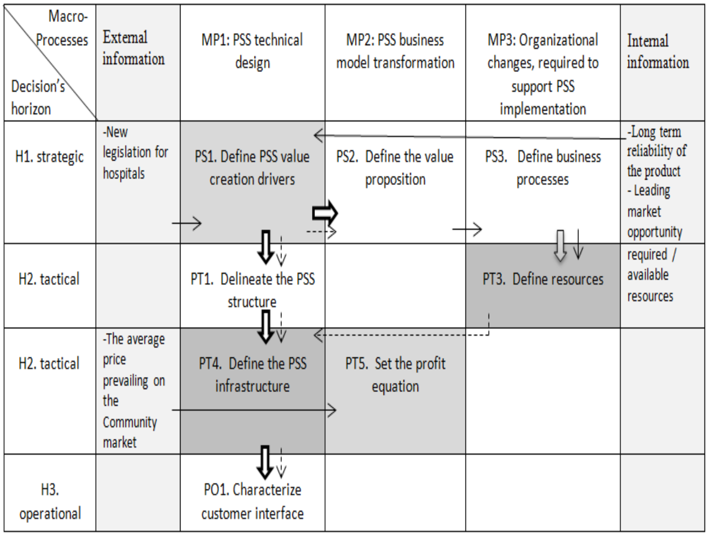
4 Case Study: Ecobel

4.1 General Presentation of Ecobel

To concretely illustrate our approach, we propose an application on a case study of a French SME named Ecobel. The company's main activity is the manufacturing, sale and installation of shower heads based on an innovative technique that allows water savings and protecting from legionella. The company accounts in its current market basically establishments receiving general public. Ecobel is planning to adopt a servitization model for its offering, so the company has initiated a debate on the implementation of a servitization strategy and decision-making process. This case study has aroused our interest because of its positioning in the transition process. Indeed, Ecobel currently offers two models: the classic offer selling only the product of showerhead and the integrated PSS offer selling PSS: showerheads reliable over 5 years. The PSS offer includes service contracts of regular maintenance and periodic exchanging of the product of showerheads with a visual identification. Ecobel's leader highlights the difficulty of placing it on the market. The main barriers to the commercialization of the proposed PSS lie in the difficulty of its value measuring and to convince potential customers of it. Ecobel remains cautious about the development of servitization model on its entire range.

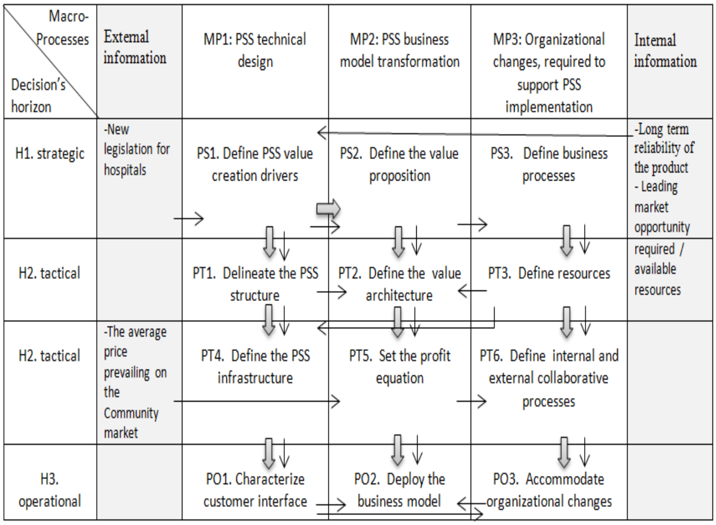
4.2 Instantiating the GRAI Grid on Ecobel: A Comparison between the Reference Model and the Current Model

We undertook a process of qualitative data collection through 3 semi-structured interviews with ECOBEL's leader over a period of 3 months. This data collection has allowed instantiating the generic GRAI grid transitioning process relatively to ECOBEL.



Macro-Processes / Decision's horizon	External information	MP1: PSS technical design	MP2: PSS business model transformation	MP3: Organizational changes, required to support PSS implementation	Internal information
H1. strategic	-New legislation for hospitals	PS1. Define PSS value creation drivers	PS2. Define the value proposition	PS3. Define business processes	-Long term reliability of the product - Leading market opportunity
H2. tactical		PT1. Delineate the PSS structure		PT3. Define resources	required / available resources
H2. tactical	-The average price prevailing on the Community market	PT4. Define the PSS infrastructure	PT5. Set the profit equation		
H3. operational		PO1. Characterize customer interface			

GRAI grid Ecobel "current model"



Macro-Processes / Decision's horizon	External information	MP1: PSS technical design	MP2: PSS business model transformation	MP3: Organizational changes, required to support PSS implementation	Internal information
H1. strategic	-New legislation for hospitals	PS1. Define PSS value creation drivers	PS2. Define the value proposition	PS3. Define business processes	-Long term reliability of the product - Leading market opportunity
H2. tactical		PT1. Delineate the PSS structure	PT2. Define the value architecture	PT3. Define resources	required / available resources
H2. tactical	-The average price prevailing on the Community market	PT4. Define the PSS infrastructure	PT5. Set the profit equation	PT6. Define internal and external collaborative processes	
H3. operational		PO1. Characterize customer interface	PO2. Deploy the business model	PO3. Accommodate organizational changes	

GRAI grid Ecobel "reference model"

Fig. 2. Comparison of Ecobel's GRAI grids "reference model" and "current model"

Using a comparative approach, we performed the instantiation of the GRAI grid in two stages. We carried out the construction of the GRAI grid specifically to the firm's decision-making process. This *current model* translates the followed servitization approach of ECOBEL. Then this tracking model is compared to a *reference model* built to ECOBEL's data but anticipates a servitization path which is finite and consistent. The instantiation of the generic model refers to ECOBEL's characteristics to define the decision consistency over the grid's lines and the decision concordance over the grid's columns. In a hypothetic-deductive approach, *the reference model* represents the "supposed to be followed" trajectory, as shown in Figure 2.

The instantiation of the generic model highlights ECOBEL's closer exchanges of information and decision-making between decision centers (DC). The analysis of the current and reference models can be addressed on three levels:

1. Structure of the Grids: the objective is to highlight the apparent differences between the *reference model* and the *current model* of servitization. The comparison of the two grids underlines the absence of certain DC in the current model. As the absence of a set of information and knowledge would have a significant impact on the overall missing critical processes, we consider it as a total failure of missing DC. In addition, although some CDP are actually represented in the *current model*'s grid by their current DC, this does not automatically imply the efficiency of their results. In fact, some DC reflect a failure in their elemental composition in terms of decision-making activities. We consider this as a partial failure that spreads through generated information and decisions flows. Shades of color saturation mentioned in the *current model* then allow assessing the level of failure of the present DC. To locate the origin and degree of a DC failure, we should return to the networks that constitute the GRAI DC, which is not presented in this paper.

2. Information System: represented through the flow of internal and external information in the grids. Information orients the servitization decision-making system. The lack of certain information's elements can cause the DC malfunctioning. In fact, every DA generates a stream of data elements necessary to achieve the next activity. This interdependence produces the spread of possible malfunctions through the information exchanged.

3. Horizontal and Vertical Exchanges between DC: aiming to highlight the consistency and concordance linking between DC. The DC' vertical exchanges analysis, on a specific MP of the grid among three horizons, clarifies consistency between the decisional centers. The DC horizontal analysis brings information about exchanges between the three functional designated areas on a specific horizon (line of the grid), and clarifies concordance between DC.

The exploratory case study of Ecobel, allowed a concrete illustration of our approach to modeling servitization transition process. GRAI tools instantiated on Ecobel's features enable visualizing the composition of the GRAI grid. Then, the comparison between the reference model and the current one allowed us to highlight the origins of the difficulties in advancing the servitization process of this firm.

5 Conclusion

This research work emphasizes the systemic nature of servitization process. The analyzing approach proposed aims at decomposing the complexity of servitization decisional process and then at facilitating its management by the manufacturer. The complexity of the decisional servitization process impacted by the ecosystem dynamics may discourage the decision makers, because of too many risks to consider. Thereby this research work introduces a perspective of servitization process diagnosis for manufacturing companies. The objective is to emphasize and explain decision-making process potential failures and inconsistencies in order to avoid managerial risks.

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Simulation-Based Service Process Benchmarking in Product-Service Ecosystems

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Abstract. Increasing market competition leads to a differentiation of service providers by offering hybrid services as value added services. In product-service ecosystems the effectiveness of cross-company business processes constitutes a major competitive factor. In this paper, we present a procedure model for simulation-based process benchmarking in the domain of industrial service procurement. In focus are cross-company business processes in service networks in bilateral collaboration scenarios of service providers and service consumers. A systematic analysis of performance indicators measures reveals weaknesses and potential for improvement. A set of hands on uses cases realizes validation and evaluation of yielded benchmarking results.

Keywords: service processes, service procurement, benchmarking, business process simulation.

1 Introduction

Current surveys highlight that services will constitute an integral element of many products creating value offerings to customers [1]. Industrial services being a part of product-service systems (PSS) gain importance. These value added services are delivered through external service providers granting availability and reliability of industrial facilities and infrastructures. Industrial services make a significant share of companies total spending and ensure required operational levels and availability of systems and facilities. For the procurement of industrial services, organizations consisting of service providers and service consumers interact in product-service ecosystems. The paper is focusing on how the collaboration and interaction of organizations can be measured and improved. Our presented research approach is based on case studies of a research and standardization project [2][3].

2 Product-Service Ecosystems for Service Procurement

Today digitalization is omnipresent and increases competition between companies. New developments in ICT (information and communication technologies) require

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 40–47, 2013.

companies to create new innovative value offerings for their customers combining products and services in order to sustain on the market. Hence, the ability to integrate and share products and services offerings of external business partners turns out to be a major competitive factor in future. In consequence, service suppliers take focus on supporting customer's processes or even offering to take offer whole or parts of its value creation processes (through outsourcing). Service suppliers and service consumers are collaborating in so-called industrial *service networks*. These networks are part of product-service ecosystems. In these service networks, the production of services is in focus. Since service consumers request different service types from different service suppliers, new ways of flexible collaborations are emerging. The internal and cross-company business processes describing the administrative processes for the procurement of services are called *service processes*. The collaborations are always confronted with similar challenges: The missing harmonization, integration and standardization of cross-company service processes. Therefore creation of new collaborations suffer from low quality of business interactions caused by integration and transaction costs, manual exception handling, offline communication (media breaks) and procurement times; also resulting in less transparency and low quality of processes and data. In focus of industrial service procurement is an integrated perspective of goods and services [4][5].

Service E-Procurement and E-Business-Standards. The use of e-business solutions supports strategic and operative procurement activities, resulting in lower costs and improved competitiveness. *Service e-procurement* constitutes an important segment of e-business activities. It compasses extensive use of ICT to improve productivity and business processes. Effective service procurement requires looking at distinct phases (encompassing planning, negotiation, delivery to payment). Respective automation of a business process, in whole or in part results in an electronic process. In electronic business documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules [6]. Electronic processes support business interactions reducing interfaces, process and throughput times and support harmonization of meta data, activities, procedures and integration of resources. *E-business standards* support a shared process understanding and increase process transparency amongst business partners by harmonization and structuring of exchanged business data. In this way, e-business standards facilitate enhanced interoperability. For the domain of service e-procurement, various e-business standards do exist, however, do not adequately support service procurement operations, lacking appropriate business objects (documents, information) and required service logic of respective procedural rules and control flows.

Challenges. Business processes and respective exchange of documents and information lack harmonization. Business processes must support procedural rules and service logic of required business interactions and communication between service suppliers and requesters [4] [5]. Industrial service procurement is still source of high cost because underlying business processes are error prone. Errors and failures occur foremost through the absence of coherent e-business standards and reference frameworks offering meta models of processes, data objects and interaction patterns taking into account the service logic. Although, a variety of e-business standards and frameworks is available, they typically cover solely parts and phases of business processes, and are cause of numerous media breaks and inefficiencies such as manual error and exception handling, decreasing productivity of service operations. Due to these challenges, collaborations in service procurement networks seek for standardized, optimized and key performance indicator based service processes.

3 Quantitative Evaluation of Service Processes

To meet the challenges described above, a quantitative evaluation of service processes identifies further improvement opportunities. A quantitative analysis of service processes validates pre-defined service process targets based on best practices and leading companies. The result is the improvement of the efficiency (performance) and productivity of the business processes. The process efficiency does have several impacts, hereto especially the following improvements are of interest like the reduction of process costs, reduction of process times, reduction of process throughput time, the improvement of process quantity, improvement of process transparency and increase of process flexibility. Service processes of administrative order processing in product-service ecosystems in the domain of service procurement weren`t drew much attention. These service processes need many resources, long process times and throughput times. Inefficiencies result from the internal and especially cross-company handling und coordination of transactions und non-harmonized and non-integrated electronic service processes.

Business Process Simulation. *Business process simulation* (BPS) [7][8][9] can used to support business process benchmarking and furthermore BPS can be seen as a part of business process improvement (BPI) [10]: the continuous progression of market competition by a continuous comparison of market competitions and adaption of business processes. In the domain of service procurement, different service process variants, internal and company-wide service processes in product-service ecosystems can be compared. The efficiency of service processes in service collaborations can be measured by defining different service process simulation models. Those simulation model variants of simulation models can be simulated. For the execution of simulation runs, relevant process inputs and process parameters have to be defined. Possible scenario variants are order volumes as process input or the amount of human resources. The execution of simulation experiments can be used to gain insights about a real system at build time [11]. The advantages of business process simulation experiments are [8][12][9]:

- Most real systems cannot be analyzed by analytical methods
- Simulation models allow for analysis in different environments and under different conditions and lower risks and can easily be changed and adapted
- The behavior of business processes can be analyzed on a much broader scale and alternative developments can be syntactically and semantically analyzed and visualized
- Simulation experiments are repeatable and can be designed easily and executed in a cost-efficient way

- Systems can be simulated in very short or very long time periods. A simulation experiment takes less time than real experiments and no experiments are executed on real systems so they are not endangered
- Different action alternatives and scenarios can be simulated to gain important statement prospectively

Business Process Benchmarking. Camp [3] defines *benchmarking as "the search for solutions, based on the best methods and procedures of the industry, the best practices, to lead a company to top performance"*. Benchmarking is a method to compare products, services and business processes. A systematic analysis of performance differences and their cause helps to detect possible improvement potentials. Benchmarking is a continuous process to compare business processes across different companies. Therefore differences and causes as well as possibilities for further improvements will be detected. Target dimensions of benchmarking are quality, costs and times and customer orientation. Types of benchmarking of companies are *internal* and *external* benchmarking. An internal benchmarking is company-related (internal benchmarking). An external benchmarking is market-related (competitive benchmarking of best practices) [13]. The *process benchmarking* serves as an instrument to expose existing deficits like productivity and performance gaps, lacking process transparency and lacking link between strategic and operative targets. The analysis of service processes serves as identification and provision of mission critical data for a performance comparison to identify potentials for improvement. In the domain of service procurement inefficiencies of service processes result from sequential process flows, multistage processes, poor data quality of information flows, insufficient customer-supplier-orientation, poor information transparency and non-value creating activities. In product-service ecosystems in the domain of service procurement, service customers and service supplier are benchmarking partners. Different combinations of service customers and service supplier can be benchmarked pairwise to compare and improve the business process performance.

4 Procedure Model for Simulation-based Service Process Benchmarking

For the execution of simulation-based service process benchmarking, a procedure model in dependence on Neumann [7], Schuster [12] and Wildemann [14] is presented. The procedure model defines a structured approach for the quantitative evaluation of service processes. In order to meet the requirements in line with business process benchmarking, an adequately structured procedure model needs to be defined. The described approach extends and details a phase oriented procedure model for the analysis, modeling, simulation and benchmarking of business processes in product-service ecosystems. The procedure model combines the advantages of business process simulation and business process benchmarking in a common approach. Bilateral collaborations of service consumers and service suppliers can be benchmarked. In Fig. 1, the procedure model is shown with its cyclic different phases.

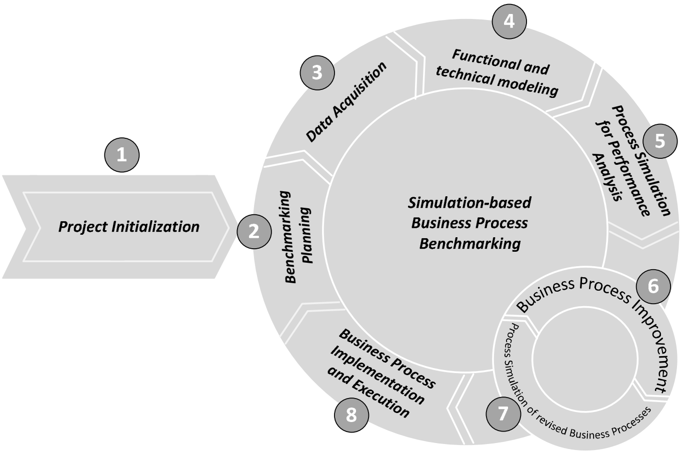

Fig. 1. Simulation-based business process benchmarking procedure model

Project Phases. The procedure model consists out of eight process phases:

1. ***Project Initialization*:** The organizational determining factors are defined. The fundamental target of the project and the project scope as well as the involved people and organization units are defined. Data and information suppliers are defined and the project specific framework like resources, budget and timeline are determined. Based on strategic planning, targets are refined to derive tactical and operational targets.
2. ***Benchmarking Planning*:** The target definitions of service processes have to be reviewed continuously. In the benchmarking planning phase, benchmarking targets are defined. Benchmarking objects are defined like the analysis area, the choice of structured business process models, needed resources, benchmarking-partners, key performance indicators and methods. Conditions are defined for the execution of benchmarks with the benchmarking partners. For the modeling and simulation of business processes, a modeling language and a modeling and simulation tool has to be chosen.
3. ***Data Acquisition*:** Process inputs and process outputs of the business processes are defined. The existing process flows are analyzed and comparative data of potential benchmarking partners are collected. Secondary data sources are also used.
4. ***Functional and Technical Modeling*:** Technical framework requirements are defined for the technical modeling. Requirements for resources are determined. During the functional modeling, service processes and service objects are modeled. In the context of a hierarchical process modeling, service processes are modeled on different abstraction layers. During a successive refinement, service processes are modeled on a high modeling layer and complex activities are consecutively refined. Hierarchical service process models combined with a modularization of service processes support the decomposition and application of service processes.

5. ***Process Simulation for Performance Analysis*****:** For the business process evaluation, key performance indicators are selected and defined. Critical factors and main influence factors are specified. The service processes are simulated. Based on the simulation evaluation of service processes, possible patterns can be identified. The simulation of service processes is executed for a longer time period. After the simulation, the simulation model has to be verified and validated. For the verification, the transformation of the process model into a simulation model is analyzed. For the validation, the reproduction fidelity of the process model and the fidelity of the simulation parameters based on the simulation results are analyzed.
6. ***Process Improvement*****:** Targets of process improvements are defined and possible process alternatives are generated. Based on alternative process flows, improved process structures can be identified and realized. The process model is configured with alternative parameters in order to enable a comparison between different configurations und their implications on the process model.
7. ***Process Simulation of Revised Business Processes*****:** Improved service process models or different service process model variants are simulated. The phases of process improvement and process simulation of improved business process are iterative: improved process models and variants can be simulated until the target definitions are met. The process simulation of the revised business processes ends with the preparation of the simulation results.
8. ***Business Process Implementation and Execution*****:** The improved service process models can be implemented to operate a business. Change management has to be executed for practical training and mind change of personal resources.

5 Evaluation of the Procedure Model

The procedure model for simulation-based service process benchmarking serves as an approach to strengthen the competition position of a company. Business process simulation complements business process benchmarking and serves as an adequate method. The advantages of business process simulation increase the value of process benchmarking. The execution of a process benchmarking identifies differences of relevant factors like throughput times, resource assignments or cost items. The causes of performance gaps can be analyzed. Based on benchmarks, performance gaps can be quantified. Redundant service processes and non-value creating activities can be identified. Possible automation potentials for service processes can be identified and the error data is reduced. Also the cost-effectiveness of service processes can be ensured. Problems of the simulation-based service process benchmarking evolve due the comparability of service processes and the effort for the information search of competitive company data. However, the information retrieval of other companies can be difficult as a result of losing competitive advantages. For the simulation models, a realistic model calibration has to be found. The identification of benchmarking objects, the modeling of service processes and process evaluation acquires some effort.

Benchmarking of Service Processes in bilateral Service Procurement Networks. The method of simulation-based service process benchmarking has been successfully applied in a research projects in the domain of service procurement [4]. The service process models of 18 use cases between six service suppliers and four service customers were analyzed, modeled, simulated and benchmarked. The evaluated uses cases were compared pairwise for benchmarking applying the presented procedure model. Service process models were modeled with service nets [15], a higher petri net variant of XML nets. The modeling of service nets was based on a reference process model to structure and align the individual service processes. For the modeling and simulation of service process models, the software tool Horus [6] was used for a software based simulation. As key performance indicators for obtaining relevant conclusions about the efficiency and performance of the analyzed service process models, we were concentrating on the process time, the process throughput time, used human resources and media breaks. For the benchmarking of several service procurement use cases in bilateral collaboration scenarios, historical data from real business process evaluations were used to calibrate the simulation process models [5]. As process input, the data amount of service orders per day, the time period of a year, the average amount of resources, the amount of failure checks and repeating activities like double work and the process and process throughput times were taken. As business process simulation method, a discrete event driven business process oriented simulation was used [9]. The strengths of this approach are the independent simulative analysis of the real system and the possibility of a "*playground*" by simulating different process alternatives. Evaluation of simulation results can shed light on correlations of system parameters at build time and can be used to develop action strategies [7]. Therefore alternative resource configurations in business processes and their allocations can be simulated and possible impacts on process times and process throughput times at run time can be identified. Unlike analytical procedures, the simulation can be used for the analysis of large systems. Weaknesses are the abstraction of the simulation models since with an increasing abstraction level, the granularity of model descriptions of the real system decreases. Also the dependency of data input for the benchmarking approach can be an obstacle. As a main implication of our analysis results, we can state that the benchmarking approach based on process simulation can serve as an adequate analysis method for a long-term process evaluation. Limitations exist due to the characteristics of the simulation and the derivation of the appropriate conclusions and measures.

6 Conclusions and Outlook

In this paper, a procedure model for the simulation-based service process benchmarking was presented. The procedure model offers an adequate proposition of an efficient way for the quantitative evaluation of service processes for benchmarking of bilateral collaborations in product-service ecosystems. The procedure model combines two efficient approaches for the quantitative evaluation of business processes: business process simulation and business process benchmarking. The integration of business process simulation for benchmarking allows for cost and effort efficient way to analyze and improve service processes in product-service ecosystems. This approach was evaluated from real-life case studies [5]. Next steps foresee to elaborate further detailed steps for this approach. Further benchmarkings of business process models in different domains are planned.

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GloNet: Service-Enhanced Products

Interplay of Collaborative Networks in Product Servicing

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Abstract. Application contexts such as the support to service-enhanced products require the interplay of various collaborative networks along the product life-cycle. Based on the solar energy parks case, various long- and short-term networks are identified and their inter-dependencies briefly analyzed. A cloud-based collaborative environment is developed to support the various types of networks. Presented results are achieved in the context of the GloNet project.

Keywords: Collaborative networks, service-enhanced products, cloud computing.

1 Introduction

Most past works on Collaborative Networks have focused on a single network form, e.g. a Virtual Organization (VO). In some cases the interactions between two forms of network have been analyzed, namely the interactions between a Virtual organizations Breeding Environment (VBE) and the VOs created within that VBE [1]. Some application cases, however, require the interplay among several networks. That is the case of enterprise networks to support service-enhanced products [2].

In this case, in addition to an underlying VBE, various VOs can be foreseen namely for product manufacturing, designing the business services to enhance the product, providing multi-stakeholder composite services, etc. The reason for this need is that different stakeholders play a role at different stages of the product life-cycle. The collaborative efforts in each stage have a different purpose, and are carried out by different groups of members, although some members might be common to various networks. The life-cycles of the various networks and their duration are also different. For instance, while a service design / service co-creation VO is short-term, a service provision VO might have a long duration accompanying the life of the product. The service provision VO might include some members of the service design VO but in any case some inheritance mechanism between the two needs to be established.

On the other hand, in the context of a collaborative network various other formal and informal networks may emerge. Formal networks are regulated by explicit contracts or agreements. For instance, during the operation phase of a product, and thus in the context of its service provision VO, a need for a new service might be detected, what might trigger the formation of a temporary VO for the co-creation / co-design of the new service. Informal networks, which do not involve any formal contract, emerge as "aggregations" of entities that share some common interest, often

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 51–60, 2013.

a case of communities of practice or social networks. These networks are often seen as the glue that holds together cross-functional process improvement initiatives or the seed for product / service co-innovation processes [3].

Understanding the interactions and dependencies among multiple collaborative networks is thus an important research challenge. This work aims at contributing to this challenge through a service-enhanced product case study conducted in the context of the GloNet project.

2 Related Areas

In the areas of complex networks and social networks analysis (SNA) the concept of overlapping sub-networks or communities is widely addressed. In recent years, considerable effort has been put on developing algorithms for overlapping communities' detection [4], [5], [6], [7]. The notion of *community* in this area, although not very well defined, typically represents a cluster or group of nodes that interact with each other more frequently than with those outside the group. As such, the aim of community detection algorithms is to identify groups of nodes more densely interconnected relatively to the rest of the network, i.e. resorting to information encoded in the graph topology.

Unfortunately, the notion of *network* in these areas, although conceptually attractive due to the clear mathematical properties that can be associated to the graph representation, also presents some limitations when applied to collaborative enterprise networks. For instance, the links between nodes are typically of the same kind, abstracting some form of connection (e.g. information interaction). In collaborative enterprise networks, the interactions among network members can be of very diverse types e.g. control relations, reporting relations, information flow relations, material flow relations, etc. Some approaches in SNA try to capture this diversity of relations through the notion of *multiplexity*, which comes from early literature in the area based on the realization that human relationships are normally multiplex or multi-stranded. It was also considered that a multiplex relation is stronger than a uniplex relation because it contains more than one basis for interaction [8], which led then to the notion of relation's *strength*. But such simplistic notion does not fully capture the individual semantics of the various relations and as such does not adequately support management strategies for the networks. In spite of some works on multiplex networks, the underlying mechanisms of multiplexity remain poorly understood [9]. One interesting attempt to analyze multiplexity in the context of inter-organizational networks, and particularly to understand the role of social and economic ties in the formation of dense multiplex ties is the work of Ferriani et al. [9].

The methods explored in the areas of complex networks and SNA certainly have applicability in various problem areas, namely when basic data on nodes and links exist and the purpose is to extract / discover structural properties. In the case of collaborative enterprise networks however, the "starting point" and the granularity of the analysis are usually different. The problem is not so often to identify the existence of a network / community and its members; the members are often known and the membership is established through some "contract" or agreement, which reflects some common objective. Within such collaborative group, many interactions of different nature might occur but they are not always known a-priori, or at least, it is not the existence of data on such interactions that lets us identify the existence of the CN. In this sense, there are fundamental differences in the scope and approaches of the two areas.

The challenge in CNs is not to study the links/ties and their structural properties (or even how they emerge) – which are typical of a “link-oriented analysis” – but rather to progress on understanding aspects such as: Membership dependencies, time dependencies, purpose / goal dependencies, and inheritance dependencies between networks and also their supporting environments.

3 Service-Enhanced Products Case

The notion of service-enhanced product, also known as product-service, resulted from the need to increase product differentiation and the value of product offers. By associating business services that add value to the products, greater forms of differentiation can be achieved and new business opportunities generated since buyers of manufactured products increasingly want more than the physical product itself [10].

After decades of industrial decline, due to deliberate policies that advocated an exclusive move toward a service-oriented society, while neglecting the production of tradable goods, many countries have lost part of their industrial competitiveness in the manufacturing sector. The service-enhancement of products, and particularly the introduction of knowledge-based services, will likely help regaining competitiveness and facilitate some form of sustainable reindustrialization. Ties with end-users and local suppliers are vital in manufacturing supply chains, adding not only valuable know-how and multidisciplinary expertise while better fitting customer needs, but also increasing potential access to new markets. The agile formation of service provision networks associated to customized products and the effective involvement of the customer and local stakeholders allows for both (1) opening opportunities for manufactured goods combined with high value added services, and (2) an optimized mobilization of resources and competencies from different geographical regions. Furthermore, this approach will contribute to a transformation from a resource-intensive to a knowledge-intensive industry.

In line with this trend, GloNet, a project funded under the Factories of the Future program of the European Commission, aims at supporting complex, highly customized and service-enhanced products through collaboration with customers and local suppliers [11]. The project assumes that collaboration and co-innovation in business services, supported by Internet and cloud computing, open new perspectives of value creation in this context. GloNet started in September 2011 with a planned duration of 3 years, and involves the following organizations: CAS (Germany), UNINOVA (Portugal), University of Amsterdam (Netherlands), iPLON (Germany), SKILL (Spain), Steinbeis (Germany), KOMIX (Czech Republic), and PROLON (Denmark). The main use case in GloNet focuses on the production and life cycle support of solar energy parks [12]. The primary aim is thus to develop a solution to promote and facilitate collaboration among partner companies in this industry, while improving the process of designing, developing, monitoring and controlling solar plant installations. In addition to this use case, and in order to extend the applicability of GloNet results, other domains with similar abstract characteristics, such as building automation and physical incubators of enterprises, are also considered.

The effective development and life-cycle support of service-enhanced products in these domains involve the interplay of different forms of collaborative networks (Fig. 1), including long-term strategic networks and goal-oriented, short- and long-term networks, comprising a wide variety of stakeholders and roles. In summary:

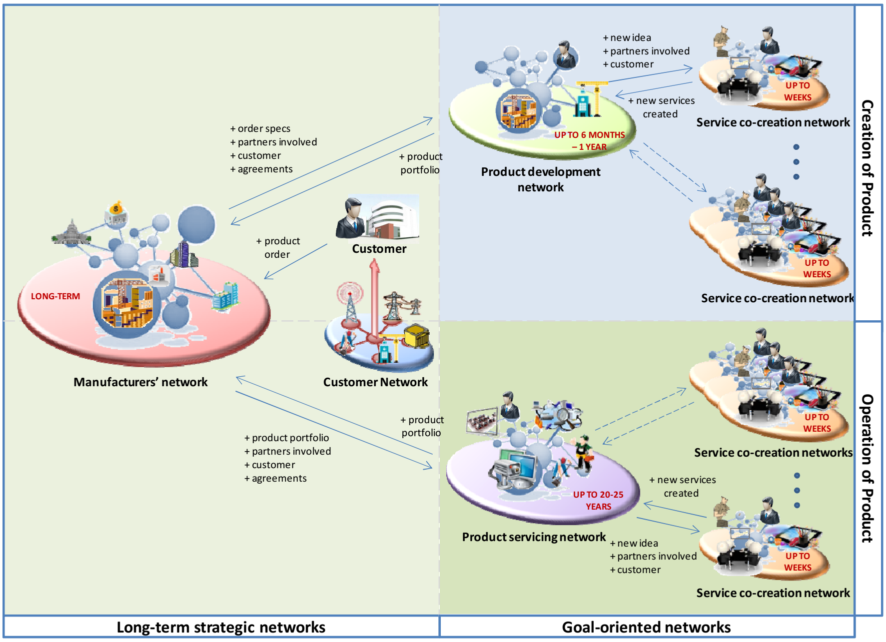

Fig. 1. Mix of collaborative networks in product development and servicing

- *Manufacturers' network* – a long-term alliance that typically involves product / project designers, manufacturers, service providers, and some support entities, configuring a kind of virtual organizations breeding environment (VBE) [13].
- *Customer "network*"- or *customer related community* - involving, besides the customer, local non-critical components suppliers, services providers, and a variety of support entities. Although this group might not be well organized and structured, it shares some minimal bonds like geographical vicinity, culture, business environment, legal regulations, etc.
- *Product servicing network* – a long-term VO organized to provide integrated or composite (multi-stakeholder) business services along the product life-cycle. In the case of the solar energy domain, an example of such network can include a monitoring and supervision company, maintenance companies, training provision entities, etc. This network needs to work in close interaction with the customer and other local stakeholders, namely regulators, utility companies, insurance companies, etc.

- *Service co-creation network* – a dynamic (temporary) virtual organization (VO) involved in the design and development of new business services associated to the (physical) product. Since this area is the least developed, creation of new business services typically requires a co-innovation process carried out by a temporary consortium involving a number of participants selected from the Manufacturers network and Customer network or Product Servicing network.

Table 1 summarizes the main characteristics of these networks, based on the analysis of the solar energy parks use case.

Table 1. Summary characteristics of networks involved in service-enhanced products

Network	Aspects	Description
Manufacturers' network	*Purpose*	To jointly acquire new businesses (products and associated services).
	Membership	In the solar parks case: Project development firms, Engineering, Procurement & Construction (EPC) companies, PV equipment manufacturers, Monitoring & Control companies, Construction & Commissioning companies.
	Time	Long-term alliance (a kind of VBE)
	Inheritance	The product portfolio of this VBE will integrate the outcomes of the various product development VOs and service co-creation VOs.
Customer's "network"	*Purpose*	As it is not a formal network, it does not have a direct goal; nevertheless, the general sustainability of the associated region can be seen as a common goal.
	Membership	In the solar parks case: Customer (owner), Utility company, Lending organization, Government agencies, Insurance companies, Operation & maintenance companies, other suppliers, etc.
	Time	Long-term community
	Inheritance	It has access to the benefits of the product and its associated services.
Product development network	*Purpose*	To design and manufacture a new customized product.
	Membership	Typically includes members selected from the Manufacturer's network the Customer's network. Example: Project development companies, EPC, PV equipment manufacturers, Construction & Commissioning companies, Monitoring & Control companies, Lending organization, Insurance company.
	Time	Short/Medium-term VO
	Inheritance	The outcome of this VO will be inherited by the product-servicing VO and will become part of the product portfolio of the manufacturers VBE.
Product servicing network	*Purpose*	To provide integrated (multi-stakeholder based) business services along the life of the product.
	Membership	Example: Operation & maintenance companies, Monitoring & Control companies, Utility company, etc.
	Time	Long-term VO
	Inheritance	It has access to the results of both the product development VO and service co-creation VO.

Table 1. (*continued*)

Service co-creation network	*Purpose*	To design a new service for the product, following a co-creation process.
	Membership	It might include members from the product development network or from the product servicing network (depending on the time of launching), combined with some elements from the customer's network, including the customer.
	Time	Short-term VO. Different service co-creation networks can be launched during the operation phase of either the product development VO or the product servicing VO, according to identified needs for new services.
	Inheritance	The outcome of this VO (the service design) will be inherited by the service provision VO. In case the service is generic enough to be exploitable in other products, it is also inherited by the manufacturers' VBE.

4 Support Environment

In order to support the life-cycle and interplay of the various collaborative networks involved in service-enhanced products, an ICT support environment is developed in GloNet according to the general architecture illustrated in Fig. 2.

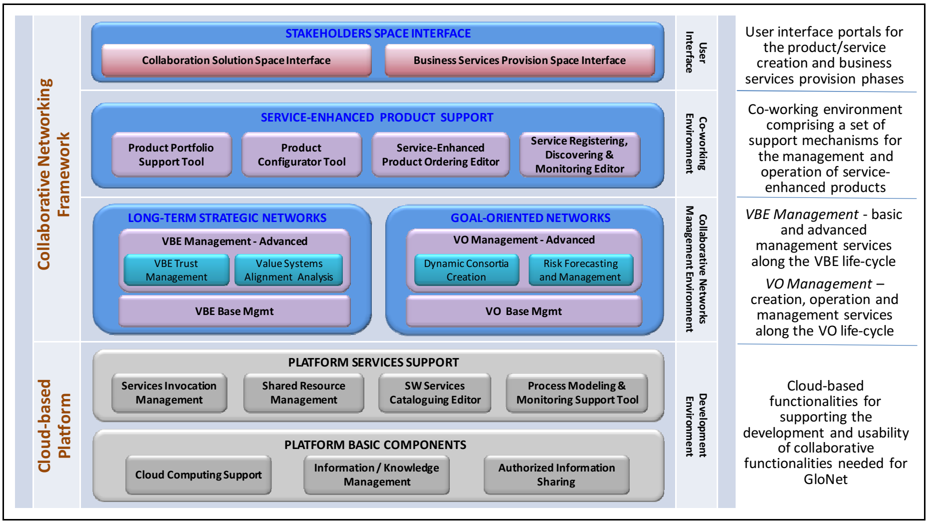

Fig. 2. GloNet system architecture

This system consists of two high-level modules, namely:

- *Cloud-based Platform* – which aims at providing the enabling cloud services for giving support to the development and usability of collaborative functionalities needed for GloNet.

- *Collaborative Networking Framework* – which aims at providing functionalities needed for collaboration spaces and to support the different forms of collaborative networks, comprising a wide variety of stakeholders that get together in order to create service-enhanced products.

These two high-level modules of the architecture are then divided into a set of layers.

One of the main components of the CN Framework is the VBE management subsystem, whose functionalities, inspired on ECOLEAD [14], are illustrated in Fig. 3.

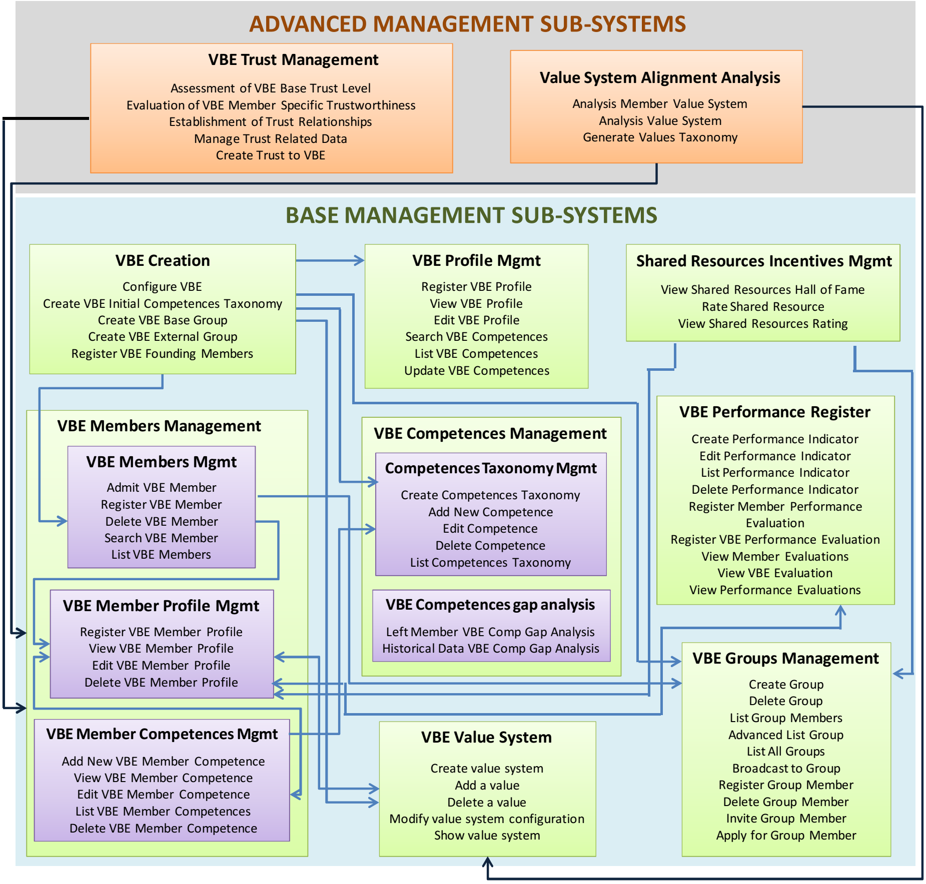

Fig. 3. VBE Management functionalities

Another important component is the VO management system, to support the various goal-oriented networks. As an example of the modules included in this component, the functionalities to support the VO creation are illustrated in Fig. 4.

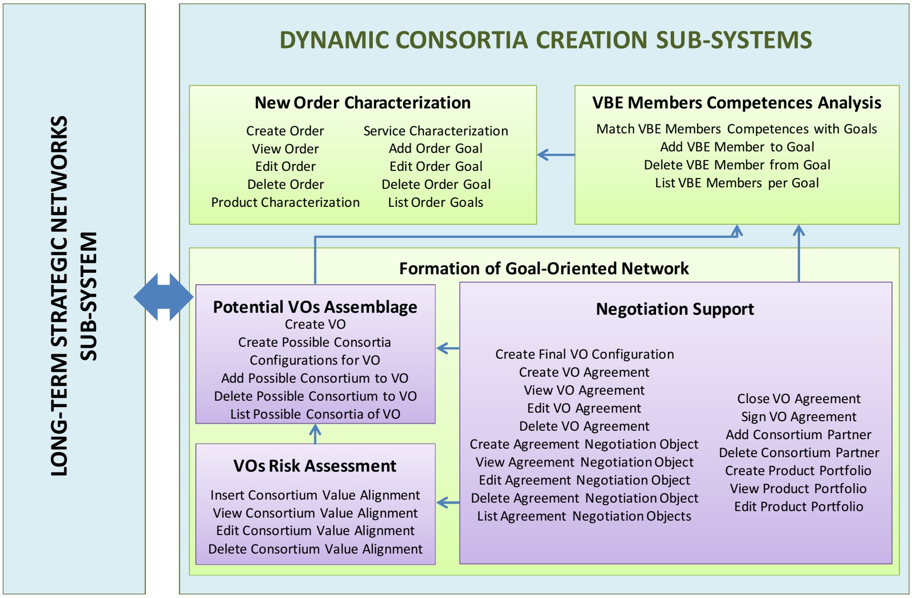

Fig. 4. VO Creation functionalities

On top of these components, GloNet introduces a *co-working environment* that comprises a set of support mechanisms for the management and operation of service-enhanced products, including product and service configuration, product portfolio management, user interfaces, etc.

At the *user interface* layer there are two portals: the *Collaboration Solution Space Interface* that aims at providing an access point through which manufacturers, local suppliers and customers "meet" to co-create the product and its associated services; and the *Business Services Provision Space Interface* that aims at providing an access point to the “registry” of the products along their life-cycle through which customers can have access to the specific services associated to the customized product.

The GloNet system is developed on top of a cloud-based platform. Besides the initial lower cost in setting up the cloud's hardware as compared to conventional physical local setups at every company, factors such as ease of servicing, upgrading and maintaining suggest a cloud-based infrastructure as a promising environment for this context. There are, however, various aspects to be better assessed, e.g. vendor lock-in, integration of components running in different infrastructures, and the associated business models.

Considering the above support functionalities, Fig. 5 illustrates the process of selecting partners for a VO creation. In this example, potential partners are selected from both the VBE (e.g. Manufacturer's network) and the Customer's "network" (indicated as *External Interested Stakeholders* in the diagram).

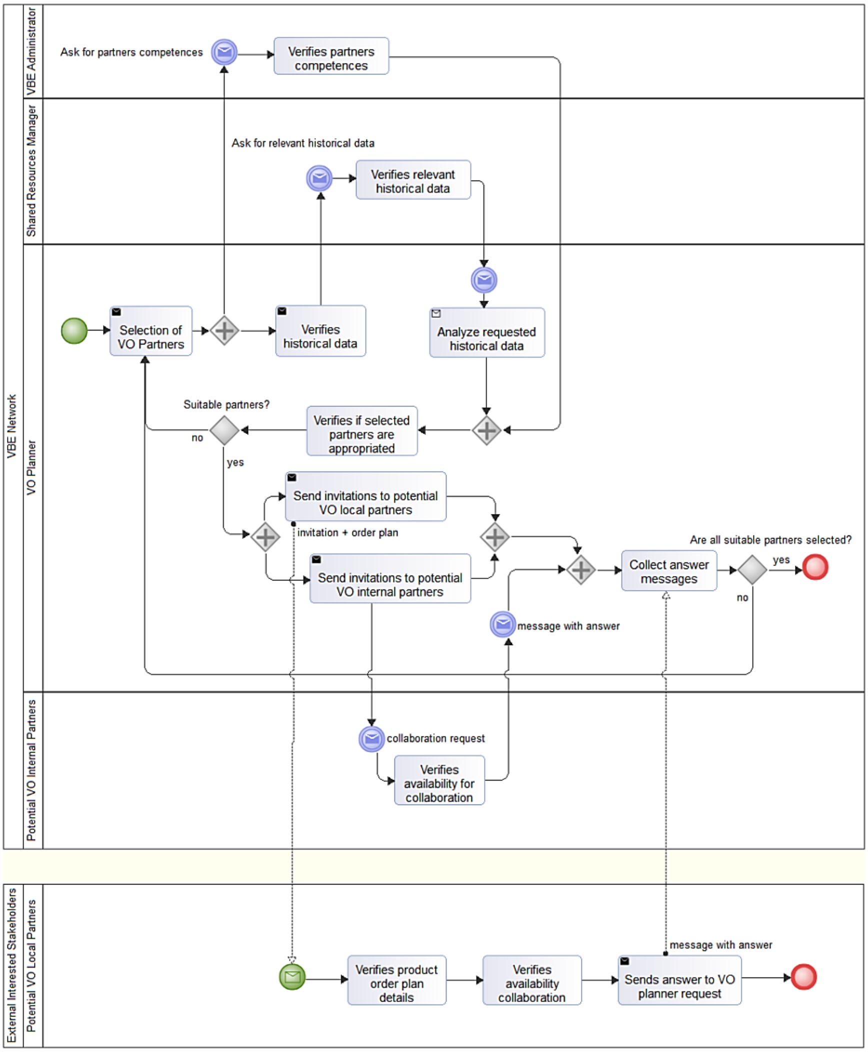

Fig. 5. BPMN diagram for the selection of goal-oriented VO partners

5 Conclusions

The concepts and mechanisms originated in the CN area are nowadays penetrating many application domains. Furthermore, in various use cases we can identify a mix of long- and short-term networks, strategic and goal-oriented networks, and formal and informal networks. The coexistence and interactions among these multiple networks, often with overlapping structures and membership, raises new research challenges.

As a contribution to better understand the interplay among diverse CNs, and to support their life-cycles, GloNet project is focusing on the needs of service-enhanced products and their associated servicing networks. The proposed collaboration environment was designed to also cope with the needs of involving local stakeholders, close to the customer, in the process of co-creation of new services. The actual validation of the proposed solutions in the context of solar energy parks is an ongoing work.

Acknowledgments. This work was funded in part by the European Commission through the GloNet project (FP7 programme). The authors also thank the contributions from their partners in this project.

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A Cloud–Based Approach for Collaborative Networks Supporting Serviced-Enhanced Products

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Abstract. Collaboration through sharing competencies and resources has been a key approach to both creating new competitive environments, as well as achieving the needed agility to rapidly answer to market demands. Establishing proper collaborative networks for service-enhanced products is challenging considering the wide diversity of business operations and involved resources. The creation of software solutions to support such collaboration is an effort-intensive task, especially when these solutions are designed to run in the cloud and when they are required to be highly customisable to different end-user scenarios. In this paper we describe how a cloud-based platform can support the creation of software solutions for the collaborative development and operation of highly customised and service-enhanced products. The platform has been designed based on numerous key requirements that have been generated from the analysis of different business scenarios from various use cases/domains, as well as general key requirements a cloud based platform should provide to support collaboration among organisations.

Keywords: Collaborative networks, Virtual Organisation, Cloud Computing.

1 Introduction

There is a growing trend in manufacturing to move towards highly customised products, even one-of-a-kind, which is reflected in the term *mass customisation*. Mass customisation refers to a customer co-design process of products and services which meet the needs/choices of each individual customer with regard to the variety of different product features. The development of these products typically requires a variety of competencies and resources, hardly available in a single enterprise, which calls for collaboration among several companies and individuals. Collaboration through sharing competencies, resources and services has been a key approach to both creating new competitive environments, as well as achieving the needed agility to rapidly answer to market demands. Being able to rapidly react to a collaboration opportunity in fast changing market conditions is a key requirement for dynamic virtual organisations (VOs) [1].

The notion of *glocal* enterprise emerged to represent the idea of thinking and acting globally, while being aware and responding adequately to local specificities, namely in collaboration with local stakeholders and customers for VO.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 61–70, 2013.

Software that runs in the cloud has gained significant attraction in the past few years representing the emerging paradigm for distributed value added services. With cloud computing, enterprises are given new opportunities to push virtual collaborative alliances to the next level, breaking down some barriers and enabling dynamic continuous collaboration that generates globally composed business value. In this paper, we propose a cloud based platform, developed in the GloNet project [5] and providing support for the co-creation/ mass customisation of service-enhanced products. The rest of the paper is organised as follows: in Section 2 describes related work followed by Section 3 describing the main functionality required for collaborative networks. Then in Section 4, we describe the essential design principles for a cloud-based approach for collaborative networks. Next, in Section 5 we describe the main architecture of the GloNet platform. Finally we offer our conclusion in Section 6.

2 Related Work

A number of research and development work has been focusing on the collaboration platform problem. Despite the research and development work done in the last decade, the collaboration platform problem remains a practically unresolved issue, each addressing separate concerns of the collaboration domain. A number of research projects i-SURF [9], CONVERGE [10], COIN [11], SUDDEN [12] focussed on the support of collaboration across the supply chain to enhance planning, decision making and coordinate supply networks. Other research works such as ATHENA [13], SODIUM [14], COMMIUS [15], DIP [16] focused into development of web-based tools to enable interoperability of tools and applications. In addition to the web-based tools, ECOSPACE [17] offers service-oriented tools to manage complex daily work tasks in collaboration spaces. Significant research works such as LABORANOVA [18], SYNERGY [19], COIN [11], ECOLNET [20] have also looked into creating tools to enable collaboration in teams, companies, organisations, networks and social communities in general. GloNet follows a top-down research approach and build on existing results from completed and on-going research projects for a best practice in Virtual Enterprise management for complex industrial units, supply-chain management, knowledge sharing, tracking complex processes and products as well as privacy issues.

3 Functionality Required by Collaborative Networks Supporting Serviced-Enhanced Products

The driving use case in GloNet is in the Solar Park construction sector. The different stakeholders range from customers, project developers, construction and commissioning firms, equipment suppliers, service provision companies and many others, are considered to be either a member of a long term alliance of stakeholders involved in the area of the product, that is a VBE (Virtual organisation Breeding Environments) [21] member or a partner in a goal-oriented collaborative network which is established to perform specific task for the product that is a VO partner.

Based on numerous business scenarios identified in the GloNet project, focusing on product characteristics, stakeholders' characteristics, organisational structures and collaborative tools needs and shortcomings (as described in Section 2), the following five functionalities [6] have been identified as key for collaborative networks (CN) in service-enhanced products contexts. They are:

1. **Support for Setting Up a Collaborative Space for Project among Different Stakeholders in Terms of Goal-Oriented Network.** Platform functionalities shall facilitate setting-up a goal-oriented networks (i.e. VOs), whereby individuals and/or organisations can strategically join their competencies to rapidly respond to a business or collaboration opportunity. It should be noted that different VOs, with very different time durations, can be needed during the life cycle of a complex product. Each VO must be able to plan and schedule the collaborative work as well as the option to allow new partners to join the VO. It is also important to have a robust and reliable negotiation mechanism that supports the potential VO partners in achieving agreements during the VO formation process, reducing the amount of time spent in this process. These VO agreements will then be the basis for the governing principles of the VO during its operation phase.

2. **Supporting Different Roles in a CN and Permissions for Accessing Information and Knowledge Resources.** The platform must ensure resources protection in terms of permissions of members accessing shared resources as well as privacy of the shared resources. Appropriate mechanisms need to be in place through the identification of the property rights per resource and provision of authorised access for network members, according to their roles.

3. **Sharing Knowledge, Data among Stakeholders in the CN.** The platform must provide functionalities for sharing of knowledge among CN members (for example standardised product definitions and processes), software tools, and lessons learned. As such, the system must support organisations in the process of sharing their resources, allowing that each organisation inside the CN can search, retrieve and update information and knowledge about e.g. templates, standard processes, ontologies, etc. The system should also include mechanisms to implement incentive policies to increase resources sharing.

4. **Groupware Related Tasks (Appointments, Task Management).** The platform must provide a collaborative environment for groupware related tasks of members within the product/service development project. This can be reflected, in terms of sharing appointments, tasks to meet the project goals within a VO.

5. **Defining and Tracking Workplans/Processes.** VOs involved in service-enhanced products must support and promote the collaborative design of products and services as well as the emergence of innovative solutions. It includes two main aspects: i) mass customisation combined with offering value added services that improve the perceived product quality and prolong the product life cycle; and providing services based on innovation, knowledge and customer orientation; ii) emergence of new products identifying future needs, through collaboration among manufacturers and the customer and members of the customer's community.

4 A Cloud-Based Approach for Collaborative Networks

Cloud computing can provide a centralised platform [8], which can be accessed from anywhere, by any (authorised) collaborator, and at any time over the Internet. Cloud solutions are typically presented as exhibiting a number of advantages for the involved stakeholders in terms of:

- **Reduced Initial Costs.** Cloud computing provides cost reduction that particularly SME organisations can benefit from whereby they do not own the resources (server, storage) that produce the computing capabilities they require and pay for.
- **Ubiquitous, Simple Access through Internet.** With cloud computing, organisations are given new opportunities to push virtual collaborative alliances to the next level, breaking down geographical barriers and enabling dynamic continuous collaboration that generates globally composed business value.
- **Centralised Platform for Collaborative Scenarios, Integration Hub.** Cloud computing provides a centralised platform, which can be accessed from anywhere, by any (authorised) collaborator, and at any time over the internet.
- **Flexible Cost Models.** In addition, customers benefit from the fact that cloud computing employs a *pay-per-use* model. Customers do not have to do a high initial investment in hardware and software, instead they are typically paying monthly or yearly fees depending on the number of user licenses they need and/or the resources they consume.

It is essential for a cloud–based software solution to be designed considering the fundamental requirements of a collaborative workspace environment. As such we believe the following five key design principles [7] are essential in building a collaborative environment support platform:

1. **Modularity and Extensibility.** In cloud-based software solutions, software subsystems are typically consolidated having a code-base that works for all customers. However in collaborative networks, this approach is not feasible, since customer specific configurations, data models, business rules and workflows, need to be tailored to each individual user need. As such, software solutions need to support programmatic extensible and customisable features, namely allowing the addition and removal of modules for specific needs.
2. **Multi-tenancy.** Multi-tenancy is the capability of a software system to serve multiple customers or tenants (which in turn comprises multiple users). In essence, having a cloud-based approach, two potentially conflicting requirements need to be addressed. That is on one hand the cloud-based approach needs to leverage the economy of scale principle by employing a consolidated architecture that handles all customers uniformly, and on the other hand customers demand that the software they use can be tailored to meet their specific requirements and match with their highly-individual business and the processes they work with. This implies that both data and customisations have to be *isolated* on a tenant-based level by the cloud-based platform.

3. **Scalability and Availability.** For any collaborative environment, coming up with a scalable software architecture is a major concern. For cloud-based systems, this is even more critical. The software will be used by thousands of users in parallel, namely the expected average number of concurrent users per customer, multiplied by the number of customers having licensed the software. There are different ways to achieve scalability. One way is to *scale-up* the system, that is to move the software to more powerful servers (for example having more processing power, more RAM, more and faster storage) when the need arises. For a cloud software approach, a *scale-out* strategy is much more suitable. This means that the workload of the system can be distributed among several servers. A scaling-out architecture offers two main advantages. First, standard and cheap off-the-shelf servers can be used instead of expensive high-end servers. Second, it offers higher availability, since many instances of the same application server are deployed.
4. **Security and Trust.** An important issue in adopting a cloud approach is ensuring data security. For collaborative solutions security mechanisms need be designed in a way that they still allow for data sharing among users that want to collaborate.
5. **Network Access.** Cloud architectures need to be designed for network access from the ground up. This concerns the end-user interfaces (web-based UIs) as well as programmatic access (web services).

5 The GloNet Platform

The GloNet platform is built according to functionality required by collaborative networks as discussed in Section 3 and the five key principles a cloud-based approach should take into consideration. It uses a framework-based approach: it defines an application architecture and provides a number of components that implement the basic building blocks of this architecture. In addition, the platform is extensible, providing customisation mechanisms as well as extension and integration mechanisms for additional modules and services that may complement the basic features of the platform.

5.1 GloNet Platform Architecture

The GloNet platform follows a layered architecture [2], whereby a system is decomposed into several distinct layers or *tiers* that can be developed, maintained and (often) deployed independently from each other. Figure 1 shows the GloNet three layers and the Cloud-based layer comprising of 3: the presentation layer, the application layer and data layer. The *presentation layer* focuses on interacting with the user through a graphical user interface. It displays data and collects user input and commands. The application layer or *business logic layer* provides operations that implement the processes and operations that the software solution provides. The *data layer* encapsulates the storage and provides access to the persistent data of the solution. In most cases this layer makes use of a database management system.

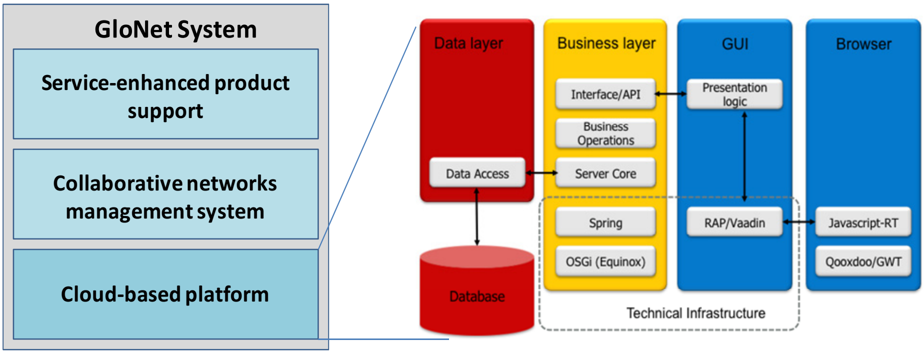

Fig. 1. GloNet system overview

The most important modules of the GloNet cloud-based platform are the following:

- The *data access* module that encapsulates database specifics. It enforces tenant isolation and implements a permission system, thereby strictly controlling the access to the data stored in the databases. As a clean interface, it provides a database and platform neutral simplified SQL-like language for data access including a number of helper functions to simplify the access to more complex data structures.
- The *server core* module, which builds the backbone of the backend implementation of the GloNet platform. It provides mechanisms to register and unregister additional modules, which in turn may provide additional operations. It is also responsible for enforcing a strict security policy by providing and verifying security contexts (for example, based on user and tenant credentials) when executing any kind of operation. Furthermore, it makes use of the data access module to manage generic (extensible) data objects.
- A number of *business operation* modules provide implementations for the basic services of the GloNet platform. Such operations include infrastructure-related operations (user and tenant management, permission management), but also operations concerning more end-user related features (e.g. document management, calendar management). New modules can be registered using mechanisms provided by the server core module, creating an extensible platform.
- Any operation from the business operation modules or the server core with a publically defined interface is exposed via a number of *external interfaces*, namely in-process method calls, RMI and SOAP-style web services. A subset of those is also accessible as REST-style web services. This way, the GloNet platform provides a service-oriented *application programming interface (API)* suitable for a large variety of use cases and implementation technologies.
- The presentation layer of the GloNet platform provides a framework for creating and presenting a web-based user interface. The *presentation logic* module provides generic user interface functionality like reusable controls, the application frame, and configurable list and form views.

The other layers of the GloNet system are not addressed in this paper. The platform supports customisation facilities on all layers of the software system:

- *User Interface*. The GloNet platform allows users to define and customise their user interface to match with their corporate branding, that is adapt rather simple things like logos, colours and fonts, or to better reflect their internal nomenclature. Users can also modify the layout and ordering of the presented information in order to put an emphasis on business critical information.
- *Business Logic*. The platform allows users to implement their daily business needs, by supporting customisation of business logic layer rules. For instance, a VO member in could define rules that are used to evaluate the rating or potential of a customer. In such situation, one CN member's rating rule might be based on the yearly turnover with that customer, whereas another CN member might prefer to make that rating dependent on the number of sold licenses for a software company or the overall value of profitable insurance contracts for an insurance company.
- *Data Model Extensions*. The platform allows CN member users to store additional information in the system. In these cases, the platform supports extensions of the data model using custom objects or custom fields for each user.

5.2 GloNet Users Roles and Permissions

The GloNet platform provides a framework for the authentication and authorisation of its users. These are classified in three main categories:

- *Users, Groups and Resources*. These are called permission owners. Users can authenticate themselves with the platform’s authentication methods. Users can be organised into groups. For each user, the platform maintains some basic attributes.
- *Security Contexts*. After authenticating a user login, the platform creates a security context. Any operation runs within this security context. The platform provides different classes of security contexts, with user contexts always associated with an authenticated user and a user can only perform privileged operations based on the , privileged contexts set to the user.
- *Permissions*. Most data elements and operations are associated with permissions. Permissions are used for authorising the access to data or the invocation of operations within the platform. For example, for permissions related to financial details, such as an employee’s salary, the platform ensures only people from the HR department can be granted the permission to change the salary; however the platform ensures administration members are able to read the value in order to give out the pay checks.

5.3 GloNet Platform Implementation

The GloNet platform implementation employs a number of industry standards and off-the-shelf components which form the technical infrastructure of the GloNet platform. Fig. 2 illustrates the basic infrastructure for the deployment of GloNet.

It consists of a *farm* of standard *Linux*-based PC-Servers that operate either as *Java* application servers based on *Apache Tomcat* or as database servers using *MySQL*. The presentation layer is currently implemented using server-side frameworks for AJAX-style user interfaces [4], Vaadin and Eclipse RAP. These components are standard building blocks of a Java based technology stack. Therefore, an instance of the GloNet platform can be deployed on almost any cloud infrastructure provider offering that allows for standard VM images as units of deployment. Adaptations to specific cloud infrastructure provider offerings are only necessary regarding the load balancing and VM administration interface. Alternatively the GloNet platform can be hosted in almost any computing centre that has some capability of operating Java-based application servers.

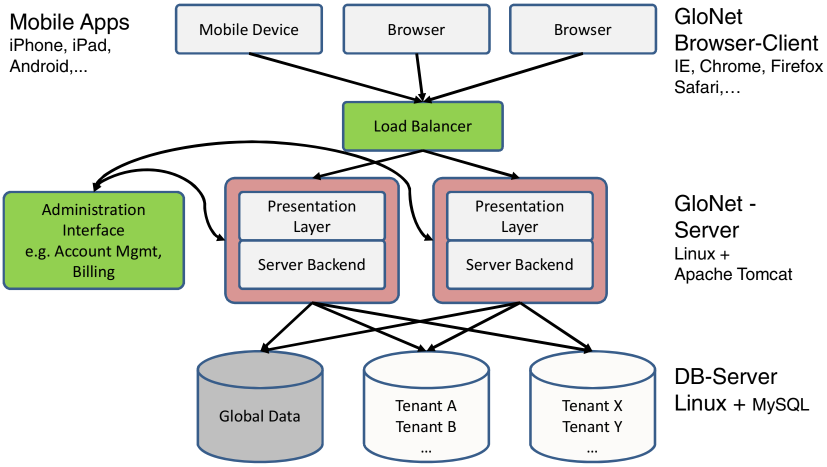

Fig. 2. GloNet platform deployment architecture

5.4 Mechanisms for Integrating Existing Services in GloNet

The GloNet platform provides two key approaches to integrate external components or systems: *proxy-based* and *mashup-based*. In the proxy-based mechanism each external service has a proxy within the GloNet platform that performs the mapping between the GloNet platform and the external service. The mash-based approach, external services makes use of their own user interface that can be plugged-in to the GloNet platform. To exchange data with the GloNet platform, the provided web service API can be used. In order to interact with the GloNet application, basic user interface context information is exposed using a RESTful interface [3]. This approach is used to build the upper layers of the GloNet system, namely the Collaborative networks management system and the Service-enhanced product support (see Fig. 1).

6 Conclusions

In this paper we have described the required functionality for a collaborative networks environment and proposed the GloNet platform, a cloud based framework for creating applications for the collaborative design and operation of complex service-enhanced products. The platform is built according to a tailored cloud based principle, taking into consideration specific requirements of collaborative networks. Additionally, the platform provides mechanisms for the integration of external systems and services.

We envisage enhancing the platform customisation part. In this perspective we want to investigate on meta-data based configuration that can be used to provide customisation of services across all the three layers (User interface, business logic and data model extensions) of the GloNet platform architecture. The current platform has been designed on the needs identified in the context of solar plants, and we envisage validating the approach to other context industries involved in service provisioning.

Acknowledgments. The work on this paper is funded in part by the European Commission through the GloNet project (FP7 programme- GLONET [FP7 / Project No. 285273, 2011-2014]). The authors would also like to thank the contributions of the different partners of the GloNet project.

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Value Systems Alignment in Product Servicing Networks

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Abstract. The notion of service-enhanced product brings new perspectives for value creation and differentiation in manufacturing. The existence of complex and highly customized products, the inclusion of business services that add value to the product typically require the collaboration of multiple stakeholders. It is natural that each stakeholder has its own set of values and preferences and as a result, conflicts among them might emerge due to some values misalignment. Therefore, the Value System Alignment assessment should be included when selecting partner for the formation of long-term collaborative networks for the operation and management of the product life-cycle. This paper presents the implementation of a Value System alignment assessment model, as a component of the cloud-based collaborative environment designed to support a mix of collaborative enterprise networks involved in the solar energy sector.

Keywords: Collaborative networks, value systems, service-enhanced products.

1 Introduction

The notion of service-enhanced product offers new perspectives for value creation and differentiation in manufacturing. In the case of complex and highly customized products, the association of value-added business services to the product typically requires the collaboration of multiple stakeholders. On the other hand, decision making as well as the individual and joint behavior in a collaborative network depend on, and are reflected by the underlying value system of network participants. Therefore, the identification and characterization of the value systems of the networks as well as of their individual members are fundamental when attempting to improve and sustain a collaborative process.

Manufacturing networks typically involve heterogeneous and autonomous entities, such as: product / project designers, manufacturers, service providers etc., configuring a kind of virtual organizations breeding environment (VBE). Thus, it is natural that each network member has its own set of values. In the presence of different sets of values, conflicts among partners might emerge merely due to misalignment of values [1-3]. With different value systems, partners might have different perceptions of the outcomes of the collaborative processes that might in turn lead to a non-collaborative behavior, such as reluctance to share knowledge and other inter-organizational

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disagreements. Since values are one driver of the behavior of the involved entities, identifying partners with more compatible or common core values during the consortia-formation is important to the success of the consortia [4, 5]. The level of alignment can serve as a predictive indicator of the potential level of collaboration as well as the capability to reach agreements in the case of conflicts. However, tools to assess or measure the level of alignment among value systems are lacking.

A theoretical approach to model value systems alignment which adopted elements from the graph theory and causal reasoning to model the causal relationships among organization's core values in order to analyze their interrelationships has been previously proposed [6, 7]. This paper explores the application of this theoretical Value System alignment assessment model, as a component of a cloud-based collaborative environment designed by the GloNet project to support a mix of collaborative enterprise networks involved in the solar energy sector.

2 Concept of Value Systems Alignment

Alignment is a very broad concept which is related to consistency, fitness, and similar ideas. Therefore, in order to propose methods to analyze the alignment between Value Systems in a collaborative context, it is necessary to consider the factors that contribute to core values alignment and misalignment in that context. One of the most common criteria for alignment assessment is the identification of shared core values among network members and between the network and each member. Nevertheless, the shared values criterion might not be enough to assess values alignment, since the shared values are not the only elements contributing to the sustainability of the collaboration. Therefore, in this work, the adopted approach for the assessment of the value systems alignment considers not just a comparison between core values and priorities, but also an estimate of the impact of a value system onto another. In short, the proposed analysis of the alignment between value systems considers the following parameters: (i) the shared core values between value systems; (ii) the positive impacts between core values of the two value systems; and (iii) the negative impacts between core values of the two value systems. The assessment can be performed at two different levels: (i) the alignment among network members; (ii) the alignment between the network and the network members.

The indicators to implement these alignment criteria are proposed taking as reference the V-align framework [6]. This framework supports the analysis of the following relationships: (i) Core-values to core-values – in order to understand how core-values influence each other; (ii) Core-values to organizations – in order to know which core-values are held by each organization; (iii) Core-values to collaborative networks – in order to understand which core-values are held by each network. Starting from the set of maps obtained from the use of the V-Align framework, three indicators were proposed: Shared Values Level, Potential for Conflict Level, and Positive Impact Level (see [7] for a detailed characterization of these indicators). The implementation of these indicators assumes the existence of a Reference Core-Values Ontology, which contains a description of the possible core-values that an organization can hold. Such knowledge can be directly provided by experts or result from surveys and interviews (see [4, 8], as examples).

In order to have an indication about the global alignment level among the Value Systems of a set of members a new indicator is proposed: the network Value System Alignment Level, which is expressed as an average of the Value System Alignment Level between each pair of members, where the Value System Alignment Level between two members is expressed as the aggregation of the Shared Value level, the potential for Conflict Level and the Synergies Level, as follows:

$$VSAlignmentLevel(i,j) = SharedLevel(i,j) - PotentialConflict(i,j) + SynergiesLevel(i,j)$$

Considering n, as the number of members in the network:

$$NetworkVSAlignmnetLevel = \frac{2}{n^2 - n} \sum_{i=1}^{n} \sum_{j=i+1}^{n} VSAlignmentLevel(i,j)$$

In Table 1 the proposed Alignment Level indicators are summarized.

Table 1. Values System Alignment Indicators

Members	**Shared Values level**	*This indicator quantifies the level of similarity between two value systems.*
	Potential for Conflict level	*This indicator quantifies the level of negative impacts that two value systems have on each other.*
	Positive Impact level	*This indicator quantifies the level of positive impacts that one value system has on another value system.*
	Synergies level	*This indicator quantifies the level of positive impacts that the members value systems have on each other.*
	Value Systems Alignment level	*This indicator quantifies the overall level of alignment between two members, aggregating the levels of: potential for conflict, synergy, and shared-values.*
Network	**Network Value Systems Alignment level**	*This indicator gathers the input concerning the indicators of the Value System Alignment between each pair of network members towards providing a measurement indicator for the Value System alignment of the network as a whole.*

3 A Support Tool

In one-of-a-kind production industries products and services are typically delivered through complementary competences shared between different project participants. A key challenge in this case is the design and delivery of multi-stakeholder complex services along the product life cycle. To fulfill the global interests of the involved stakeholders, a set of main services have to be available to support the management of networks, either long-term strategic networks or goal-oriented networks. This includes among others: VBE creation; VBE Members Management; VBE Competence Management; VBE Groups Management, Dynamic Consortia Creation, Dynamic Consortium (VOs) Creation, Risk forecasting and Management. Moreover, with the aim to enrich the base services to VBE Management, advanced management services are also proposed in GloNet: the Trust Assessment and the VBE Value System Alignment Analysis.

This section focuses the implementation of the VBE Value System Alignment Analysis services, and its integration with the other available services provided to support collaborative network management (see Fig. 1).

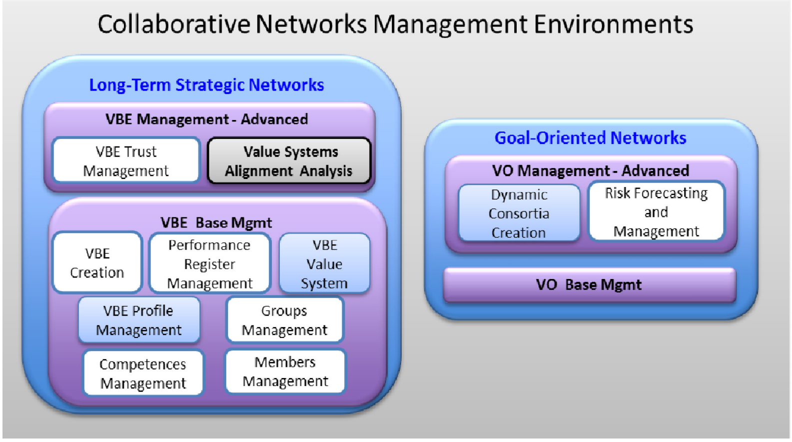


Fig. 1. Collaborative Networks Management Environments Framework

The VBE Value System Alignment Analysis components aim to provide a way to assess the Value System Alignment, according to the model previously presented, and it is composed of the following services:

- VBE Value System Alignment Assessment - This service is used to assess the alignment between specific Member Value System and the VBE Value System. This service receives the network Value Systems and the Value System of a member and computes a set of indicators about the alignment level, and generates an aggregate network core-value map (see [6] for the maps specification).
- Members Value System Alignment Assessment - This service is used to support the Value System alignment assessment of a set of members according to the V-align framework. This service receives the value systems of a set of members in order to generate a complete aggregate map and a set of alignment indicators that allow making an analysis of the alignment level among a group of members.
- Manage Values Knowledge Base Management - This service is used to retrieve the list of core-values and their description.

The services described above do not work in a standalone basis, they rather use information provided by other upstream subsystems and produce information to be used by downstream subsystems. Fig. 2 shows an adapted i* Rationale Strategic model representing the involved actors and their dependency objectives concerning the other sub-systems. Moreover, the services and sub-services within Value System Alignment Analysis boundaries are presented.

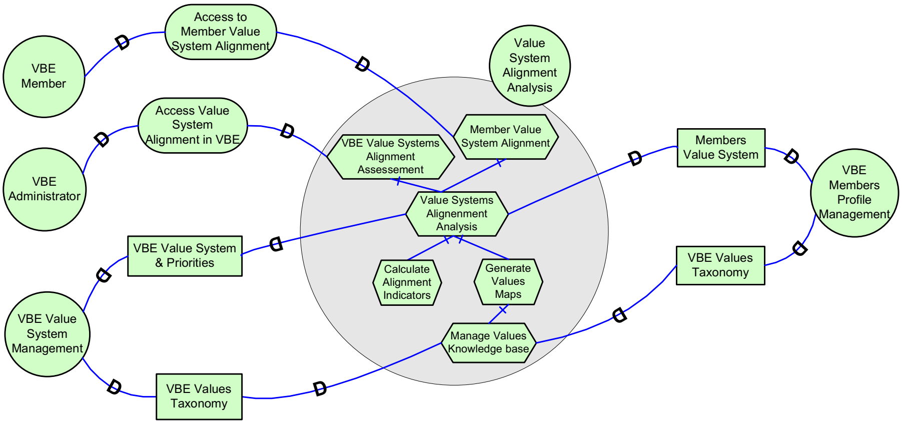


Fig. 2. Adapted i* Rationale Strategic Model for the VS Alignment Analysis System

The implementation of these services faced a set of challenges:

- Develop a user interface that fulfills the needs of the different users-devices (smart-phone, tablets, PCs, etc.), and that provides dynamics graphs rendering.
- Develop a set of web-services that guarantee the integration of the three subsystems: Value System Alignment Analysis, Value System Management, and Members Profile Management.

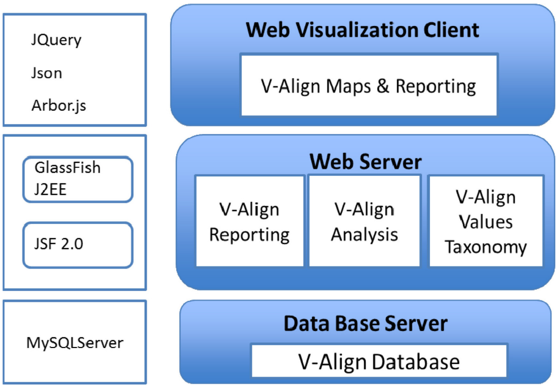


Fig. 3. V-Align Software Tool Architecture

In order to fulfill these main requirements the following technology was adopted: (i) Java script with Jason files, used to render the V-Align maps, from the client side, (ii) JSF 2.0 framework to implement the alignment assessment methods, generating alignment reports, and the management of core-values taxonomy (Fig. 3).

4 Application in Virtual Organization Creation

In dynamic consortia formation of goal-oriented networks, which typically assume the form of either a short-term Virtual Organization (VO) or long-term Virtual Organization, the selection of appropriate partners assumes a crucial step for the success of these networks, as mentioned in [9, 10]. These kinds of networks have the particularity of being composed of not only members of the long-term strategic alliances of manufacturers but also of the customer and local suppliers (customer's network) in order to support the notions of co-creation and *glocal* enterprise [11]. In the context of solar energy plants, these goal-oriented networks might be created for different purposes: the Product Development Network is a short-term virtual organization responsible for the design and creation of the physical product, the Product Servicing Network is a long-term virtual organization responsible for the operation and management of the product life-cycle and finally, the Service Co-creation Network is a short-term virtual organization dynamically created with the aim of co-creating new innovative business services to add value to the physical product.

Effective creation of VOs faces a large number of challenges, considering the wide diversity and large number of organizations active in the global market, the main challenges limiting the success of VOs include: (i) finding the most suitable partners worldwide, (ii) building trust and cooperation spirit among partners, (iii) effective formation of VOs, through both division of rights / responsibilities and reaching necessary agreements on co-working and system of values, as well as (iv) establishing the needed commonality on concepts / models / infrastructure etc., which set the foundation for interoperation and collaboration among independent, heterogeneous, and autonomous organizations.

Having taken into account the environmental characteristics of collaboration, every VO has a certain level of associated risks. These risks can have different drivers and sources. Therefore, if the VO planner could know more about the potential risk of a certain consortium, then the decision about the final consortium for the VO formation can be more accurate. In order to assess the risk level of a potential VO, the Members Value System Alignment Assessment services introduced above can be used. However, the use of this service for partner selection, assumes that each of the potential VO members is registered in the VBE system and that its Value System was already set on its profile. During the VO creation phase, the VO planner identifies a set of possible lists of members to form the VO, and for each list of members uses the Members Value System Alignment Assessment service to:

(1) Determine the Network Value System Alignment level, the higher this level, the lower is the risk level.

(2) Obtain the aggregate Members Value map, in order to identify the synergies between members, and the conflict values.

5 Product Servicing Network Application Example

In this application example, we aim to illustrate how the Value Alignment Assessment Model presented in Section 2, and the Software Tool presented in Section 3 can be used in the decision-making process aiming the selection of a set of partners.

Let's consider the manufacturers of solar parks as a long-term base network (a VBE) that is constituted of a number of companies involved in different positions of the value chain, such as Project development firms, Engineering, Procurement & Construction companies, Photo Voltaic equipment manufacturers, Monitoring & Control companies, Construction & Commissioning companies, etc. As support institutions, we can consider training institutions, regulators, insurance companies, lending organizations (banks), etc.

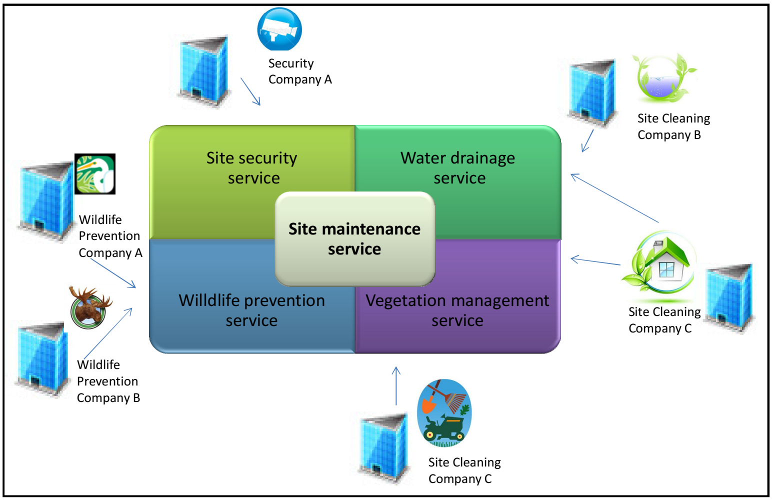


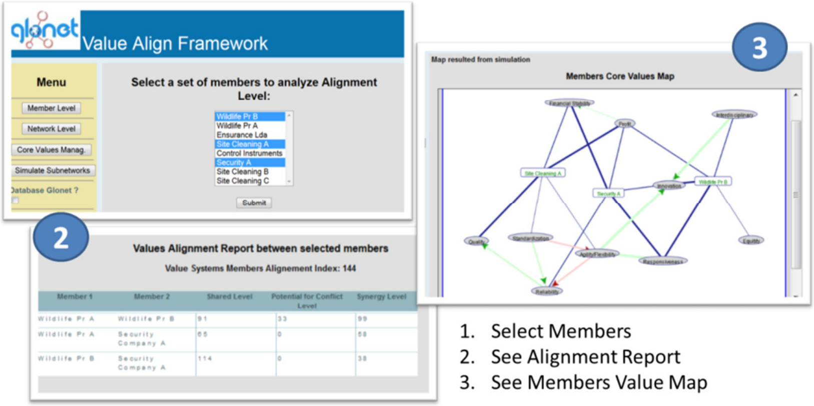
Fig. 4. Application Scenario

In this application example we consider the existence of a Product Servicing Network, which was created to perform the operation and maintenance of the solar park after the conclusion of the development of the physical product. The partners that constitute this long-term network were first recruited from the manufacturers network (VBE), naturally considering those that were involved in the manufacturing phase, and additional partners were added both from the customer's network and from local stakeholders. It is considered that during the operation of the solar plant, the customer is interested in an integrated site maintenance service that includes various simpler services: site security service, wildlife prevention service, vegetation management service, and water drainage service. The various services that compose the site maintenance service might be provided by different companies, as illustrated in Fig. 4. In order to create this VO, the Product Servicing Network has to recruit the appropriate partners. In the example, it is assumed that the VO planner has found three distinct sets of members that satisfy the competencies required to provide the site maintenance service (see Table 2). In order to assess the risk level of each VO configuration, the Network Value System Alignment Level will be evaluated for each one of the three possible VO configurations.

Table 2. Network Value Systems Alignment Level for multiple consortium configurations

Network Value Systems Alignment level		
Configuration 1	**Configuration 2**	**Configuration 3**
Wildlife Prevention Company A Security Company A Site Cleaning Company A	Wildlife Prevention Company B Security Company A Site Cleaning Company B Site Cleaning Company C	Wildlife Prevention Company B Security Company A Site Cleaning Company A
50	**114**	**144**

During the registration process, each company has set its own Value System on its member profile. According to this information, and using the software tool presented in Section 3, the three VO configurations are set and the Network Value Systems Alignment is analyzed for each one, according to the method presented in section 2. The identification of shared values, synergies, and conflicting values in each consortium can be easily identified in the Members Core-Value Map. Fig. 5 illustrates the tree steps performed to analyze each of the three configurations. According to the results obtained (see Table 2) the consortium based on Configuration C is the one that presents a higher alignment level index, and as a result is assumed as the one with a lower potential risk.



Select a set of members to analyze Alignment Level:

Wildlife Pr B
Wildlife Pr A
Ensurance Lda
Site Cleaning A
Control Instruments
Security A
Site Cleaning B
Site Cleaning C

Values Alignment Report between selected members

Value Systems Members Alignement Index: 144

Member 1	Member 2	Shared Level	Potential for Conflict Level	Synergy Level
Wildlife Pr A	Wildlife Pr B	91	33	99
Wildlife Pr A	Security Company A	65	0	58
Wildlife Pr B	Security Company A	114	0	38

1. Select Members
2. See Alignment Report
3. See Members Value Map

Fig. 5. V-Align Software Tool

6 Conclusions

This paper explores the application of a Value System alignment assessment model, as a component of the cloud-based collaborative environment designed to support a mix of collaborative enterprise networks involved in the solar energy sector. Starting with a Value Systems Alignment model previously proposed to specify and analyse the alignment of Core Value Systems in collaborative environments, it has been explained how a set of software services can be developed to provide Value Systems Alignment assessment services. Moreover, it was defined how these services can be integrated with other main services in order to provide an integrated Collaborative Networks Management Environments System that supports the management of a mix of collaborative enterprise networks.

In order to illustrate how the Value Alignment Analysis Services can be applied to support the selection of partners in VO creation, an application example for a Solar Park Product Servicing Network was presented.

The work done so far suggests that the presented artefacts have a practical and theoretical relevance in the partner selection during VO creation, thus, the integration of the Value System Alignment Service in the Dynamic VO Creation Service will be the next step.

Acknowledgments. This work was funded in part by the European Commission through the GloNet project (FP7 programme). The authors also thank the contributions from their partners in this project.

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Specification and Configuration of Customized Complex Products

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Abstract. This paper addresses the design of an information system for specification of complex configured products, such as the solar power plants or large intelligent buildings, which by nature are designed, constructed, installed, operated, and maintained through virtual consortium of enterprises. In other words, typically a number of virtual organizations are involved during the entire life cycle of these products. The involved companies include the equipment suppliers, business service providers, and tailored software system developers, that form a consortium typically coordinated and managed by an EPC (Engineering, Procurement, and Construction) contractor or a so called project developer. Furthermore, remote access is required through the cloud to different elements of the complex product's specification, to effectively support these products. An approach and a set of mechanisms are introduced in the paper for effective cloud-based specification of such complex products. The addressed generic system supports different involved stakeholders with customization of the planned complex product, satisfying both their preferences and mandatory standard criteria. The specification system is being implemented as a generic pilot information system, supporting iterative specification of configured sub-products for the planned complex product. This information system also constitutes the base for the next step of this research, focused on semi-automating the process of sub-products cataloging and building an intelligent recommender for complex product configuration, in dialogue with the user.

Keywords: Complex Product Specification, product information systems, complex product configuration.

1 Introduction

Product configuration has been addressed in the areas of computer science and systems engineering and in research related to several domains, and particularly in manufacturing [1]. A number of commercial product configurator software systems exist today in the market, many of which categorize themselves as user-friendly tools for configuration of customized products. Every such system however, contains its own peculiar set of functionality and a proprietary design to support certain specific domain requirements. Furthermore, besides being costly and proprietary, most

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existing commercial systems are specialized in specific domains, e.g. manufacturing of customized products, such as cars, boats, bicycles, etc.

This research however aims differently, at the design and development of a *generic complex product information management system for the specification of service-enhanced configured complex products, exemplified by solar power plants and intelligent buildings.* There is a lack of standard definitions for such complex products and their components, as well as for the standard functionality and features that need to be supported for their configuration. Typically these products involve large number of stakeholders participating in different virtual organizations that are formed to support these complex products during their entire long life cycle of more than 20 years. For instance, their design and construction stage typically takes about one year, and their specification and customization is achieved incrementally involving a number of stakeholders. Furthermore, the participating stakeholders are typically dispersed geographically, sometime in different continents, and thus need to share their requirements and other information detailing the specification of these complex products through the cloud.

We have designed a generic information management system in support of our targeted service-enhanced complex products. Later on, in the conclusion section of this paper, we further reflect on the comparison between our developed features in the information system versus the main functionality supported by the existing commercial products.

One commonly referenced definition for the product configuration process is provided in [2]:

> "**Given:** (i) a fixed, pre-defined set of components, where a component is described by a set of properties, ports for connecting it to other components, constraints at each port that describe the components that can be connected at that port, and other structural constraints (ii) some description of the desired configuration; and (iii) possibly some criteria for making optimal selections.
>
> **Build:** One or more configurations that satisfy all the requirements, where a configuration is a set of components and a description of the connections between the components in the set, or detect inconsistencies in the requirements."

Considering the increasing rate of competition among the companies in the market, as well as the variety and number of involved stakeholders, the role of presenting the customer with a specification of the configured complex product that best meets his/her requirements and at the lowest possible cost, has become increasingly significant.

As the first main step in this configuration process, in order to make the process less complex for the involved stakeholders, there is a need to provide users with effective and iterative mechanisms and tools for specification of their product. As such, the complex product specification tool must also support the iterative and incremental nature of definition of complex product configuration.

To help stakeholders with co-configuring and/or ordering complex products, or their related sub-products, in this research we aim to design a generic reusable approach and mechanisms supporting stakeholders with effective customization of complex products, based on their preferences and/or mandatory criteria.

For the purpose of designing the complex product specification system, as the base we have mainly used the following: the requirements analysis of complex products, such as the PV (Photo Voltaic) power plants, as addressed in [3], the set of designed business scenarios addressed for this domain in [4], as well as the introduced information/knowledge provision services addressed in [5]. The important features aimed by the design of this complex product specification system are summarized below:

- Generality and Reusability – The designed meta-data (schema) for the database system, for storing complex product specification details, must be generic. The aimed generality/reusability is in the sense that it should be able to model any entity and concept belonging to any complex product, and not dedicated to supporting only one or two specific complex products.
- Usage Simplicity – While designed functionality for complex product specification system can be complex, designed interfaces for using these functionalities must hide system complexity and provide easy to use operations.

2 Complex Product and Its Atomic and Composite Sub-products

A complex product is composite and consists of a set of sub-products. A sub-product may represent a specific piece of equipment, a business service, or a software-based service, which is produced and/or provided in the market and is used for generating the complex product. Sub-products can also be composite, in the sense that they may consist of other sub-products. For example an intelligent building is a complex product, including a large number of equipment sub-products, such as an intelligent thermostat, while the intelligent thermostat itself consists of other equipment e.g. including a thermometer, etc.

The term Sub-product refers to all constituents of the complex product, being themselves atomic or composite. Furthermore, sub-products have a set of known characteristics, which we model through ***feature-kind*** in this paper, representing the "kind/type" of their characteristics/*features*. For example, a Pyrnometer can be characterized by its following feature-kinds. Each feature-kind below is also exemplified inside parenthesis by one specific feature-instance for this sub-product:

- Manufacturer (such as iPLON company)
- Minimum light sensitivity (such as 7µV/W/m2)
- Maximum light sensitivity (such as 14µV/W/m2)

Aggregation of a set of features identify/form, a *product* while the aggregation of a set of feature-kinds identify/form an ***object-class***. As such, each real physical sub-product is usually an instance of several object-classes, where each may characterize a different set of its feature-kinds.

3 Feature-Kind and Features

A feature-kind is a characteristic of a sub-product, and may have multiple scales. One specific value together with the ***scale*** for a feature-kind of a sub-product constitutes a tuple that we call a ***feature*** *of that sub-product*. The combination of all the features of each sub-product makes that sub-product unique.

For example the atomic sub-product lamp has the feature-kinds of: input voltage, amount of energy it consumes, amount of light it produces, and the color of its light beams. But the definition of *one specific lamp* is not unique until we indicate that it has an input voltage of 220 volts, consumes 100 watts of energy and provides 800 lumens of blue light. Therefore, while the latter definition of lamp may fully represent one real lamp, traditionally called an instance of the type lamp, the former definition of lamp only represents meta-data for type lamp in traditional database descriptions.

4 Separating Offer Information from Sub-product Information

An ***offer*** is either an agreement discussed between two stakeholders, or a special deal on a sub-product suggested by one stakeholder to the public (i.e. all potential buyers).

In the former case, during the creation phase of complex products, agreements on details of complex products are gradually reached between the project developer/EPC and the customer (or its consultant), constituting *offer under negotiations* between these two entities, related to the configuration of complex product.

Another kind of offer, the latter case, is for instance the specification of a special deal offered by a supplier/seller for a new sub-product. For example, an offer may include a 1MWp cabinet, to be delivered in Paris, on March 15th, with the price of 10000 Euros. Multiple offers could also be defined for one possible sub-product. For example, a sub-product could be offered by a seller with the price of 10 euros if it is delivered in Amsterdam, but 15 euros if delivered in Dusseldorf. Following gives a set of differences between the “sub-product” entity and the “offer” entity, when the offer consists of specification of a special deal. We therefore model these two entities differently in the complex product specification system:

- *Supplier/seller* of a sub-product may create an *offer*, while a *sub-product* itself is produced by its *equipment manufacturer and/or a service provider.*
- *Offer specification* contains information about the supplier/seller, while the *sub-product specification* contains information about manufacturer/provider.
- *Offer specification* contains sale conditions, geographical location for delivery, pricing, payment, etc. (as indicated in the example above), while *sub-product specification* indicates the production aspects and conditions.
- etc.

In our model, we classify both the manufacturers of equipment and the providers of services as the producing/providing ***organizations***.

Although the process of purchasing one sub-product is usually simple, the process of purchasing a complex product is much more complicated. It involves configuring the complex product, which in turn involves the configuration of all its sub-products. And finally it involves configuring an offer for the complex product, so that the customer can approve or reject it. In all the sub-steps for the process of purchasing a complex product the customer should be involved, so that the final result (the final specification of the complex product) meets all his/her requirements and that the final offer is acceptable by the customer.

5 Object-Classes

As addressed before, the feature-kinds of a *sub-product* together represent specific classification for that sub-product in the system. This is similarly true for the feature-kinds of the *offer* in the system. As such, we introduce ***object-class*** as a basic class defined to model the generic categorization of all sub-products, and offers, where each object-class (for a sub-product or offer) has a specific set of feature-kinds.

Furthermore, we can enforce a set of obligatory feature-kinds to sub-products and/or offers. For example, definition of an object-class "Electrical" (a class representing certain kind of sub-products and/or offers) can simplify the search for the sub-product in the category of "Electrical", while at the same time it can enforce the definition of an obligatory feature-kind, such as "voltage" to this class. In other words, any sub-product class that has the object-class "Electrical", must have the "voltage" feature-kind and therefore any instance of that sub-product class must have a feature (e.g. a value) for its voltage.

Figure 1 shows four different example object-classes that are defined for sub-product classes in the PV power plants, and represents a set of feature-kinds that are specified for each of these object-classes, e.g. sensor object-class has a feature-kind called accuracy. Furthermore, object-classes can be used to identify and filter what feature-kinds are relevant to which stakeholder. For example, the feature-kind "life span" might be interesting for an insurance company, but it might not be interesting for another stakeholder, e.g. the government regulator.

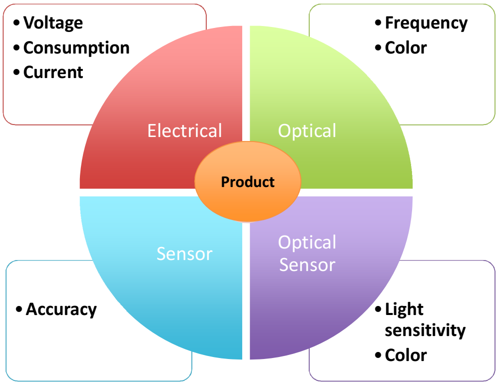


Fig. 1. Example sub-product related to four object-classes and their features

In addition to what is mentioned above, introduction of object-classes provides the following main benefits, both in product and in offer specifications:

- Flexibility to categorize the same product or offer as different kinds of products (e.g. electrical, optical, etc.) and/or different kinds of offers (e.g. Geo-based, etc.) based on a sub-set of feature-kinds of them.
- Guaranteeing that the user will provide the required (obligatory) input for each product and offer through binding feature-kinds to object-classes.
- Ensuring efficient and easy access to product and offer information for different stakeholders by providing views based on object-classes.

6 Relationships among the Entities and Concepts

In order to clearly specify our complex product specification system we model all needed entities and concepts involved in the system and define their interrelationships. Figure 2 provides a summary class diagram (representing only the class names and their inter-relationships). These classes model all the entities and concepts in the complex product specification system, while satisfying the requirement of being generic and reusable. It is important to note that in this diagram the class "Object-class" models classification for both sub-products and offers, while aggregating a set of feature-kinds related to their definition. Furthermore, the "Product" class represents any sub-product of a complex product, as well as ultimately the complex product itself.

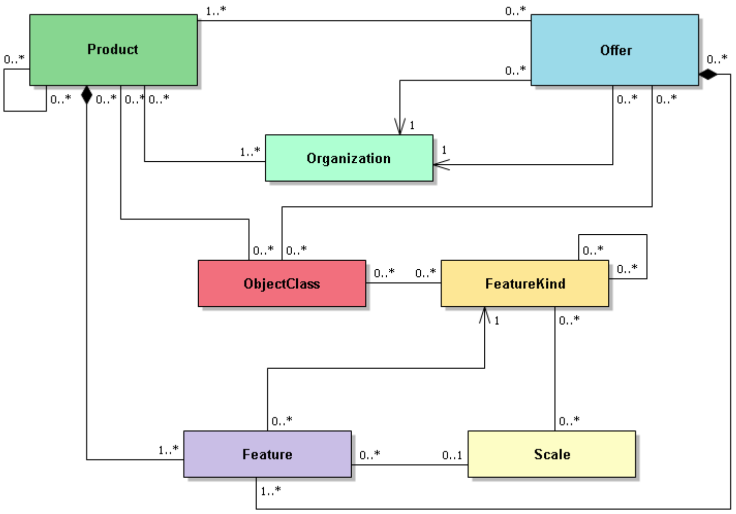


Fig. 2. Summary class diagram of modeled object in complex product specification system

7 Requirements Analysis and Use Cases

The main requirements considered for the design of the specification information system are partially *functional* and partially *non-functional* requirements. Non-functional requirements are those that are not directly related to the functions performed by the system. These include the security, scalability, availability, etc., and are primarily related to software provision constraints and quality requirements. Details of the non-functional requirements for our specification system are outside the scope of this paper.

Functional requirements on the other hand, define the necessary functions expected to be performed by the system, and also describe the input and outputs of the system.

One mostly used tool for documenting the functional requirements of a system is the use case definition. Below we briefly address use cases for the complex product specification system.

Each user of the specification system may interact with the system differently, mostly depending on under which class of stakeholders it falls. In general, the users that are classified as customer or consultant (i.e. customer's consultant) only interact with the complex product specification system in terms of viewing its data and/or approving the data (e.g. offers) made by other stakeholders related to the complex product.

An offer is at the heart of the complex product specification system. It allows the providers of a sub-product (Suppliers for equipment, or providers of the software-based services and business services), to suggest a specific sub-product to the public (including the EPC, project developer, or customer), which is related to the domain of the complex product. It is important to note that for the complex product specification system it is assumed that for viewing and evaluating offers, while frequently the EPC member will act alone (on behalf of the customer), it is also possible that the customer and the EPC members sit together for configuring the plan for the complex product, for viewing the offers related to the complex product, or at least to check certain criteria, e.g. range of price, delivery condition, etc. Then the offer maybe approved or rejected by the relevant stakeholders (e.g. the consultants or the customer).

Please note that in this paper, the EPC/Project developing firm is simply indicated as EPC. Furthermore, the function named as "manage", which is also introduced for different classes in many use cases of complex product specification system, refers to a set of data manipulation functionalities related to those classes. For instance "manage offers" addresses the functionality: *add, edit, view,* and *change status of* the offer class. Below the main use case for the complex product specification system is presented, addressing the functionality related to managing the offers.

The stakeholders that can create an offer include the suppliers, sellers, and the EPC.

Each supplier/seller is in charge of managing *(add, edit, view)* its own offers, which are the offers that are made by it, (i.e. offers related to sub-products of a complex product). Furthermore these offers are usually used by the EPC for making a more composite offers related to the complex product.

On the other hand the EPC may be in charge of managing the complete large offer(s) that is made for the entire complex product. In some cases, the EPC may create multiple offers related to big sub-products of the complex product. For example, the EPC may address the construction and the maintenance support of a complex product in 2 separate offers. On the other hand, the EPC can receive and then manage offers made by other stakeholders, although these offers can then only be viewed, approved, or rejected by it.

Finally the customer (with the advice of the EPC/project developer) and consultants (authorized by the customer) represent the ultimate consuming side of the offers that can only manage offers made by other stakeholders to them, in most cases by an EPC, although these offers can only be viewed, approved, or rejected.

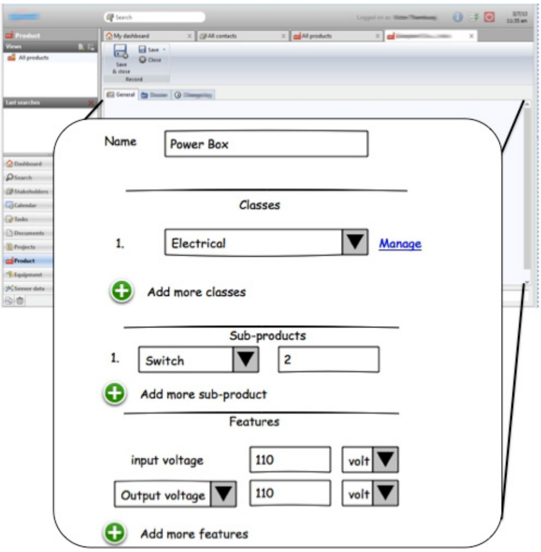
Please note that in principle, within a collaboration community/alliance established among the complex products' stakeholders, there are some stakeholders who act as **providers** (e.g. providers of equipment, manual services, software-based services, and composed services, etc.) and the others who act as **consumers** (e.g. including customers, as well as the intermediary organizations such as EPC, project developer, service integrator, etc.). Within this alliance, different kinds of offer may appear. One kind of offer is related to customization of a sub-product (large or small) to match certain specific requirements related to the complex product. Another kind of offer however, is related to the announcement / advertisement of a sub-product within the alliance. While the former kind of offer is made to a specific recipient, who would be the only stakeholder with the authorization to view and approve/reject that offer, the later kind of offer is made to "*public*", and therefore all members of the alliance can view and approve this kind of offer. Table 1 shows the Use Case of Managing offers.

Table 1. Managing Offers Use Case

Use Case Name	Manage Offers
Description	Supplier/Seller/EPC can review and manage its offers by choosing to add, edit, or view the offer details. EPC/Customer/Consultant can review and manage offers made to them by other stakeholders, by choosing to view, approve or reject the offer.
Actor	Supplier/Seller/EPC/Customer/Consultant
Precondition	Supplier/seller EPC successfully logs into the system
Normal Flow	*1.* System displays the offers that the Supplier/Seller/EPC has made 2. System displays the offers that other stakeholders have made to the EPC/Customer/Consultant or to the public. 3. The stakeholder selects an offer to view, edit, approve, reject or selects to add a new offer depending on its role 4. System redirects the user to the relevant use case.
Alternative Flows	

8 Implementation and User Interface

While the pilot implementation of the complex product specification system is the next step of this work, which will be implemented on top of the GloNet cloud platform [6], at this stage we have designed an abstract view for presenting the system functionality (e.g. data manipulation services) to the users, namely designed the main elements of the user interface.



Name Power Box

Classes

1. Electrical

Sub-products

1. Switch 2

Features

input voltage 110 volt

Output voltage 110 volt

Fig. 3. Adding New Product window

In other words, clearly the user interface that will be implemented for the complex product specification system will be user-friendly and easy to understand and use by the stakeholders, while hiding the complexity of this system. But at the moment, the aim of the current interface design is to give a first feeling for how the planned functionality can be used through this interface. Figure 3 shows the position of this interface within the GloNet platform's user interface, and provides an abstract view of the window for adding a new product.

9 Conclusion

In order to support the customizable configuration of our targeted complex products, we have designed a complex product specification system. This system introduces generic constructs and functionality needed by different stakeholders, and assists them with their incremental and iterative complex product specification tasks. It further aims to properly authorize the stakeholders, depending on their roles and responsibilities, in relation to the product specification.

Our proposed complex product specification system is distinguished from other similar systems [7], due one or more of the following features:

1. Providing an information system that simultaneously supports the needed access and usage by two distinct types of stakeholders involved in our targeted service-enhanced complex products:
   a. those stakeholders that provide/supply sub-products (e.g. providing equipment and services catalogues), e.g. manufacturers introducing a new sub-product related to the complex products

   b. those stakeholders that participate in specification of the complex product itself
2. Supporting the collaboration and joint specification of one complex product by multiple involved stakeholders that can also be geographically dispersed
3. Providing a customized role-based view on the complex product for each of the involved stakeholders
4. Profiling both the users and the software systems that access the information system, thus keeping the history of actions related to the complex product

It is important to mention that item 1 mentioned above is the main distinguishing feature of our proposed approach against all other commercial configuration systems, while this feature is a necessity in support of the virtual organizations involved in our targeted class of service enhanced complex products.

Furthermore, the proposed complex product specification system provides the base for the next step of this research, focused on semi-automating the process of sub-products cataloguing, and building an intelligent recommender, in dialogue with the user, for the complex product configuration.

Acknowledgment. This work is funded in part by the European Commission through the GloNet project.

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Innovation in Networks

Intentional Creation of Innovation Networks: An Exploratory Multi-case Study from German Industry

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Abstract. Due to its promising effects on the economic development, innovation networks have been recognized as an important instrument for the industrialization of regions and nations. Therefore, the creation of innovation networks has been fostered by national and regional innovation systems, as several EU nations are launching clustering and networking incentive programs. For example, the German Government initiated in 2002 an incentive program to foster the creation of innovation networks between SMEs, large enterprises, and research institutes. This research aims at identifying different strategies used in practice for the intentional creation of innovation networks by means of a multi-case study on a German enterprise that adhered to the German Government incentive in order to create nine networks during the past three years. Through this exploratory study, we were able to identify three distinctive strategies used by the network managers for the intentional creation of innovation networks: Cooperation Project, Partner Alignment, and Activity Alignment.

Keywords: Innovation network, network creation, network strategy, case study research, innovation policy, Germany.

1 Introduction

National Innovation Systems have been implementing several policy measures aiming at strengthening the economic performance and welfare of nations. Both developed and newly industrialized countries and regions regard innovation strategies and policies as a systemic process with a specific socio-cultural, institutional and R&D environment [1]. The fostering of innovation networks through public or private initiatives is one of these policy interventions implemented in the EU regions [2]. This is a consequence of the several industrial economy theories that emerged arguing that network forms of organization (innovation networks, industrial networks, clusters) are important instruments for the economic development of regions and nations [3–5].

National Innovation Systems have been often defined in the literature (e.g.[6, 7]). In these definitions the importance of linkages and relationships between institutions -

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 93–102, 2013.

enterprises, universities and government research institutes -, along with the production and diffusion of knowledge and technologies among them is mentioned recurrently. These linkages are formed through private or public incentives. Innovation Networks defined "as the linkages between organizations (companies, universities and regulatory agencies) in order to create, capture and integrate the many different skills and knowledge needed to develop complex technologies and bring them into the market" [8], strongly relate to National Innovation Systems, since these can be fostered under their incentives and agendas [9].

Koschatzky and Sternberg [10] discovered through the European Regional Innovation Survey (ERIS) that regions develop at different rates through innovation networks that constitute the regional innovation system. Their study also indicates that Germany has a well networked innovation system. Over the years the German innovation policy has shifted away from traditional R&D funding schemes and toward a focus on collaborative R&D projects and the establishment of regional clusters thereby stimulation interregional competition [11]. According to Nooteboom [9] Germany is oriented towards more enduring network relations, which increases its innovative capability. Dohse [11] and Eickelpasch and Fritsch [12] analyze and compare many of the innovation network fostering programs implemented in Germany. One of these programs is the ZIM-NEMO program, which is the focus of this research.

The German government started the ZIM NEMO initiative in 2002 with the goal to elevate the technological basis of small and medium sized enterprises (SMEs) and increase inter-firm-university networking, thereby increasing their technological competencies [13]. The initiative started in East Germany under the name of Netzwerkmanagment-Ost NEMO – Meaning: Network Management East - and was enlarged to the whole country in 2008 under the program called ZIM (Zentrales Innovations Program Mittelstand - Central Innovation Program for Middle sized Industry)-NEMO. This initiative consisted in sponsoring the administrative costs for the network management up to 90% in the first year, 70% in the second, and 50% in the third year. The networks are created intentionally under a specific technological scope, with the objective of establishing cooperative projects and synergies. These networks are composed by SMEs, large enterprises (LEs) and research organizations - such as universities and research laboratories. The creation of these networks is actively coordinated by a network manager [14–16].

The networks are selected for funding through the following evaluation process: 1) Groups with a minimum of 6 partners (SMEs, LEs or Research Institutes) and a network manager are invited to submit a network concept proposal: 2) The proposals are evaluated according to three criteria: technological strategic interest for Germany, potential market existence, and network manager curriculum; 3) Proposals are selected for fund, rejected, or selected for further elaborations.

Although research on the network form of organizations is ample, the intentional creation of innovation networks have not, so far, been much studied. Further insights into the strategies of successfully creating these networks at a managerial level would assist both network managers and policy makers. Therefore, the study presented in this paper aims at contributing to the identification and characterization of the strategies adopted for the intentional creation of innovation networks.

The remainder of this paper is organized as follows. Section 2 reviews the literature on the emergence of networks in general, and defines the network-level of study and the networks under analysis. Section 3 explains the research method used for this empirical study. Finally, sections 4 and 5 present the research results and conclusions.

2 The Creation of Innovation Networks

Networks have been studied from various perspectives of analysis - interpersonal, intra-organizational, and inter-organization [17] – and based on different theoretical frameworks. The emergence of networks has been object of study for many years mostly as a natural occurring phenomenon. Barringer and Harrisson [18] consolidate the literature on this matter and present six theoretical paradigms used to explain the natural emergence of networks: transaction cost economics, resource dependence, strategic choice, stakeholder theory, learning theory, and institutional theory.

Several authors have contributed to the understanding of how the behavior of networks can be intentionally influenced. Some focus on the firm level [19] whereas others focus on the network level [14, 20–22]. Moreover, various conceptual frameworks have been suggested for the creation and management of innovation networks (e.g: [23–25]). However, contributions, based on studies from empirical data, towards strategies for the intentional creation of networks have so far been scarce. Human and Provan [15] focus on the evolution of intentionally created networks and implicitly mention creation strategies. More recently, Thorgren et al. [26] analyze innovation performance as a function of governance type, network structure and incentive type. Olsen et al. [27] investigate 101 networks fostered under a program from Innovation Norway, similar to the ZIM-NEMO program. They point out the drivers of success for networks: network design, network content and structure, network management, and team spirit, anchoring, involvement and knowledge transfer. Ritala et al. [28] focus on networks evolution from explorative to exploitive, and distinguish between “coordinating by commanding” (i.e. network management) in a later exploitive network state, and “coordinating by enabling” (i.e. network orchestration) in an earlier explorative network state.

Innovation networks have been defined by several authors [8, 14, 29]. More specifically, we adopt here the definition of Calia et al.[8], considering Innovation Networks “as the linkages between organizations (other companies, universities and regulatory agencies), in order to create, capture and integrate the many different skills and knowledge needed to develop complex technologies and bring them into the market”. By focusing on the need to bring technologies to the market, this definition accurately describes the goal of the ZIM-NEMO innovation networks.

As with networks in general, innovation networks can have different characteristics which will be discussed next.

Network Structure. The structure of innovation networks may be distinguished between a ‘‘network of organizations’’ and a ‘‘network organization’’. While the former refers to any group of organizations or actors that are interconnected with direct or indirect exchange relationships, the term “network organization” refers to networks that contain a finite set of parties [20]. The existence of strong ties in a network structure leads to a larger share of resources and information. Weak ties lead to a share of more novel information between the partners [30]. Ahuja [30] points out the advantage of a balanced weak and strong tie mix in a network.

Network Governance. Provan and Kenis [16] distinguish three different sets of possible governance forms for a network organization. First, participant-governed networks are governed by the members themselves with no separate and unique governance entity. Second, lead-organization-governed networks occur normally in vertical, buyer/supplier relationships, especially when there is an unbalanced distribution of power in the network. In this scenario, all major network-level activities and key decisions are coordinated by a single participant. Third, in a Network Administrative Organization (NAO) a separate administrative entity governs the network and its activities, acting often also as the network broker.

Main Activities (Exploitation vs. Exploration). In the study by Bierly et al. [31] innovation networks are claimed to have exploration and exploitation activities within firms. While in exploration innovation networks there is a greater emphasis in developing new technologies for innovative products and services, exploitation networks aim to enhance current capabilities for current products or processes. Supply networks would be a good example of the latter.

Geographical Span. Innovation networks can be local or have a global span depending on their regional concentration. Clusters, for instance, are a type of network with high regional concentration [4].

Value System. Möller et al. [20] define and discuss the importance of the value-system in intentionally formed networks that contain a finite set of parties. Three types of networks can be generally identified based on their value-systems: 1) - Vertical networks (ex. supply networks); 2) - Horizontal networks (ex. competition alliances, market and channel access/cooperation alliances); 3) - Multidimensional value nets (MDVN) (networks including partners aligned on the horizontal and vertical value system). For networks to function correctly, partners should not be completely aligned horizontally or vertically, since this fact may lead to direct competition inside the network [33]. The networks under analysis in this study are considered MDVNs.

3 Research Methodology

The research question driving this study is: “What are the strategies used to intentionally create innovation networks?” Due to the exploratory nature of the research, the case study method was selected as an appropriate research methodology [34]. For this purpose a multi-case study was carried out involving nine innovation networks created between 2009 and 2013. These innovation networks were fostered by a German consulting enterprise that received funding from the incentives created by the German Federal Ministry of Economics and Technology (ZIM-NEMO program, introduced in section 1), and acquired additional revenues from R&D project funding. Although created under the same firm, each innovation network has a separate network manager, different network partners, and operates within a distinct industrial setting. By focusing only on networks created under the same policy program, network variability due to external factors, such as different incentives, is somewhat reduced.

In researching network organizations, three levels of analysis are widely accepted [17]: interpersonal, intra-organizational and inter-organizational. As the purpose of our research is to study the strategies for the creation phase from the point of view of the network administrative organization (NAO), we selected the innovation network as the unit of analysis. This focus provides a holistic approach and the study of the network as a whole as described by Provan et al. [33]. Regarding the characterization of the studied networks, they all have a network organization structure, initially weak or non-existent ties (to the time of the creation of the network), a NAO governance model, conduct mainly explorative activities, possess a global span, and a multidimensional value net (MDVN) system.

The data collection method used was semi-structured interviews with network managers and three to four partners of each innovation network. The interviewees from enterprise partners were the CEO's of the companies and the research leaders from the research institutions. Each network manager was questionedregarding the context in which the idea for the network arose; his/her initial expectations for the network; the strategy and tools used for the creation of the network; his/her current network experience and critical issues; and what, in his/her opinion, would be the future of the network. Carrying out interviews to several network partners allowed data triangulation and increased the validity of the study. Partners thought to have different opinions from within the network were selected in order to obtain a more insightful picture. Network manager advice was used in selecting the partners to interview. All interviews were conducted in the interviewees' native language (German) and recorded when consent was given. Only two interviewees did not give consent to be recorded. In these cases notes were taken simultaneously to the interview. Other materials such as projects internal documents and partners profile descriptions were also used as data sources to complement the information from the interviews. Table 1 shows an overview of the different networks studied in terms of sector, partners, and year of creation, ongoing projects and key interviewees.

Table 1. Innovation networks overview. E - Enterprise; RI - Research Institution; PE - Project in Execution; Project in Planning; PI - Project in Idea; N/D - No Data Available; NM - Network Manager; NP - Network Partner.

No	**Main field of activity**	**No .of Partners**		**Active Period of the NAO**	**No. of Projects and budget (€)**			**No. of Interviewees**		**Main Strategy**
		E	**RI**		**PE**	**PP**	**PI**	**NM**	**NP**	
1	**Hybrid Sensors**	15	1	01/2010 - Ongoing	6 4,8M	5 0,5M	N/D	1	3	Partner Alignment
2	**Electric Mobility**	23	5	12/2011 - Ongoing	5 11M	6 4M	3	1	3	Cooperative Project
3	**Algae for high-value**	17	6	04/2012 - Ongoing	0	2 7,3M	12	1	3	Partner Alignment
4	**Industrial LEDs**	17	3	10/2012 - Ongoing	6 3,8M	14 8,7M	5	1	3	Cooperative Project
5	**Biomass for Energy**	23	13	10/2011 - Ongoing	5 1.2M	3 2M	15	1	3	Field Alignment
6	**IT**	13	1	01/2012 - Ongoing	4 0.8M	1 0,7M	N/D	1	3	Partner Alignment
7	**Smart Grids**	16	3	04/2011 - Ongoing	0	17 23M	66	1	4	Partner Alignment
8	**Wind Energy**	17	9	07/2012 – Ongoing	1 0,5M	3 5,7M	52	1	4	Field Alignment
9	**Drones**	7	6	01/2013 - Ongoing	0	3	2	1	3	Partner Alignment

Data was analyzed with the assistance of a case-level partially ordered meta-matrix as suggested by Miles and Huberman [35].

4 Strategies for the Intentional Creation of Innovation Networks

The innovation networks presented in Table 1 were created intentionally. This means that the mechanisms available for the emergence of networks [18] did not necessarily exist in the first place. For this reason, the network managers employed different strategies to ensure a sustainable environment where the network partners could come together and foster new innovation projects. Based on the actions described by the network managers, and the perceptions of the network partners, this study identifies three strategies used by the network managers to ensure the creation of the network environment, namely: Cooperative Project; Partner Alignment; and Field Alignment. Characteristics of these strategies in terms of partner ties [30], partner complementarities [20], knowledge transfer [17] and project generation are summarized at the end of this section in table 2,

Table 2. Characteristics of the identified strategies

Strategies	**Characteristics**			
	Partner Ties	**Partner Complementarities**	**Knowledge Transfer**	**Project Generation**
Cooperative Project	Active participation in project creates stronger network ties over time	Partner competencies complement each other well, but network will be compromised if partner exits network	Higher transfer of tacit knowledge, due to stronger ties	Main project guaranteed. Smaller amount of weak ties could be responsible for lower amount of project ideas.
Partner Alignment	Weaker ties with low danger of partner competition	Good partner complementarities. Network flexibility to adapt to new or restructured projects.	Information transfer between partners.	Project breeding environment. Pressure to create projects to ensure partner commitment.
Field Alignment	Weak ties with danger of partner competition	Large variety of competencies. Complementarities not guaranteed. Danger of competency overlapping.	Highly novel information transfer between partners	Idea breeding environment. High Pressure to create projects to ensure partner commitment.

4.1 Cooperative Project

The Cooperative Project strategy is probably the most straightforward of the three. In this strategy the manager starts by planning a large R&D project that addresses a specific emerging market, or a specific problem proposed by a large enterprise. The partners are screened and selected to be acquired into the network based on their specific core-competencies to tackle a certain part of the project. This strategy has the benefit of guaranteeing that every partner is actively engaged in the network during the planning and execution of the project. During this time networking and informal ties tend to occur within the network. Network number 2 is a good example where this strategy was well implemented. There is however a risk inherent to the Cooperative Project strategy: if key partners opt to leave the network and project, the whole network may be compromised, since its replacement might be difficult to achieve. In an attempt to use this strategy, in Network 4 some of the key potential partners refused to participate in a cooperative project. The network manager was able however to implement a different project concept, thus ensuring the future of the network while maintaining the same strategy.

4.2 Partner Alignment

While not having a concrete R&D project as a goal, the Partner Alignment strategy aims at providing a network partner mix of competencies and characteristics that will maximize the probability of concrete projects emerging after some networking events and workshops. Two aspects are vital to use this strategy: (1) the competencies of the network partners must be complementary; and/or (2) they should be active in different market segments. This ensures that there are no direct competitors in the network. Network managers that were using Partner Alignment as the main strategy emphasized the importance of carefully assessing possible competitors. Partners can have the same competencies as long as they are not active in the same fields, as can be the case in MDVNs [20]. Since the competencies needed to create the network are less specific as in the Cooperative Project strategy, the manager has a larger potential partner base at his disposal. The network will also be more resilient in case a certain partner decides to abandon it. In more than one project it was shown necessary to substitute a partner during the creation phase of a project. The higher flexibility this strategy provides to the network, made partner substitution and project reformulation an easier task. Evidence from the case studies showed, however, that since network partners were not involved in an R&D project at the time of network beginning, their commitment towards the network became reduced. This eventually led some partners to abandon the network.

4.3 Field Alignment

The Field Alignment strategy provides the largest potential partner base. Managers using this strategy approached potential network partners based on the fact that their field of activity was aligned with the field of activity of the network. The main advantage of this strategy is the high amount of network partners that can exist along with diverse and novel information and competencies. Since with this approach it takes generally longer to generate concrete R&D projects, the network manager must sometimes incentivize the network partners to participate in the network by other means, other to R&D project collaboration. Network 5 is a good example of the Field Alignment strategy. In this case, the network manager highly invested in Public Relations related work, such as the organization of events with networking activities and public presentations.

4.4 Final Remarks

During the interviews different partners expressed different expectations from the network: Easier access to market, higher visibility, access to partners and projects, and access to networking and new ideas. It is up to the network manager to ensure the correct strategy is being used. Network managers, active in the networks with highest ongoing projects and highest budgets, emphasized the importance of knowing their partners well and interacting with them as much as possible.

The coordination skills that are required by the network managers in these networks are consistent with the "coordinating by enabling" (i.e. network orchestration) defined by Ritala et al [28].

5 Conclusion and Future Work

This study analyses nine intentionally created innovation networks financed by the German ZIM-NEMO program, in order to identify and characterize strategies used to intentionally create innovation networks. All nine networks were created under the same incentives, thereby decreasing variability due to external factors. The networks are analyzed as a whole network in a multi-case study with the network as the unit of analysis in order to ensure a holistic approach, as mentioned by (Provan et al, 2007). The end result is the identification of three strategies used by the network managers to create innovation networks.

Understanding how these strategies influence networks may be helpful in sharpening the definition of policy initiatives in order to create innovation networks more successfully. The successfully implemented innovation networks of the type analyzed in this study have been shown to foster the creation of new industrial products and services [1, 13], and may in the future very much contribute as well to the economic growth and regional productivity [4, 10].

This is an intermediate study of a research project with the goal of creating a knowledge base platform to support the creation phase of innovation networks. To complement these results the end work of the research project will count with the analysis of other networks created under other circumstances. For this purpose, at least, the networks created in Portugal will be object of future study.

Acknowledgments. This research was funded by the Portuguese Foundation for Science and Technology, grant SFRH / BD / 51582 / 2011. The authors wish to thank all the interviewees, networks managers and partners, for their dedicated time and helpful insights. We are especially grateful to the company EurA Consult, AG for having facilitated the access to the empirical data and given all the support needed to carry out this research in Germany.

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Circulation of Knowledge in a Co-innovation Network: An Assessment Approach

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Abstract. The development of complex products and services require the domain of distinct types of knowledge that enterprises do not usually hold. In order to address this problem, the issue of assessment the knowledge circulation in collaborative environments started to attract attention. Starting with some discussion on mechanisms of production and circulation of knowledge that might operate in a collaborative environment, this paper introduces an approach for assessing knowledge circulation in a co-innovation network. Finally, based on experimental results from a Portuguese collaborative network, BRISA network, a discussion on the benefits, challenges and difficulties found are presented and discussed.

Keywords: Circulation of Knowledge, Collaborative Networks, Case Study.

1 Introduction

In order to be competitive enterprises must develop capabilities that will enable them to respond quickly to market needs. According to several authors, one of the most relevant sources of competitive advantage is the innovation capacity. [1]. The development of complex products or services requires access to several distinct types of knowledge that enterprises do not usually hold. As a result, in order to solve the lack of knowledge, enterprises can get new knowledge either from their own assets, making sometimes high investments or from the knowledge that may be mobilized through other enterprises based on a collaborative process. Literature in the field has pointed out that the participation in a collaborative process brings benefits to the involved entities [2] [3].

In fact, there is an intuitive assumption that, when an enterprise is a member of a long-term networked structure, the existence of a collaborative environment enables the increase of knowledge circulation as well as the production of knowledge within the network, and thus enterprises may operate more effectively in pursuit of their goals. In other words, the network acts as a channel to transfer knowledge from one organization to another, and may become the locus of new knowledge creation, rather than within the organizations members of the network.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 103–110, 2013.

However, in spite of this assumption, it has been difficult to prove its relevance due to the lack of performance indicators that assess the production and circulation of knowledge in collaborative environment. In this context, the definition and application of a set of indicators can be a useful instrument to the network manager, to a VO broker, and also to network members.

This work aims at contributing to answer the following main questions:

- What are the factors that facilitate co-production of knowledge in collaborative environment?
- How can competences circulation be analyzed in a collaborative context based on an inter-organizational perspective in order to support decision-making processes?

2 Production and Circulation of Knowledge in Collaborative Networks

In the emergent economy and society, the accumulation of knowledge becomes the main motivational strength towards growth and development. The knowledge-based economies are, essentially, economies where the knowledge managing activity, in relation to the innovating process, has become decisive in the competition among economic actors [4]. Networking, dense social networks, trust, cooperation, learning and knowledge accumulation and circulation are some of the key intangible factors of the knowledge-based economy. It is now commonly accepted that knowledge ranks first in the hierarchy of strategically relevant resources [5].

According to Gibbons *et al* [6] the exchange of information between scientific institutions and the commercial community is increasing through networking. The new industrial communities are characterized by a trend for knowledge production processes as a new pattern characterizing the new societies. The multidisciplinary nature of knowledge-based production is less isolated and on the other hand the network relations take a new relevance. This networked trend requires a collaborative participation of multiple disciplines and institutions in a bounderless collaboration space where knowledge sharing and value takes a relevant importance. The distributed character of knowledge production constitutes a fundamental change. To it are linked other dimensions of change: the marketability of knowledge, the blurred boundaries between disciplines and institutions and across institutional boundaries, increasing importance of hybrid *fora* in the shaping of knowledge. Gibbons presents a distinction between Mode 1 knowledge production, which has always existed, and Mode 2 knowledge production, a new mode that is emerging next to it and is becoming more and more relevant. While knowledge production used to be located primarily at scientific institutions (universities, government institutes and industrial research labs) and structured by scientific disciplines, its new locations, practices and principles are much more heterogeneous. Mode 2 knowledge is produced in different organizations, resulting in a very *heterogeneous* practice. The range of potential sites for knowledge production includes not only the traditional universities, institutes and industrial labs, but research centers, government agencies, think-tanks, high-tech spin-off as well. The Table1 illustrates the two modes (I, II) of knowledge production and its characteristics taking as reference the collaborative networks.

Table 1. Modes of Knowledge Production

Modes of knowledge production	Mode 1	Mode 2
Problem solving	academic community	context of application
Nature of Knowledge	Disciplinary	Transdisciplinary
Communication of knowledge	Dissemination trough established institutional channels	Diffusion though problem solving and shared in new contexts of application
Organizational form	Hierarchical	Networked

Mode 2 refers to a production and transfer of knowledge, which is not exclusively reserved for qualified academic research, but which focuses on the different actors integrated in a contextualised problem solving oriented process. The importance of knowledge is then assessed by its interest to stakeholders engaged in the process of production. This perspective is particularly relevant considering our case study.

3 Indicators of Production and Circulation of Competences

Having in mind the knowledge transfer model designed by Urze and Abreu [7] under the CoRe project[1], which incorporates three main dimensions, it is our purpose in this paper to develop mainly the competences management one, by creating a set of indicators. The absence of indicators related to production and circulation of knowledge clearly showing the amount of new knowledge created and transferred, might be an additional obstacle for a wider acceptance of collaborative-networked paradigm. Taking into account the context of collaborative networks and adopting indicators developed by Abreu and Camarinha-Matos [8] to assess how the assets are shared in collaborative networks, Table 2 shows a number of basic indicators that can contribute to evaluate the level of expertise of an enterprise and how production and circulation of knowledge is done within the network. Furthermore, these indicators can be determined for a particular collaboration process or over a period of time (average values) and can be used in decision-making processes, such as the planning of a new collaborative network.

Table 2. Indicators for competences production and circulation analysis

Indicator	Short Description	Expression
Total of Competences (C)	**Definition** The number of distinct competences held by the network. **Potential Use** This indicator measures the level of versatility/polyvalence of the network.	C – Number of distinct competences involved in the network

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[1] The present results are based on research work developed under the project – CoRe - Competências de I&D para a Criação de Valor na Rede Brisa, FCT/UNL, BRISA, ISEL/IPL, 2011-2012.

Table 2. (*continued*)

Total of enterprise Owned Competences (TOC)	**Definition** The number of distinct competences held by an enterprise. Applying concepts from Social Network, it corresponds to the enterprise's node degree. **Potential Use** This indicator measures the level of expertise and the potential capacity of an enterprise in terms of knowledge transfer.	TOC = Number of competences held by an enterprise.
Apparent Owned Competence Index **(AOCI)**	**Definition** The ratio between the number of competences that belong to an enterprise and the number of distinct competences held by the network. **Potential Use** An enterprise with an AOCI close to one means that this enterprise is the owner of nearly all competences available within the network.	$AOCI = \frac{TOC}{M}$ M – Number of competences held by the network
Owned Competences Index **(OCI_i)**	**Definition** The ratio between the number of competences that belong to an enterprise and the sum of the number of distinct competences held by all enterprises involved in the network. **Potential Use** • Normalization of the number of competences held by an enterprise in relation to other members of the network. • Benchmarking with enterprises involved in other networks.	$OCI_i = \frac{TOC_i}{\sum_{j=1}^{N} TOC_j}$ N – Number of enterprises involved in the network
Owned Competences Progress Ratio **($OCPR_i$)**	**Definition** The ratio of the owned competences index of an enterprise in two distinct periods of time. **Potential Use** • The aim of this ratio is to measure the progress of competences held by an enterprise over a period of time. If: $OCPR_{i[t_1,t_2]} \begin{cases} =1 & there\ is\ no\ change \\ >1 & OCPR_i\ increased \\ <1 & OCPR_i\ decreased \end{cases}$ • Benchmarking with enterprises involved in other networks	$OCPR_{i[t_1,t_2]} = \frac{(OCI_i)_{t_2}}{(OCI_i)_{t_1}}$ $t_2 > t_1$
Competences Abundance **(CA_i)**	**Definition** The number of distinct ownership relations of a competence. In terms of social network analysis, it corresponds to the node´s degree. **Potential Use** This indicator measures the level of abundance of a competence inside the network. A competence with a CA near to zero means that it is exclusive because it is owned by few enterprises of the network.	CA_i = Number of ownership relations connected to competence i.

Table 2. (*continued*)

Apparent Competences Exclusivity Index **($ACEI_i$)**	**Definition** The ratio between the level of proliferation of a competence and the number of enterprises involved in the network. **Potential Use** This index gives a simple to compute measure of exclusivity of a competence. A competence with an ACEI near to zero means that such competence belongs to few enterprises. On the other hand, a competence with an ACEI close to one means that such competence is owned by all enterprises in the network.	$ACEI_i = \frac{CA_i}{N}$ N –Number of enterprises involved in the network
Competences Exclusivity Index **(CEI_i)**	**Definition** The ratio between the level of proliferation of a competence and the sum of the number of distinct competences held by all enterprises involved in the network. **Potential Use** • Normalization of the level of exclusivity of a competence in the network. • Benchmarking with other networks.	$CEI_i = \frac{CA_i}{\sum_{j=1}^{M} CA_j}$ M – Number of assets held by the network
Competences Exclusivity Progress Ratio **($CEPR_i$)**	**Definition** This index measures the ratio of the exclusivity index of a competence in two distinct periods of time. **Potential Use** • The aim of this ratio is to measure the variation of exclusivity of a competence over a period of time. If: $CEPR_{i[t_1,t_2]} \begin{cases} = 1 & there\ is\ no\ change \\ > 1 & CEPR_i\ increased \\ < 1 & CEPR_i\ decreased \end{cases}$ • Benchmarking with other networks	$CEPR_{i[t_1,t_2]} = \frac{(CEI_i)_{t_2}}{(CEI_i)_{t_1}}$ $t_2 > t_1$

4 Application of the Proposed Indicators – Brisa Case Study

Methodology

The research is based on one case study pointed to the largest Portuguese motorway[2] is based on two main projects developed by Brisa, namely E_TOLL – *Electronic Tolling System*, a self-service toll lane where it is possible to pay by bank card or cash, and ALPR – *Advanced License Plat Recognition*, an enforcement system based on the automatic license plate recognition for situations where the vehicle is not equipped with an on-board-unit (OBU) or the OBU fails to electronically identify the vehicle. Brisa identified E_TOLL and ALPR as the projects that contribute the most to the return on investments. It means that they were relevant in terms of innovation and created value to the company. These were the criteria for choosing E_TOLL and ALPR as pilot projects. On a first stage, companies and other institutions (technology centres, universities) involved in the projects were contacted and invited to cooperate with our research. Empirical data stems from two main sources: in-depth interviews (the basic tool for qualitative research on social systems) conducted with key participants belonging to the network, and a brief survey (for quantitative data) applied to participants by using a social network analysis. The involvement of various partners in the network is critical in order to foster a spirit of openness and cooperation in this fundamental process.

Brisa Case Study

The Brisa company currently operates, on a concession basis, a network of eleven motorways, with a total length of around 1096 km, constituting the main Portuguese road links. Given its importance and dimension, Brisa owns several companies specialising in motoring services aimed at improving the quality of the service provided to customers and increasing its own operating efficiency. The Brisa co-innovation network is a long-term collaborative network (a VBE) that has more than 30 members from several domains and business activities (e.g. research institutions, universities, associations, governmental entities, start-ups, business angels, and suppliers).

The BRISA *Network Case Study*

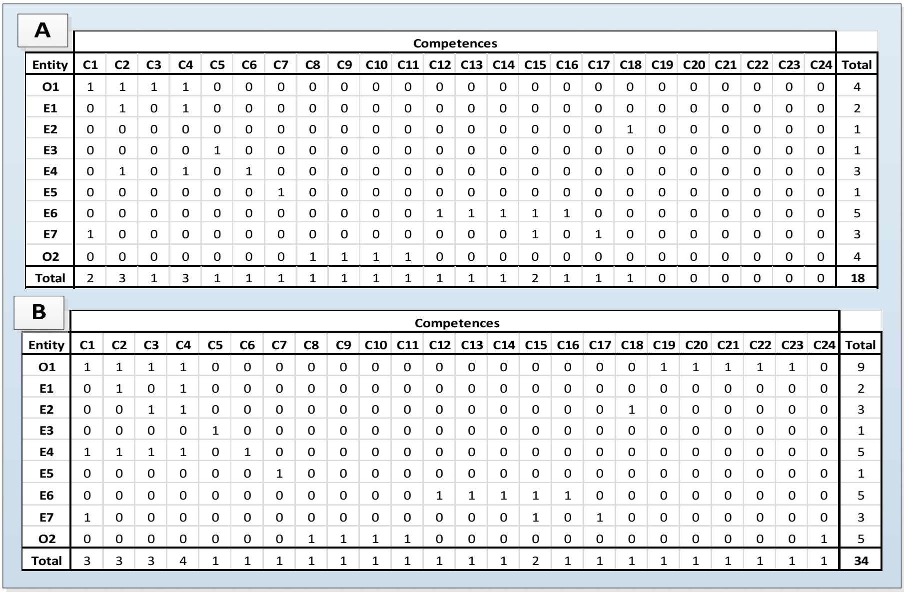
The paper's empirical section is based on one case study pointed to the largest Portuguese motorway operator. *Brisa* - Auto-estradas de Portugal, founded in 1972, currently operates, on a concession basis, a network of 11 motorways, with a total length of around 1096 km, constituting the main Portuguese road links. The Brisa co-innovation network is a long.term collaborative network (a VBE) that has more than 30 members from several domains and business activities (e.g. researches institutions, universities, associations, governmental entities, start-ups, business angels, and suppliers).

The empirical work is grounded on two main projects developed by BRISA, namely E_TOLL – *Electronic Tolling System* a self-service toll lane where it is possible to pay by a bank card, money and ALPR – *Advanced License Plat Recognition* an enforcement system based on the automatic license plate recognition for situation where the vehicle is not equipped with an on-board-unit (OBU) or the OBU fails to electronically identify the vehicle. In the case study three techniques were combined to carry out the empirical research: *in-locu* observation of the work processes, semi-directive interviews and questionnaires addressed to actors belonging to different organizations that take part of E_TOLL and ALPR.

Taking into account the data collected, Table 3A shows the types of competences used by each partner in the collaborative projects, and Table 3B identifies the types of competences held by each partner in the end of the collaborative projects. Based on the data presented in Table 3A, and Table 3B, and applying the equations defined in Table 2, Table 4A evaluates the production of new knowledge based on the number of distinct competences held by network in the end of the project E_TOLL and ALPR, and the number of different competences used by the network when the projects started. Based on these data, it is possible to verify that 6 new competences were produced (C19, C20, C21, C22, C23, and C24). Table 4B shows indicators to analyse, for instance, how the competences are held by network members, and the benefits of the entities' participation in a collaborative process.

Assuming that the benefits of an entity can be viewed as the capacity of involvement in a collaborative process; in this case, we are not particularly concerned with whether this benefit is due to the development of exclusive competences, but rather in analysing how many distinct competences might be performed by a member. According to Owned Competences Progress Ratio (OCPRI), at the end of those two projects, there are three members, O1, E2, and E4 that had a significant increase in terms of acquiring new competences that might be used in the future, and consequently, they have more

Table 3. A) Record of the competences used by each partner in the collaborative projects. B) Competences held by each partner in the end of the collaborative projects.



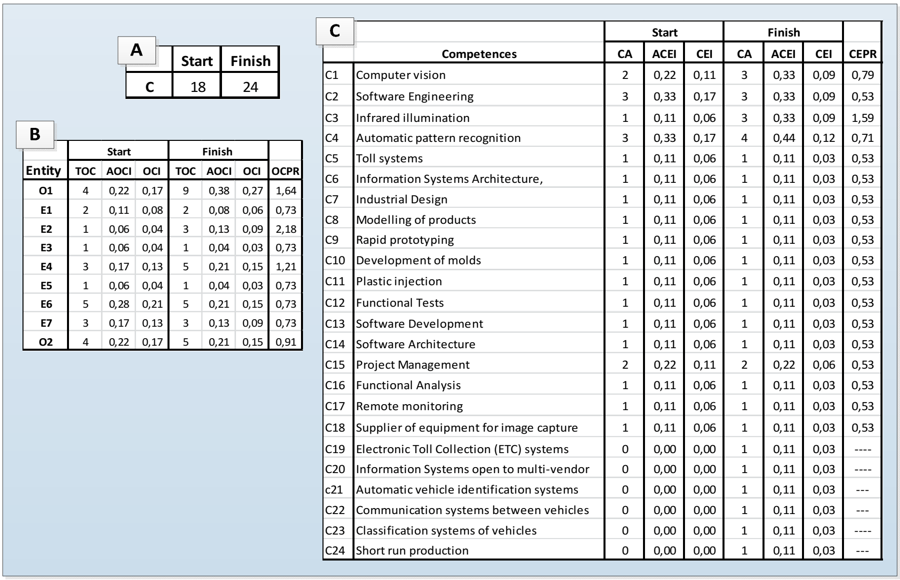
A

	Competences																								
Entity	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**	**C21**	**C22**	**C23**	**C24**	**Total**
O1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
E1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
E2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
E3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E4	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
E5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E6	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	5
E7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
O2	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Total	2	3	1	3	1	1	1	1	1	1	1	1	1	1	2	1	1	1	0	0	0	0	0	0	**18**

B

	Competences																								
Entity	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**	**C21**	**C22**	**C23**	**C24**	**Total**
O1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	9
E1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
E2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
E3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E4	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
E5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E6	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	5
E7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
O2	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Total	3	3	3	4	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	**34**

Table 4. Indicators for Knowledge production and circulation analysis



A

	Start	**Finish**
C	18	24

B

	Start			Finish			
Entity	**TOC**	**AOCI**	**OCI**	**TOC**	**AOCI**	**OCI**	**OCPR**
O1	4	0,22	0,17	9	0,38	0,27	1,64
E1	2	0,11	0,08	2	0,08	0,06	0,73
E2	1	0,06	0,04	3	0,13	0,09	2,18
E3	1	0,06	0,04	1	0,04	0,03	0,73
E4	3	0,17	0,13	5	0,21	0,15	1,21
E5	1	0,06	0,04	1	0,04	0,03	0,73
E6	5	0,28	0,21	5	0,21	0,15	0,73
E7	3	0,17	0,13	3	0,13	0,09	0,73
O2	4	0,22	0,17	5	0,21	0,15	0,91

C

		Start			Finish			
	Competences	**CA**	**ACEI**	**CEI**	**CA**	**ACEI**	**CEI**	**CEPR**
C1	Computer vision	2	0,22	0,11	3	0,33	0,09	0,79
C2	Software Engineering	3	0,33	0,17	3	0,33	0,09	0,53
C3	Infrared illumination	1	0,11	0,06	3	0,33	0,09	1,59
C4	Automatic pattern recognition	3	0,33	0,17	4	0,44	0,12	0,71
C5	Toll systems	1	0,11	0,06	1	0,11	0,03	0,53
C6	Information Systems Architecture,	1	0,11	0,06	1	0,11	0,03	0,53
C7	Industrial Design	1	0,11	0,06	1	0,11	0,03	0,53
C8	Modelling of products	1	0,11	0,06	1	0,11	0,03	0,53
C9	Rapid prototyping	1	0,11	0,06	1	0,11	0,03	0,53
C10	Development of molds	1	0,11	0,06	1	0,11	0,03	0,53
C11	Plastic injection	1	0,11	0,06	1	0,11	0,03	0,53
C12	Functional Tests	1	0,11	0,06	1	0,11	0,03	0,53
C13	Software Development	1	0,11	0,06	1	0,11	0,03	0,53
C14	Software Architecture	1	0,11	0,06	1	0,11	0,03	0,53
C15	Project Management	2	0,22	0,11	2	0,22	0,06	0,53
C16	Functional Analysis	1	0,11	0,06	1	0,11	0,03	0,53
C17	Remote monitoring	1	0,11	0,06	1	0,11	0,03	0,53
C18	Supplier of equipment for image capture	1	0,11	0,06	1	0,11	0,03	0,53
C19	Electronic Toll Collection (ETC) systems	0	0,00	0,00	1	0,11	0,03	----
C20	Information Systems open to multi-vendor	0	0,00	0,00	1	0,11	0,03	----
c21	Automatic vehicle identification systems	0	0,00	0,00	1	0,11	0,03	---
C22	Communication systems between vehicles	0	0,00	0,00	1	0,11	0,03	---
C23	Classification systems of vehicles	0	0,00	0,00	1	0,11	0,03	----
C24	Short run production	0	0,00	0,00	1	0,11	0,03	---

opportunities to participate in collaborative processes than those who have a low ratio. Table 4C illustrates some examples of indicators to evaluate, for instance, the level of exclusivity of each competence and the circulation of competences among members. Based on these data, it is possible to verify, for example, that according to Competences Exclusivity Progress Ratio (CEPR), the highest value belongs to competence C3 (infrared illumination) that had a great proliferation among members of the network.

5 Conclusions

Reaching a better characterization and understanding of the mechanisms of production and circulation of knowledge in co-innovation networks is an important element for a better understanding of the behavioral aspects, and also to improve the sustainability of this organizational form.

The development of a set of indicators to capture and measure the circulation and production of knowledge can be a useful instrument to the manager of this network, as a way to support the promotion of collaborative behaviors, and for a member as a way to extract the advantages of belonging to a network. Using simple calculations as illustrated above, it is possible to extract some indicators. Some preliminary steps in this direction were presented. However, the development of indicators to measure the potential impacts and worth related to production and circulation of knowledge, for instance, at a member level, in terms of capacity of generating new ideas, development of new processes, new products or services, organizational improvement through the combination of the existent resources and diversity of cultures and experiences of other enterprises is not yet well understood and requires further research and development.

Acknowledgments. This work was partially supported by BRISA Innovation and Technology (BIT) through a research and development project.

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Key Roles and Process to Foster Successful Firm – University Collaborations: The CEMEX Case

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Abstract. In 2007 the Processes and IT area in CEMEX launched an Open Innovation Strategy to collaborate with external experts such as universities, consultants and associations at a global level in key strategic topics. As a result, a portfolio of more than 50 collaborative research projects has been launched in particular with different academic organizations mainly in Europe and Mexico. Different lessons learned have been obtained, but one of the most relevant ones, has been the acknowledgement of different ways to manage collaborative research projects according to the business opportunities and the need to identify a process and roles to enable successful collaborations. Such collaborative spaces enable the sharing and co-creation of knowledge and the emergence of knowledge markets where intellectual capital is co-developed. This paper proposes a process to enable firms collaborate with Universities to deploy an open innovation model and the actors enabling it.

Keywords: Firm – University Collaboration, Open Innovation, Knowledge Markets, Knowledge Seeker, Broker, IP Entrepreneur.

1 Introduction

Growing global competition requires companies to be more competitive, improving their productive and business processes to operate in a leaner way. Enterprises are constantly under pressure not only to offer high quality products with competitive prices, but also to be constantly innovative offering new products and services to the international and borderless markets.

Research and Development to achieve innovations is a very costly, risky and lengthy process. As a consequence, it is difficult and challenging for companies to innovate in short periods of time in an ever increasing global market where customers' needs change quickly and the products' life cycles get shorter (Flores M. 2006a, Flores M. 2006d).

In this context, Henry Chesbrough from the University in Berkley defined the traditional innovation process as a Closed Innovation Model. The reason is that all innovation activities are located inside the company from the ideas creation, development process, sales and marketing. In this case, companies think that they are

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the best on their field; they have enough knowledge and resources inside their firm boundaries to develop such new solutions. Although this innovation model has been followed by many companies he argues that it cannot satisfy the fast changing demands of global customers in a changing society. As a result, Henry Chesbrough (2003) proposed a new concept which we coined the Open Innovation model as the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation.

Universities play a critical role as a source of fundamental knowledge, therefore should contribute in the formation of new collaborative environments increasing the innovation capabilities and continuous improvement. Universities can in fact be considered as a focal element for the development and dissemination of new knowledge and technologies for the design, development and commercialization of new products and processes (Flores, 2006b, Flores, 2006c).

Several highly innovative companies, such as Nokia, IBM, Intel, General Electric, among many others, have developed open innovation strategies to launch joint initiatives with Universities to catalyze their innovation process. As a result, CEMEX Processes & IT has launched more than 50 collaborative projects since 2004 with different Universities, Consultants and Associations in the Americas and Europe. Additionally, the role of Business Process Research and Networking Sr. Consultant was integrated in the Processes & IT team to coordinate the open innovation efforts.

One of the lessons learned of these latter collaborations is the definition of a clear process for CEMEX in which projects' outputs can be translated into valuable intangible assets which match the following criteria:

- **It Must Add Value:** it does not need to be new but it must at least represent an enhancement developed by CEMEX over an existing tool or process.
- **It Must Be Useful:** Intangible Assets are not measured by their cost but by their usefulness; usefulness means that it must enhance CEMEX operations, like increase efficiency, lower costs, etc.
- **It Must Be Shareable:** it should be helpful for at least two CEMEX Business Units

Furthermore, and part of the collaborative context, there are two additional concepts that are relevant while co-developing new intangibles; these latter are known as the Knowledge Market and the Intellectual Capital. A Knowledge Market fosters to create the knowledge required to innovate and therefore create more value. It is characterized by informal or formal relationships between independent partners, interested to collaborate in a win-win way.

In such a collaborative space different actors are required, which in most cases are: Knowledge Owner, Seeker, and Broker. Within the context of the CEMEX Research and Networking model, in the next section different roles have been identified to enable successful collaborations.

One outcome of the Industry-University collaboration is related to intangibles creation. A way to identify those intangibles created and also to measure their value contribution is through the Intellectual Capital. This approach groups all the intangibles in three, as follows (Guevara, 2011):

- **Human Capital:** This group includes the different assets of the person, such as knowledge backlog coming from training, skills, innovation competency, among others. Also, this group is part of the core competence underpinnings of the organization and it is rented to the business. In other words, the human capital includes those assets that return home after the business day is closed.

- **Structural Capital:** This group includes all of those assets that remain at the organization, as some could say that reside inside the walls right after persons go home. Here are included all processes, methods, systems and also intellectual property such as patents and trademarks.
- **Relational Capital:** Among the human and structural capital, there is another group of intangibles that has a direct relation to the activities employees perform outside the organization that involves external entities such as customers, government authorities, communities, etc.

This grouping method is considered to identify the value contribution of intangible assets in the organization.

2 Inputs, Outputs and Key Roles to Enable an Open Innovation Model

As a result of the lessons learned of approximately 50 different collaborative research projects carried out with several Universities since 2007 and based on a detailed literature review analysis, the following are proposed as key elements and actors to enable successful and sustainable open innovation projects in which both tacit and explicit knowledge is exchanged among them to obtain the expected results.

1. Input: a technical or business problem to be solved and the knowledge required to solve it

2. Knowledge Seeker: Entity or person with the need to resolve a technical or business problem using external resources applying the Open Innovation model. This actor belongs normally to the Firm and will become part of its R&D projects.

3. Knowledge Owner: Entity or person with the technical or business knowledge needed to resolve the Seeker's problems while using public or private funds to perform the required research. This actor in many cases is a researcher from a University, and could also be a consultant or an expert working in an Association or any other organization.

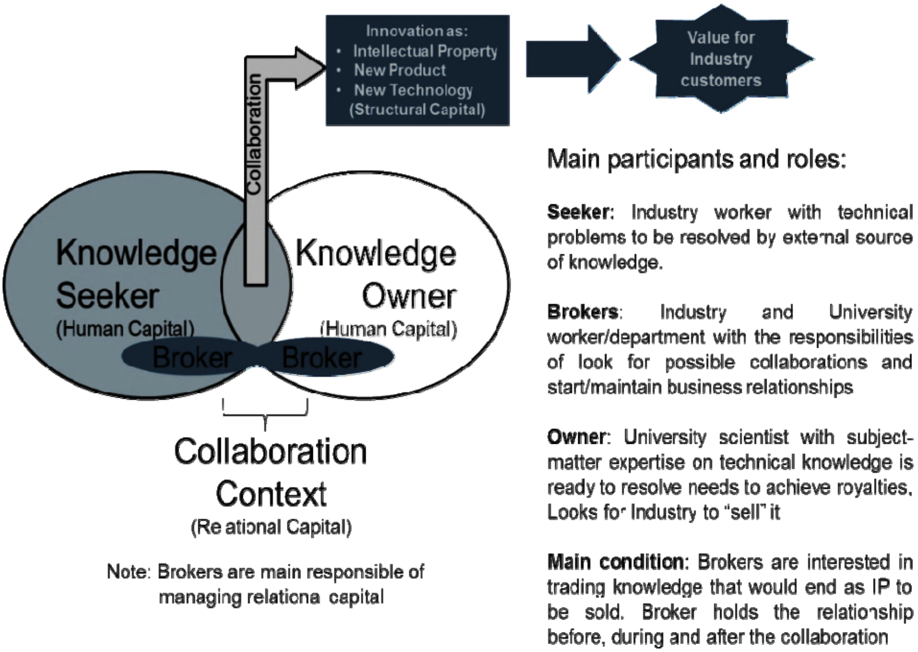
4. Knowledge Broker: Entity or person that bridges and manages the collaboration between the Owners and the Seekers. Also and before the collaboration between the Firm and the University starts, it is its responsibility to establish and agreement between the Firm and the University around the final intangibles expected due to the collaboration, as well as the commercial strategy of the new Intellectual Property (IP) created, whereas the IP is the formal documentation for the intangibles co-created or enhanced. However and depending on their functions and responsibilities, this role could be divided in two: one for the Firm and the second for the University side.

a) Firm Broker: The broker at the firm will facilitate the right understanding of the problem to clarify the project objectives and scope to look for an external partner. This latter will make sure that the knowledge owner has the right competencies and expertise to start a collaboration with the Seeker. In such context, the broker should focus so that that the Seeker and Owner collaborate to solve the problem. For that purpose a collaborative plan with key milestones will be defined in which both sides commit to deliver the outcomes.

b) University Broker: As in the case of the Firm, it has been observed that some Universities count with specialized brokers that look forward to match the knowledge developed in the University to sell it externally and develop a knowledge market in the form of IP, Licenses, basic or consulting projects to solve problems in the Industry,

5. Intellectual Property Entrepreneur: Entity or person in charge of selling/buying the IP generated during or after collaboration, as agreed by the Brokers and must be settled before the collaboration starts. It is responsible of royalties' agreements and contractual terms and conditions for licensing IP. This actor is found in some firms, for example this is an important role within CEMEX Research Group organization.

6. Output (Intangible Assets): The main deliverable of the collaboration turned as intellectual property (IP) that fulfills the requirements to be commercialized.



Note: Brokers are main responsible of managing relational capital

Main participants and roles:

Seeker: Industry worker with technical problems to be resolved by external source of knowledge.

Brokers: Industry and University worker/department with the responsibilities of look for possible collaborations and start/maintain business relationships

Owner: University scientist with subject-matter expertise on technical knowledge is ready to resolve needs to achieve royalties. Looks for Industry to "sell" it

Main condition: Brokers are interested in trading knowledge that would end as IP to be sold. Broker holds the relationship before, during and after the collaboration

Fig. 1. Key Roles to enable an Open Innovation Model for the Firm – University

Figure 1 depicts how the actors interact under a co-development environment to create a knowledge market. In here are identified the three types of the Intellectual Capital that are developed during the knowledge exchanges among the different actors. For example, as soon as the project is kicked off, the Human Capital intangibles are "adjusted" or enhanced at the Seeker and Owner roles; this is due to the fact that their interactions would transfer and enrich the knowledge, experience and others that are hold by the actors.

Similar to the enhancements of the intangibles belonging to the Human Capital, there are other intangible improvements on the Intellectual Capital. Continuing with figure 1, there are shown some relevant outcomes of the collaboration and they are related to the intangibles of the Structural Capital group. For this type are considered new patents, products, or technology that creates more value for the Firm. Moreover, the Relational Capital intangibles are enhanced as well. The improvements are more related to the relationships of the actors, and also to external entities such as new customer relationship. Regardless of the group of intangibles, it is important to highlight that the intangibles enhanced or created after and during the collaboration have a direct and high impact on the business value creation.

3 A Ten Step Generic Process to Co-create Intangible Assets

The different actors in the collaborative open innovation context interact among them in order to create value for both organizations. However, the interactions should be organized in a structured way to increase the expected successful outcome, which is to solve a problem and develop intangible assets that could be further replicated in a company or third parties.

In this section a ten step generic process is proposed by the authors for an effective collaboration (Edmondson et al, 2012; Fisher and Atkinson-Grosjean, 2002; Perkmann et al, 2011; Pertuzé, 2005).

Step 1 Identify the Need for Collaboration: In this step one of the actors, such as the Seeker, Owner or Broker identifies a technical or business knowledge gap. Within the firm, the knowledge seeker is motivated to search for external collaboration to develop a solution taking advantage of knowledge or expertise created previously by the owner.

Step 2 Request to Solve the Problem with External Knowledge: This step requires a formalization and clear definition of the problem or need to be solved during the collaborative project with the usage of external knowledge. The project objective, scope and key deliverables are defined. Also, at this point the need is translated in an ad-hoc and common "language" that could be understood between the Seeker and the Owner. In CEMEX, to facilitate the problem definition, the firm broker provides standard templates that have been designed to support the knowledge seeker define the problem in a simple way.

Step 3 Identify and Select Knowledge Owners: Once the problem is clarified between the Seeker and the Firm Broker, the next step is to identify the Owner who counts with the most advanced experience to solve the problem. In many cases knowledge owners are recognized by their high quality of publications either in journals, books or conference presentations. In CEMEX, the Broker is responsible of this activity.

Step 4 Bridge Seeker and Owner: In this step the connections between the Seeker and the Owner are built and formalized. Person-to-person interactions emerge; for example, the Seeker would be a Firm employee, and for the Owner would be the subject-matter expert or scientist in the University. In this step the working plan, deliverables, culture matching and intellectual property strategy are formalized and documented in detail. The interactions management and collaboration working plan and deliverables would be performed and monitored preferably by the Broker. Also and as part of the Broker functions, at this step all necessary agreements are established for the collaboration and they must be related to the final intangibles expected as co-created or enhanced due to the collaboration; also here is agreed the Intellectual Property (IP) strategy and partition of possible royalties if commercialized. It is important to remark that the owner of the IP must be CEMEX.

Step 5 Collaborate to Co-create Intangible Assets: The Seeker and Owner start collaborating accordingly to the plan and deliverables as intangible assets should be co-developed on time. During this step it is relevant to monitor the trustiness between Seeker and Owner, the interactions accordingly to the working plan, and it is also very important to verify the high quality of the knowledge transferred; all these activities are performed by the Broker. Additionally, is important to mention that in CEMEX the LEAD (Learn, Energize, Apply and Diffuse) project management methodology (Flores 2009) has been developed and implemented to facilitate seekers and owners to collaborate with a clear deliverables and milestones to be delivered by the CEMEX-University teams.

Step 6 Deliver Knowledge Assets as Intangibles: This is almost the final step of the collaboration. Here arise all the intangibles co-created by the interactions. The new intangibles should be protected according to the firm´s IP strategy; or it could be as new knowledge appropriation, implying that Owner knowledge is adequate to technical problem description and uses license from Owner by Seeker.

Step 7 Select Relevant Intangibles: The results of the firm-university collaborative project will be assessed to identify if they can be considered intangibles. Those that are relevant for the Firm should be documented and protected and might be also commercialized depending on the firm´s IP strategy.

Step 8 Protect Intellectual Property: After the intangibles resulting from the collaboration have been selected, at this step is implemented an agreed strategy to protect them and sell or license the intellectual property as follows: New process, model, product, brand, among others. However, the IP protection could be such as new process, model or operating system as Trade Secret, product or material as Patent or Trademark, and also software or document as Copyright. It is important to clarify the IP strategy and proportionality before starting the project. At this point, the IP Entrepreneur is involved in the process to let the firm´s Broker know about new intangibles protected as IP.

Step 9 Monitor Intangibles Performance: The new knowledge co-created as intangibles should be monitored as intangible assets using an open innovation scorecard classifying them into the three Intellectual Capital groups presented before: Human, Structural or Relational. Also, it is recommended that the Broker monitors the intangibles created and transferred internally and externally to the organization.

Step 10 Commercialize IP Internally and Externally: The firm´s IP Entrepreneur identifies potential markets to sell or license the intangibles protected as the result of these collaborations. Also and in some cases, this actor identifies and buys or licensees IP coming from other organizations.

4 The CEMEX-University Collaboration Process

Figure 2 presents a 10 steps process that has been followed in most of the collaborations with Universities in order to perform high impact projects for CEMEX. It is important to mention that there could be four potential scenarios triggering the process: 1) The Seeker at CEMEX looking for solutions for the firm, 2) The Owner (researcher at a University) proposing to implement a novelty in CEMEX, 3) The Brokers proposing to test or investigate about a futuristic trend in CEMEX which has not been yet implemented, 4) Solve a gap identified based on the discovery of external best practices or trends. In the process, the dot-lines from step 7 to step 10 highlight the area where intangibles are selected, protected and commercialized. This is because those steps are related to the intangibles management after the collaboration and also are proposed to gain more value after the commercialization of such intangibles.

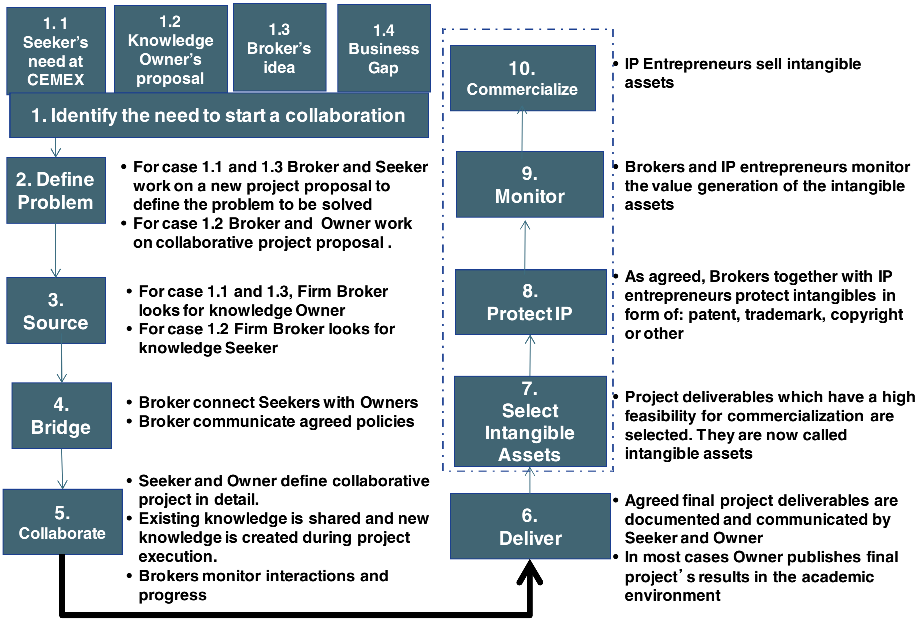


Fig. 2. Proposed Industry University Collaboration process in CEMEX (steps 7 to 10 to be implemented)

5 Conclusions

This paper integrates the following three key concepts: Open Innovation, Knowledge Markets and Intellectual Capital as key enablers to co-create intangible assets for CEMEX when collaborating with Universities. It is also highlighted that most innovative firms and Universities require the definition of specific actors such as Knowledge Seekers, Brokers and IP Entrepreneurs. To conclude, a process has been proposed to facilitate firm-university collaboration to co-create intangible assets.

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Building Collaborative Networks

An Innovative Virtual Enterprise Approach to Agile Micro and SME-Based Collaboration Networks

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Abstract. This paper demonstrates a lightweight and highly decentralized collaboration infrastructure approach for virtual enterprises and describes its added-value in the customer-oriented production domain. First, we will describe challenges and key requirements of an exemplary application scenario. Second, we are going to present the reference architecture and will explain the designs of enabling key concepts. Finally we highlight major improvements to the selected domain and the impact in economic, competition and social terms.

Keywords: Virtual enterprises, semantic data interoperability, process interoperability, business process modelling, mobile application orchestration.

1 Challenges of Micro Companies in a Virtual Enterprise

Regarding the Small Business Act for Europe [1], small and micro companies are important actors in all business fields across Europe with growing tendency. Small and medium-sized businesses (SME's) cover 37 per cent of added-value to the business economy. Micro companies with headcounts less than 10 employees cover 21 per cent of the added value to the business economy [2]. From a quantitative perspective, micro, small and medium enterprises represent 99.8 per cent of all firms all over Europe.

In the European textile sector small and micro companies faced massive changes both in retail and manufacturing due to saturated markets and their weak integration with partners. However, winners in the market have abandoned the traditional retail

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 121–128, 2013.

model for the so called vertical integrated approach. Its success is twofold: On the one hand side it is the transparency and control of the whole product value chain from the design, the production up to the retail of products. On the other hand side it is a deep understanding of their customers' needs and its integration into design and production processes as well as offering customized products.

Along the use case in the textile industry we present our vision of how micro companies can compete in a global market by transforming from isolated individual companies towards an integrated, agile virtual enterprise. A virtual enterprise is based on a temporary alliance of several businesses [3] and takes advantage of a market opportunity. It does not have own resources but consists of the resources of the individual partners.

In our visionary scenario, customers have high degrees of product personalization. Within the network, designer, producers, and end-customers communicate, collaborate and exchange relevant information in order to control a common and highly agile product value chain without high transaction costs. Ordering and production processes will be managed completely decentralized. The following six high-level requirements need to be addressed: 1) Virtuality (distributed and decentralized infrastructure) 2) Mobility (compatibility with commercial mobile devices) 3) Usability (intuitive tools for workers) 4) Flexibility (configuration of generic components) 5) Collaboration (interorganisational workflows) 6) Security (securing local data sets).

2 Architecture of a Virtual Enterprise

The ComVantage project has the goal to develop a reference architecture as well as a working prototype of a distributed collaboration infrastructure for virtual enterprises. In the following, the key characteristics are described.

2.1 Decentralized Approach

Even in a heterogeneous and distributed collaboration environment, companies want to continue running their legacy systems and want to keep full control of their valuable enterprise data. Our fully decentralized approach proposes a separation into *Domains* where a domain can be operated by an individual partner or can be shared among a couple of partners. This characteristic provides full scalability and satisfies the different needs of large and micro enterprises. Referring to the setup outlined in Figure 1, the webshop owner as major partner (partner A) of the collaboration network is running his dedicated IT-infrastructure (domain A). The tailor shop and the embroidery as micro companies (partner B1 and B2) are using a shared IT-infrastructure (domain B) which saves them efforts and costs related with running and maintaining their own one.

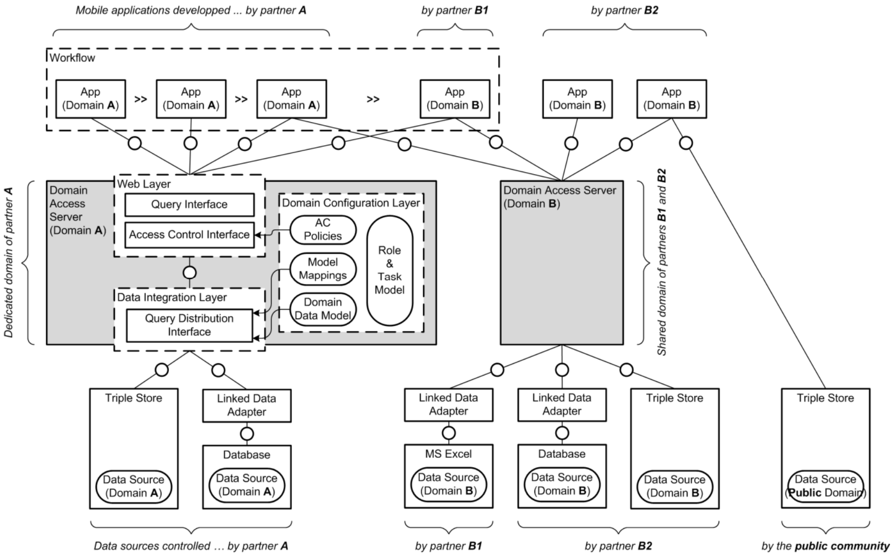

Fig. 1. Reference architecture for data- and process-interoperability in a virtual enterprise

2.2 Data Modelling

Major design-time activities in setting up a decentralized collaboration network are: First, creation of roles and tasks to define the subject of collaboration (*Role & Task Model*). This model is used to define local access rights on data sources. Second, the creation of local access control policies (*AC Policies*) guarantee full control about restricted and shared information within local data sources to each domain owner. Third, ontologies (*Domain Data Model*) to describe the data model of each domain are needed to enable the semantic data harmonization. A specification of the used methodology and the developed metamodels can be found in [4] as well as in the public deliverables D4.1.1-3 [5]. Unfortunately, ontology engineering is not easily applicable to micro companies. We envision a process that explicitly omits the complexity of developing ontologies from scratch for each partner. Micro companies should be able to join a collaboration network by simply adapting existing ontologies. In ComVantage we developed the tool *OntoSketch* that facilitates ontology engineering by offering support for ontology extension based on existing ontologies from collaboration partners and public communities. It allows the user to import existing ontologies, browse and filter their contents, and extend them with new concepts. The UI provides assistance to make ontology engineering also applicable to non-expert users.

2.3 Single Point of Access

Major difficulties of interorganisational collaboration consist in heterogeneous data models (structuring and naming of entities) and incompatible interfaces based on different technologies. In ComVantage we decided to use semantic data harmonization based on RDF, Linked Data and ontologies. RDF [6] is used as uniform data format based on the Linked Data design principles [7]. Within each domain of the collaboration network, a single point of access is provided by the *Domain Access Server* (Figure 1). The *Web Layer* of the server exposes a uniform interface for applications based on SPARQL [8] and provides an interface for enforcing access control policies. The *Data Integration Layer* is responsible for distributing requests to the connected data sources of the domain and merges all results to a combined result set. The *Domain Configuration Layer* provides components for a domain specific configuration of the Domain Access Server.

2.4 Integration of Legacy Systems at Run-Time without Modifications

Integration of heterogeneous data sources is crucial to data harmonization. The ComVantage approach is based on *Linked Data adapters* that will perform a mapping of syntactic data to RDF. The adapters are provided as generic components which will be configured with the Domain Data Model of the actual domain in order to connect to a specific data source. Using adapters offers the advantage of integrating legacy systems without modifications. Hence, the ComVantage approach can be used on top of an existing IT infrastructure and in parallel to already existing business applications. The adapters are provided for several technologies which are most common in micro-company environments. The Linked Data adapter for databases is based on the open source project D2RQ [9]. The adapter translates SPARQL queries to SQL and returns results based on a domain-specific mapping. While the mapping is defined at design-time, the content is lifted to RDF on demand at run-time which avoids the problem of keeping redundant data in sync. Since the database doesn't contain the semantic information that is required for this transformation, it is provided in a mapping file. Furthermore, adapters for Excel spreadsheets [10] and machine middleware systems are provided [4].

2.5 Access Control on Individual Enterprise Data Assets

Interorganisational collaboration relies on trust between partners and the fact that information from heterogeneous nature is accessible to authorized members only. An access control model is required that supports decentralized decision-making and that enables policy negotiation, establishment, management, monitoring and enforcement for a multi-domain access to Linked Data sources. Additionally, the mechanism should be simple enough to be applicable for micro companies. We propose an authentication process based on SAML [18]. Identity federation and security credentials interchange is performed in the first place and, afterwards, a multi-tiered authorization process takes place to provide multi-domain access control for Linked Data at two levels: (1) Rewriting of SPARQL queries by adding control checks related to the requesters user role. (2) Structuring of information in views for each data source to physically protect data that is not visible for a specific user role.

2.6 Modelling of Workflows and Orchestration of Applications

Additionally to the described data modelling approach we provide a workflow modelling workbench oriented towards business stakeholders within the design-time dimension of the architecture. A hybrid modelling method has been designed under the framework presented in [11] to capture collaboration and mobile app requirements on multiple levels of abstraction (a specification is available as a series of public deliverables at [5]). The modelling procedure recommends that each business process is first designed in a business view (with a "one responsible/activity" granularity), then extended to a technical view (with a "one required app/activity" granularity, to support the orchestration). We do not employ standard BPMN [12] tools for several reasons: a) the business process modelling language is only a fragment of a method which must integrate, on a metamodelling level, additional domain-specific semantics and abstraction layers captured in auxiliary linked models; b) the models are to be exported in a metamodel-dependent custom-made Linked Data schema, currently not supported by BPMN tools; c) practitioners reclaim a simplification of business process modelling [13], thus we try to avoid syntactical bloating and, notation-wise, the IT-inspired graphical representations. A comparison of collaboration patterns relying on swimlane-based control flows to BPMN is highlighted in Figure 2.

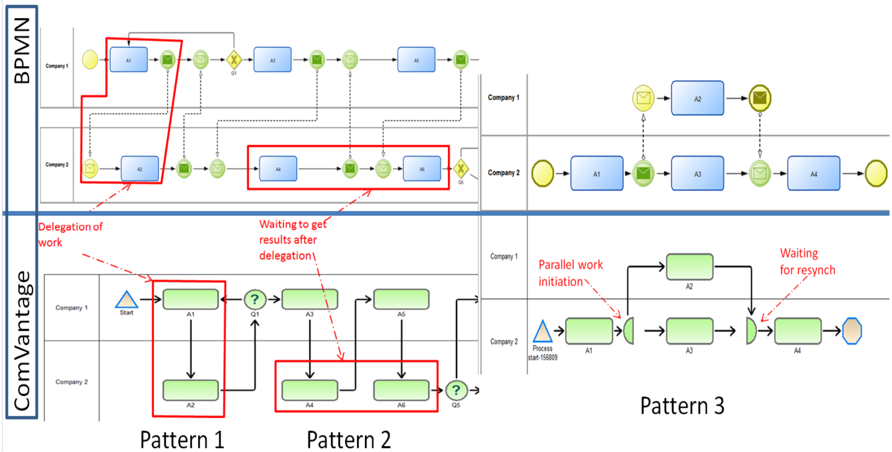

Fig. 2. Mapping of BPMN patterns (top) on the ComVantage approach (bottom)

Pattern1: Delegation or transfer of control. BPMN relies on explicit "throw and catch" messaging events between two activities. Our approach implies it with "subsequent" arrows shifting control between different roles (swimlanes). By convention, any activity initiating a cross-swimlane arrow can be considered a "notifying activity". Pattern2: Waiting to get results after delegation/transfer. BPMN relies on a sequence of activities on the same swimlane that is interrupted by throwing and catching messages. Our approach implies this with a lack of subsequent arrows continuing on the same swimlane. Pattern3: Delegation/transfer followed by parallel work. BPMN relies again on messaging to initiate a parallel flow in the partner company and to resynchronize with its results after the parallel work is finished. Our approach uses a parallelity split to distribute work between the two swimlanes, and a corresponding join to indicate where work must be synched back together.

Additional semantics are given by navigable links to related models (of other types), and can be explicitly serialized through an export mechanism (as N-quads [14]) to enable querying outside the modelling tool. For purposes of mobile app development, the most relevant links are the one from activities (in business process models) to roles and app features (in a resource pool model), for example:

:A1 a :Activity; :lane :Company1; :mobilesupport :Notifying_feature.
:Arrow1 :from :A1; :to :A2.

The first part will assure that the assignment between activities and swimlanes is not only a visual indication, but also an RDF relation that can be queried in order to detect the discussed patterns for further processing (for example, to assign mobile app skeletons based on them). The second part captures a link between the activity and an app feature required to support it, while the last part captures the process flow.

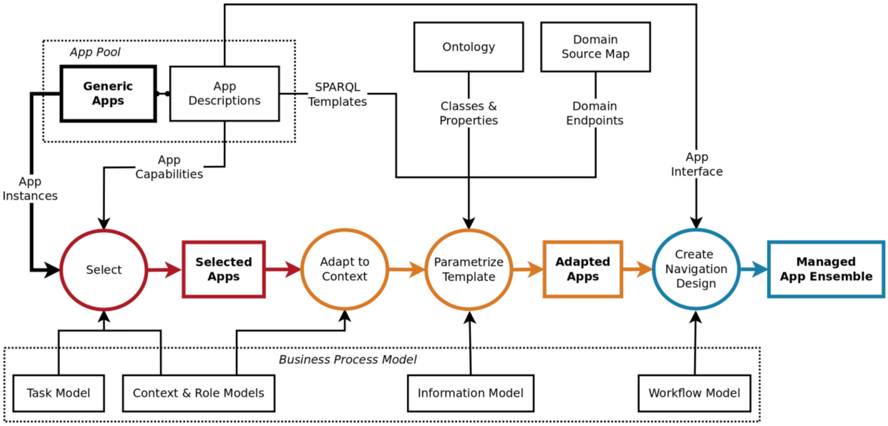

Fig. 3. The App Orchestration Process of the Industrial App Framework (see [17]). The three main steps (Select, Adapt, Manage) rely on various models as input. An App-Pool contains apps and formal descriptions that allow automatic selection. The end product is an App Ensemble that can be deployed on mobile devices and supports a specific workflow.

In ComVantage, such serializations of collaborative business process models are input for an *App Orchestration Process* [15] that is offered in the *Industrial App Framework* (IAF) (see Figure 3). Its goal is to simplify the usage of apps for mobile support of workflows in virtual enterprises. Existing models (e.g. business processes) are used to select the most appropriate apps from a pool, adapt them to the context of use, connect to data sources and create a navigation design that resembles the modelled business process [15]. The effort for supporting a workflow on mobile devices is much lower than with state of the art technology. Existing apps with proven usability can be reused and adapted to context [16, 17], missing apps are created using app templates and style guides (developed in ComVantage), and existing models can be used to drive the orchestration process.

3 Conclusion

ComVantage offers a collaboration infrastructure that facilitates data and process interoperability within virtual enterprises. Compared to related approaches in the field of semantic data harmonization like SemaPlorer [19], Aletheia [20] and Information

Manifold [21], ComVantage combines interoperability capabilities with a decentralized architecture which is crucial for the application within virtual enterprises. However, our approach is based on a lightweight infrastructure and is therefore lacking advanced semantic reasoning capabilities.

In this paper we highlighted the impact of our approach on small and micro companies that have a strong need for collaboration in order to gain a critical mass on core competencies and resources for competing with the global market. These companies need to implement lean and agile business processes to react on dynamic market opportunities. ComVantage responds to this by offering a modelling workbench for business processes and a model driven development approach for mobile apps taking into account the agility of workflows supported by the App Orchestration Concept. Furthermore, small and micro companies have a need for non-expert support for specific design-time tasks. We offer a couple of templates, guidelines and tools for facilitating tasks like ontology engineering and app development. Finally, the lightweight infrastructure of ComVantage simplifies the introduction of software tools to technology unaware environments as usually being found in small and micro companies and enables a complete end-to-end transparency among the whole production and supply chain of a product. Tracking and monitoring of used resources and related costs of a specific product will be much easier across the whole production and supply chain.

Regarding the social impact, ComVantage enables small and micro companies to join virtual enterprises on low investments but high strategic benefits. Micro companies who are suffering losses because of the global competition can benefit from the realization of the open virtual enterprise vision. This allows for example a designer, or a small tailor shop to apply for open production orders. Transferring the success factors of vertical integrated companies to a virtual enterprise consisting of a network of micro companies awakes further chance potential for European micro companies both manufacturers and retailers.

The concepts shown in this paper are result of the first year of the ComVantage project. Currently first prototypes are in development and a comprehensive business value evaluation will be conducted in the third year.

Acknowledgments. The European research project ComVantage [5] is funded by the European Commission on the grant number 284928.

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Conditions for Effective Collaboration in SME Networks Based on Graph Model

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Abstract. Collaboration represents an increasing tendency among Small and Medium Enterprises (SMEs), since the possibility of being a cooperative partner of a network allows the achievement of development strategies, either to improve production processes or to increase competitiveness. The objective of the paper is to propose and apply a new methodology to model manufacturing SME networks in terms of graph matrices, in order to identify some conditions that can foster an effective collaboration among partners of a SME network. A classification of SME networks in four typologies named “Marshallian Network”, “Supply chain network”, “Hub and Spoke network” and “Scientific Park” will be introduced. For each typology a graph-based model will be used to find out limits and critical points that can hinder the SME collaboration, or focal points for the interaction reinforcing.

Keywords: SME networks, collaboration, graph models.

1 Introduction

Collaboration represents an increasing tendency among Small and Medium Enterprises (SMEs). It is considered an effective solution allowing the achievement of development strategies [1,2,3,4,5], either to improve production processes or to increase competitiveness based on innovation and quality [6,7,8,9,10].

SME managers usually show a traditional individualistic attitude [11]. Unfortunately, small businesses often suffer in globalized markets from fierce competition in terms of products, labor and finance. On the contrary, being an independent but cooperative partner of a network could be a real possibility to obtain advantages for the SME. For example, by integrating skills of all the network partners the realization of more complex products it's possible; by cumulating SMEs capabilities, manufacturing volumes can increase; by sharing workers and resources, the effects of fluctuations of market demand can be reduced [12,13,14,15].

In the authors’ experience (based on the development of the EU-funded project “Collaborative demand and supply networks – CODESNET [16]), to complete the huge amount of papers and books published on the collaboration among SMEs, a

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 129–136, 2013.

simple and easily usable model of SME networks is required. It also represents, for the manager, an instrument for the analysis of convenience of collaborative relations in the SMEs network

This paper aims at developing a model of a SME network in terms of a graph-based scheme. The graph model provides a representation of the structure of connections among SMEs and the basic information that any manager has at disposal. Based on this simple approach, four graphs of different network types will be identified. The introduced classification is able to characterize a very large number of different SME aggregations: from industrial districts, to clusters, to poles of competitiveness, up to scientific parks.

The main goal of this paper is that, by considering the configuration of an industrial network to which a manager of a SME could be interested to participate, he/she can assess whether the network is able to support its own activities and its own business, by assuring further profit.

The paper is organized as follows. Section 2 describes the SME network classifications deriving from the experience gained from the CODESNET project. Section 3 introduces the graph-based SME network models and analyzes the four typologies of SME networks in terms of matrices derived from graphs. Finally, Section 4 draws some concluding remarks.

2 Classification of Network Types

The utilization of a graph formulation appears to be an important tool in order to provide a layout of a SME network. It also offers a starting point for modeling and analyzing flows and connections between the companies belonging to the network itself. To obtain a graph representation of a SME network, each enterprise (or a group of enterprises grouped according to appropriate criteria and to the desired level of detail) can be modeled by a node of the graph. The arcs between nodes correspond to possible links connecting SMEs; the connections can be either physical (i.e. exchange of materials, resources) or informative (i.e. exchange of information and know-how, transfer of orders).

The classification of the SME network structures has been obtained by using both the available literature on the topic and the concrete examples derived from the CODESNET database. For the derivation of the model, data of 160 industrial networks from 11 different European countries have been used. The classification consists of four graph-based configurations, illustrated in the following figures. In each figure, the network boundaries are represented by a rectangle, the small and medium enterprises belonging to the network, by the numbered circles and connections between SMEs by arcs. For formal issues without a loss of generality, a source node (named S) and a destination node (named D), if not belonging to the network, are introduced as external nodes.

The most common configuration is denoted as Marshallian-Italianate network [17]. A simple topological representation is given in Fig.1. This network is characterized by a set of SMEs, each of them can both provide and receive products / services / information from the others; this can be easily seen by the high number of arcs connecting the nodes. The node n.1 can be considered as a source node belonging to the network. Thus, the main characteristic of this topology is that it allows the presence of cycles.

Two examples of networks with this topological structure can be found in Europe. The first example is the Gold District of Valenza (“Distretto Orafo di Valenza”), an industrial district of the North-West Italy specialized in the jewelry production with an important role in the international market. The second district is the ShannonSoft, a network of Software activity in the Shannon Region in Ireland. In both these examples and in all the networks of the first type of configuration, the geographical proximity and the similarity in producing play an important role for the growth of the network.

A second type of SME aggregation has been identified as “supply chain” or, more generally, “***multi-stage supply chain***” [8]. At the right, in the previous Fig.1, a structure of a Multi-stage supply chain is represented: arrows represent links typically with an exchange of material or components. In the figure, the node n.8 can be considered as a destination node belonging to the network. An example of this organization is the Footwear District (“Distretto delle Calzature di Fermo”), located in the Center of Italy, specialized in the production of shoes.

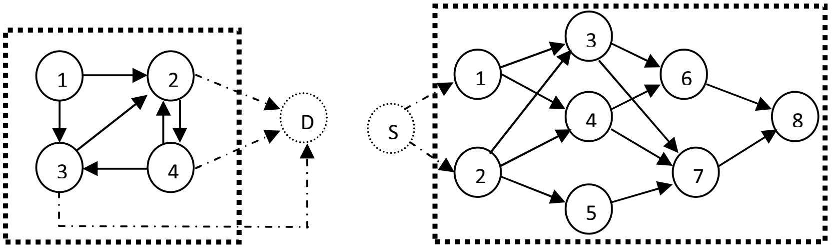

Fig. 1. Graphs of a Marshallian-Italianate network on the left and Multi-stage Supply chain network on the right, where S is the source node and D is the Destination node

Products are differentiated in order to cover different market stratification (shoes for man, women and child): to this aim, the chain is composed by stages with a number of parallel SMEs. Unlike the previous configuration, in this network cycles are not allowed.

Some SME aggregations can be described in terms of ***Hub-and-spoke*** configuration [17], owing to the presence of a leader in the network that will affect the decisions of all other partners. A simplified graph representation of the hub and spoke type with one leader and five SMEs is given in the next Fig.2. This configuration does not allow cycles and the lead node has a number of entering edges very higher that the other nodes, so it can be considered as a destination node belonging to the network.

The Eyewear District (“Distretto dell’Occhiale di Belluno”) in North Italy has a similar configuration: there are 5 leading firms corresponding to important brands of international fame, and around them a network of 1.500 small and medium enterprises specialized in the production of components or in particular production processes. In addition to these three models that represent very fixed and ruled interactions among

SMEs, there is another kind of aggregation, mainly exploited by high-tech production and/or service supply. Since the nature of such aggregation is mainly oriented to R&D, this configuration is named ***Scientific Park*** (or "*pole of competitiveness*" in France) [11].

In terms of graph representation (Fig.2 on the right), the nodes can be considered as inserted in a pre-existing network (light gray in the picture) of services and experience that can create contacts between enterprises that join the Scientific Park. In this configuration, connections are very flexible and more informal than in the other configurations. The typical feature of a Scientific Park is that each node is connected directly with the source and the destination nodes (due to the pre-existing network) and all the possible edges between nodes can be activated or interrupted at any time.

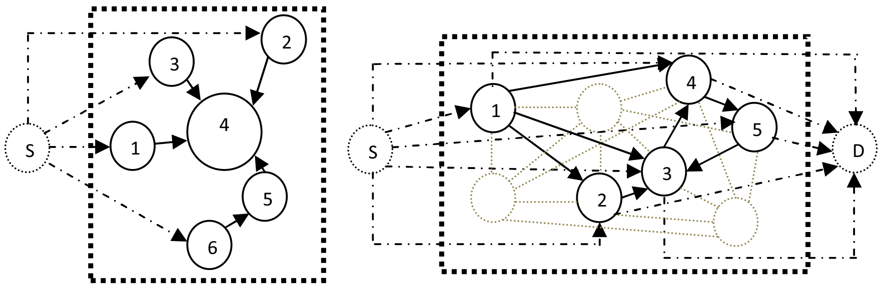

Fig. 2. Graphs of a Hub and Spoke network on the left and of a Scientific Park on the right

The exchanges between such companies does not concern materials or components but is an exchange of information (knowledge, data, models, ideas) and services, thanks to the underlying network of partners specialized in ICT and support to the innovative activities. The pole EMC2 in the "Pays de la Loire" in France, is an example of Scientific Park specialized in the sector of naval construction, aeronautics, yachting and the automotive industry. Another example is the Patras Science Park in Greece which strategic objective is to establish an Innovative Business Area in the Region of West Greece.

3 Recognizing Conditions for Effective Collaboration from Graph-Based Network Model

The modeling of a SME network requires to take into account two main aspects:

- the type of connecting structure, that means the organization of links among SMEs and the definition of types of flows on those links; the model of the connection structure is called "structural model" of the network;
- main functionalities to be performed in order to assure an efficient, effective and convenient management of operations of all SMEs in the network: that can be done through a "functional scheme".

3.1 Functional Scheme

The main functionalities that characterizes the SME network management organization can be modeled with a “functional scheme” [5]. The model is useful to give a visual representation of activities such as contribution of partners to the network management committee (if it exists); generation of production and financial strategies by the network committee; translation of strategies into activity plans to satisfy customers orders.

For the evaluation of the network performance, the basic element that should be recognized through the “functional scheme” is the network management committee in terms of its composition and its management tasks. The presence of a committee in a SME aggregation assures a coordination potential; its lack requires existence of a reciprocal trust among SME managers and, possibly, a coordination agreement.

3.2 Structural Scheme

From the structural point of view, a SME network can be represented in terms of a graph *G=(V,E)*, where *V* is the set of vertices and *E* is the set of edges or arcs. Typically, a vertex can be referred to a component SME, while an edge can represent a *SME-to-SME connection.*

For the scope of the present analysis concerning *network of manufacturing SMEs*, the graph under consideration is referred to the physical part flows (i.e., the logistic connections among SMEs).

The following different types of matrix representations could be identified for a graph *G* [19, 20] modeling of a considered real SME network,

- the *incidence matrix M* [nodes vs edges] that identifies the links outgoing from each node, i.e. the existence of output flows from a given SME;
- the *adjacency matrix R* [nodes vs nodes] that specifies the existence of all the connections among the nodes, i.e. the existence of flows from a SMEs towards another SME;
- the *path matrix P* [paths vs edges], that specifies the flows of products between two SMEs operating as suppliers and customers for the production of a specific product; the matrix P, for a particular product, is obtained by placing, for each path, a mark in correspondence with the edges (i.e., column) that belong to the working sequence of the product itself;;
- the *distance matrix L* [nodes vs nodes], where each element is a certain “magnitude” associated to each edge. The value associated to the edge can be, for example, the geographic distance between the two connected SMEs, the economic cost or the time associated to the transfer of products between the two enterprises. The *modified distance matrix L^* [paths vs nodes is obtained by placing, for each path associated to a particular product, the average production flow in correspondence with the SMEs (i.e. column) involved in the production.

This set of matrices can support the analysis of any type of SME networks and allows to recognize some conditions of either strong or weak collaboration among SMEs.

A sufficient analysis of a real SME network, based on above matrices, can be done by knowing the following “basic data”:

a) for each product type manufactured by the network,
   - the average flows to be produced per unit time (i.e., production volumes);
   - the working sequence (i.e., the sequence of SMEs involved to apply the required manufacturing activities);

b) for each component SME, the actual production capacity value, expressed in terms of the global volume of products per unit time that can be processed by the SME, in the average.

The analysis steps to be applied to a given SME network can be illustrated as follows:

1st step: Compile the following matrices M, R, P, and L^;

2nd step: Compute the production capacity of each SME, by summing all production flows reported in the same column of the modified distance matrix L^, associated with the considered SME.

3rd step: Apply a cutset recognition procedure to the path matrix P in order to identify any group of paths (i.e., groups of products that can belong to a same “product family”) and the related set of SMEs (that could belong to a same “supply chain”).

4th step: Compute the following indicators:

- network connectivity index (NCO), i.e. the number of non-null elements in matrix R, corresponding to the number of connections among SMEs;
- network utilization balance (NUB), in terms of the percentage number of SMEs for which the difference between the computed production capacity (at step 2) and the actual capacity value (type b data) is greater than a given “sufficient utilization” lower bound;
- network separation into chains (NSC), i.e. percentage number of recognized independent supply chains, if any, referred to the number of component SMEs;
- network chains independence (NCH), in terms of the percentage number of links (i.e., cutsets dimensions) connecting the recognized supply chains, if any;
- number of network bottlenecks.

	1-2	1-3	2-4	3-2	4-2	4-3	2-D	3-D	4-D
1-2-D	1						1		
1-3-D		1						1	
1-3-2-D		1		1			1		
1-2-4-D	1		1						1
1-3-2-4-D		1	1	1					1
1-2-4-2-D	1		1		1		1		
1-2-4-3-D	1		1			1		1	
1-2-4-3-2-D	1		1	1		1	1		

Fig. 3. Paths Matrix of a Marshallian-Italianate network

Referring to the Marshallian-Italianate network type, an evident measure of potential strong collaboration among SMEs is the high number of connections, then high value of NCO. A significant number of non-null element in the path matrix P in Fig.3 makes evidence of several loops, then another indication of good collaboration.

In a Multi-Stage network (see Fig. 1), each stage is a set of “parallel” SMEs, and each SME in a same stage could implement different work phases. Then, different parallel supply chains could exist, thus corresponding to low value of the NCH indicator and high value of the NSC one.

In any type of SME network, existence of independent supply chains can be a cause of a network subdivision into potentially competing and conflicting parts, mainly if the separations between any two supply chains is strong (low NCI).

A different situation occurs in case of a Hub-and-Spoke network, where partial chains could exist, but all converging on a same hub SME. Then, the NSC indicator will be low.

Specific considerations are required by the Scientific-Park type network, where two graphs exist: one composed by the SMEs already operating, and the other defining the set of all links that the park management committee can make at disposal of other new SMEs (i.e. an underlying network whose links can be activated in the future). The former network can have small NCO and almost null NSC. The underlying network, on the contrary, must be characterized by high NCO. Whilst no indicators can be computed for “empty” nodes.

4 Conclusions

In this work a bottom-up approach has been used to develop models for SMEs networks analysis. Thanks to the huge experience of analysis gained during the CODESNET project, a classification of different type of SME network has been derived from practices and formally modeled by two models. As shown, the different types of SME networks can be described by a set of matrices (adjacency matrix R, incidence matrix M, path matrix P, distance matrix L and modified distance matrix $L^\wedge$), in structural terms, and by the functional scheme, in terms of management. A procedure of analysis is also introduced in order to give a guide to conduct the SMEs network analysis and evaluation by the definition of a list of indicators. This represents a significant result of the paper since both the structure and the functionality of a SME network can be associated with few but significant indicators. The two models introduced constitute an important instrument to answer to SME manager requirement: to be able to decide having knowledge of the most critical conditions and information affecting the decision. So, in case a SME manager would like to estimate if its SME could have a profitable return becoming a partner in a network, this approach can give him/her preliminary approximated but significant criteria for taking a decision: whether trying to find an agreement with the network partners or the committee, or not. The type of network and its management, as currently operating, can give him/her the answer.

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A Practical Management Model for Supporting Virtual Organizations Creation within Their Breeding Environments

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Abstract. Among the various manifestations of collaborative networks in the literature, the Virtual Breeding Environment (VBE) has highlighted in the economic scenario since its implementation can provide the creation of Virtual Organizations (VO). The objective of this paper is to propose a practical model for supporting virtual organizations within their breeding environments, under the analytical approach of networks. The research method used is the study of multiple cases, involving eight VBEs of the manufacturing sector. The methodology that will support the creation of the proposed model is called Enterprise Knowledge Development (EKD), comprised of models of goals, concepts, business rules, actors and resources, processes and requirements and technical components. It is hoped that this model can enable the generation of concrete possibilities of facilitating the operation of the network as a whole. Additional topics will be presented in further work.

Keywords: Model, VBE, VO, EKD Methodology.

1 Introduction

The occurrence of multiple forms of relationships among companies is a topic that has been discussed in the literature recursively. Thus, there is a growing convergence of views of different schools for a better competitive performance that should focus not only on individual company alone, but primarily on investigating the relationships among companies and with other institutions [1]. In this context, collaborative networks arise, which with the advance of Information and Communication Technologies (ICT) allow regionally distributed and heterogeneous entities can share resources, skills and risks, in order to reach common goals. Aiming at a better promotion of the conditions for the establishment of virtual organizations, there are environments for creating virtual organizations (Virtual Breeding Environment - VBE), which correspond to a set of organizations and institutions that have great potential for collaboration. [2], [3].

The possibility of creating a virtual organization triggered during the operation phase of a network VBE has been one of the main mechanisms of corporation survival, since it allows different entities to offer products and services in a global

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 137–144, 2013.

market [4], [5]. In this context, the basic assumption is that the entities that are part of a VBE are prepared to collaborate [6], [7]. This preparation should include common infrastructure, documented agreements, mutual trust and work patterns. [8].

Regarding the determination of models that describe briefly the operational phase of a network VBE, it is observed as the current stage, a lack of published works on this topic. The literature presents some proposed models for collaborative networks as [9], [10]. The proposition of Camarinha-Matos and Afsarmanesh [11] lists the necessary elements of a collaborative network in a reference model - ARCON (A Reference model for COllaborative Networks). From this model, Romero and Molina [12] propose a reference model for the creation of virtual organizations, placed in the context of a VBE. This model has the following steps to create virtual organizations: a) identification and characterization of opportunities, b) project planning, c) research and selection of partners and competence, d) negotiation, e) detailed planning, f) assignment and g) launching.

However, these models do not predict a systematic overview of how the concepts are related to the processes for supporting virtual organizations creation within their breeding environments. Since the primary purpose of a VBE is to establish necessary conditions for the creation of a virtual organization, the purpose of this paper therefore is to systematize the concepts and processes involved in the steps of creating virtual organizations, within the operational phase of the VBE. From the literature review and the support of the EKD methodology, the model of concepts will then be developed. Through of the multiple cases studies, the processes model is developed.

2 Literature Review

2.1 Organizational Modeling

In the context of modeling, a model can be understood as an abstract representation of a system, which will be used as a guide for development. A model may also be important to manage the operation of a system during its life cycle [13]. Thus, some effort has been undertaken for the development of models, such as: ARCON [14], FEA [15], SCOR [16] and VERAM [17].

The methodology EKD (Enterprise Knowledge Development) provides the basis for understanding and support for organizational changes, as well as help in developing information systems that support the organization. Models that are part of the EKD methodology are [18] - a) models of objectives: concentrate on the description of the ideas of the organization, what they want to achieve or avoid; b) models of concepts: represent the entities, attributes and relationships among them; c) models of rules: used to set and maintain the rules formulated and consistent with the model of objectives; d) models of actors and resources: used to describe how different actors and resources are related and how they relate to other models; e) models of processes: used to define the process of the organization, and the way in which they interact with and deal with information and materials; f) models of components and technical requirements: used when the proposition of EKD methodology is to help define the requirements for the development of an information system. From the justifications, the EKD methodology will be used to build the proposed model, since it fosters systematic analysis, understanding, development, documentation and organization of morphological components for the creating virtual organizations by VBE.

2.2 Environments for the Creation of Virtual Organizations

A Virtual Breeding Environment (VBE) is a set of organizations and their supporting institutions, endowed with human conditions, financial, social, structural and organizational potential for the creation of virtual organizations. A virtual organization is a temporary network of companies or combination of capabilities that share resources and purposes aiming at a common goal within a given period, in response to the opportunities eventually presented to them. At every opportunity, the mission, responsibilities, competences are established and risks are shared. [19].

Since one of the main functions of VBE is to promote the creation of virtual organizations, the ARCON model was instantiated culminating in a set of steps for this purpose. [20]: a) identification and characterization of the opportunity, b) project planning of virtual organization, c) search and selection of partners, d) negotiation, e) detailed planning, f) assignment and g) launching. The model of concepts was developed to represent the phase of operation of the collaborative VBE network for creating virtual organizations (Fig. 1):

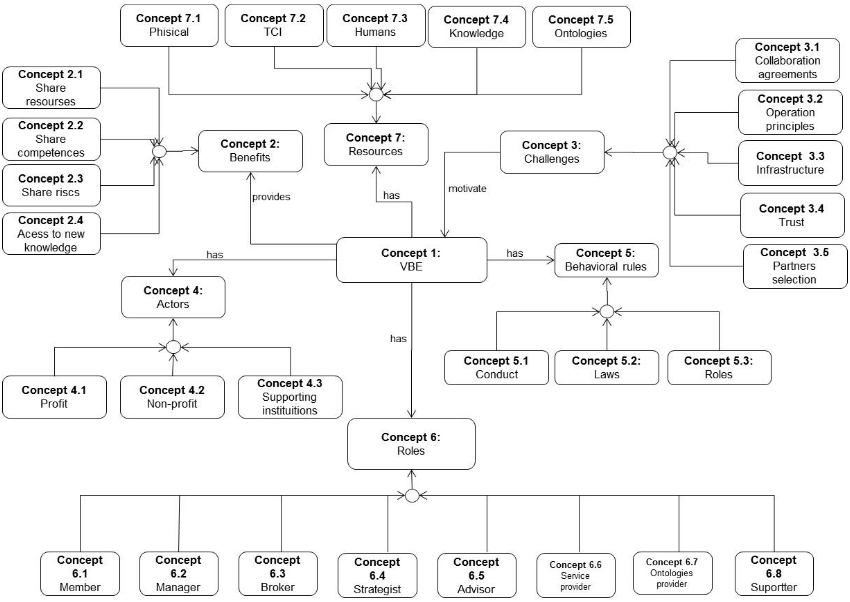

Fig. 1. Model of concepts

As shown in Figure 1, one VBE (Concept 1) provides a number of benefits (Concept 2), among which stand out: the sharing of resources (Concept 2.1), sharing skills (Concept 2.2), risk sharing (Concept 2.3), access to new knowledge, among others. Among the challenges (Concept 3) that motivate the creation of virtual organizations by VBE can be included: development of collaboration agreements (Concept 3.1), generation of operating principles (Concept 3.2), establishment of infrastructure (Concept 3.3), setting trust (Concept 3.4), partners selection (Concept 3.5), among others. Aiming the creation of virtual organizations, one VBE has behavioral rules (Concept 5) such as behavior (Concept 5.1), laws (Concept 5.2), roles (Concept 5.3), among others. A VBE also features actors (Concept 4), which are organizations registered in the VBE, which can form virtual organizations, like for-profit organizations (Concept 4.1), nonprofit organizations (Concept 4.2), supporting institutions (Concept 4.3), among others. A VBE also plays a number of roles (Concept 6), such as a member (Concept 6.1), manager (Concept 6.2), broker (Concept 6.3), strategist (Concept 6.4), advisor (Concept 6.5), service provider (Concept 6.6), provider of ontologies (Concept 6.7), support (Concept 6.8), among others. A VBE has resources (Concept 7) to provide the necessary conditions for the creation of virtual organizations, such as physical (Concept 7.1), infrastructure, information and communication technology (Concept 7.2), human (Concept 7.3), knowledge (Concept 7.4) ontologies (Concept 7.5), among others.

3 Research Methodology

This research was conducted in three stages. The first, a survey was conducted in bibliographic databases to find articles in journals related to the objects of this study.

The databases used were the Web of Science, Science Direct, Emerald, Compendex and Elsevier. The keywords considered to start the search were collaborative networks, virtual breeding environments and virtual organizations. The papers were selected based on the analysis of the impact factor of the journals that is published in the Journal Citation Report (JCR) indexed by the Institute for Science Information (ISI) and the abstracts to identify the main articles that could contribute to this research. In the second stage, multiple case studies were carried out with eight VBEs. Initially the VBEs administrators were contacted by email and phone. Among the nine VBEs contacted, seven advisors e one administrator (Mexico, Switzerland, Brazil, United Kingdom, Ireland, Italy, Germany and Spain) returned the emails confirming the possibility and interest to participate in the research, and indicated respondents that knew more deeply the working of VBEs surveyed. The purpose of the questionnaire was to understand the process of operationalization of VBE with respect to the creation of virtual organizations [21]. The last stage was the development of an organizational modeling based on the EKD methodology. Considering the purpose of this study, a process model was developed to represent the stages of creation of virtual organizations, by VBEs surveyed.

4 Multiple Case Studies

Data were analyzed, organized and systematized by EKD modeling methodology. To do this, first, the questionnaires and conversations with respondents of VBEs were printed. This information was important for making the current status model. The next model was the future status model. This model was the result of analysis and comparison with literature and the current status model. The process model of the current status demonstrates how the VBEs in the phase of operationalization perform in order to create virtual organizations (Fig. 2). The analysis of the current status allows us to understand the processes of the organization, identify the actors and resources involved, the dependencies among the actors and business objectives.

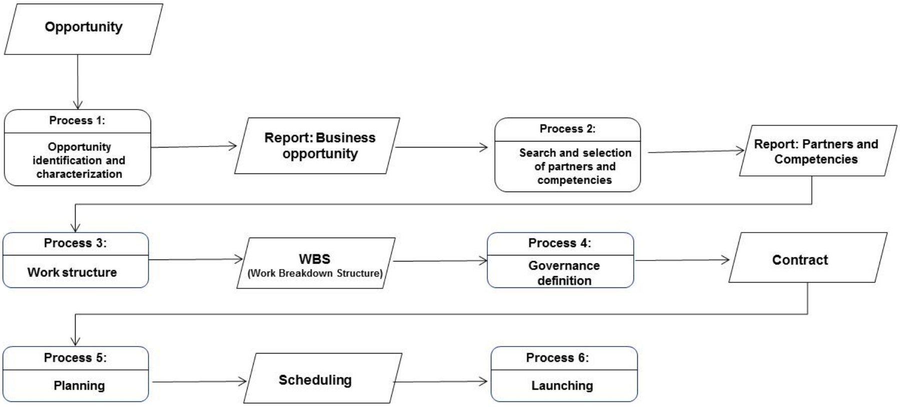

Fig. 2. How the VBEs perform to create virtual organizations within their breeding environments

According to survey respondents, an opportunity (Process 1) can arise through external market or among entities that are already part of VBE. Who usually performs the step of identifying opportunities is the broker. Then the broker performs the step of search and selection of partners (Process 2), in order to meet the identified opportunity. From opportunities and partners selected, the VBE manager prepares a Work Breakdown Structure project (Process 3) for the new virtual organization. Definitions of governance (Process 4) contained in the contract establish the rights and duties among members of the virtual organization. The planning stage (Process 5) involves the preparation of a schedule of operation of the virtual organization, from the integration of activities, deadlines and the people responsible of this. Finally, the stage of launching (Process 6) involves putting a virtual organization in operation, by activating the services and notification of members. From the literature review and multiple cases studies (which presented the current status of how VBEs perform the steps of creating VO) it was possible to build a framework (Table 1) containing the changing needs. In other words, it could be identified what are the elements that both the literature and the VBEs recommend for the creation of virtual organizations.

Table 1. Recommendations for creating virtual organizations (Overview of Literature x VBEs)

Literature Recommendations	**VBEs - Multiple Case Studies**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Identification and characterization of the opportunity	■	■	■	■	■	■	■	■
Project planning of virtual organization	■	■	■	■	■	■	■	■
Search and selection of partners	■	■	■	■	■	■	■	■
Negotiation	■		■			■		
Detailed planning	■	■	■	■	■	■	■	■
Assignment	■	■	■	■	■	■	■	■
Launching	■		■			■		

The comparison between the recommendations of the literature and the findings from multiple cases studies led to the process model proposed for this paper (Fig. 3).

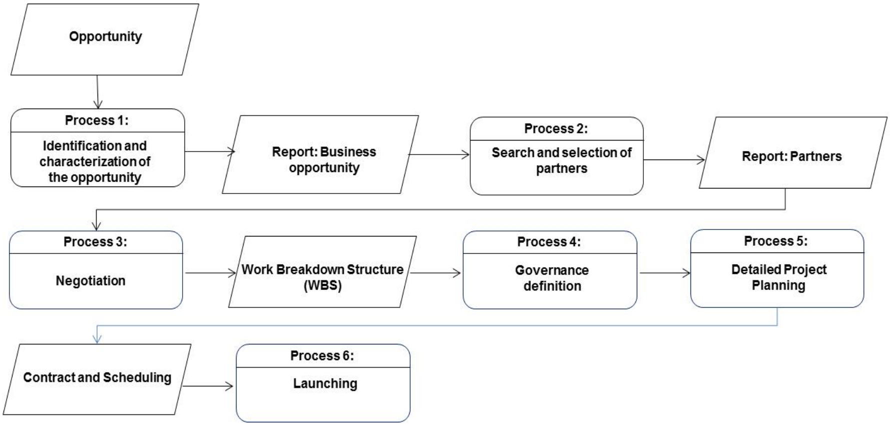

Fig. 3. Process model proposed for creating virtual organizations by VBEs

The proposed process model has six processes: an opportunity (Process 1) can arise through external market or among entities that are already part of VBE. Who usually performs the role of identifying and characterizing opportunities is the broker. In order to automate the process of identifying opportunities in a VBE, Demsar, Mozetic and Lavrac [22] developed a tool called CoFinder (Collaboration Opportunity Finder). The tool compares the potential opportunities for collaboration with the essential skills stored in a database provided by the VBE. Then, the broker executes the search and selection of partners (Process 2), in order to meet the identified opportunity. Ermilova and Afsarmanesh [23] proposed a tool called PCMS (Profile and Competency Management System) whose purpose is to organize and manage a repository of expertise of the organizations that are part of the VBE, as well as the resources and capabilities demanded. From opportunities and partners selected, critical activities related to the creation of virtual organizations are established, among them: who is responsible for virtual organization, how risk sharing among the partners occur, how the sharing of information and treatment of privacy issues should be (Process 3). Definitions of governance (Process 4) establish the rights and duties among members of the virtual organization. Detailed planning (Process 5) involves the preparation of a contract and schedule of operation of the virtual organization. The launching (Process 6) involves placing a virtual organization in operation by configuring the infrastructure of information technology and communication, resource allocation, activation and notification services of the members involved.

5 Conclusions

Over the past years, various entities (such as research centers, companies, universities and government agencies), motivated in part by the process of internationalization of the economy and partly by the highly competitive global markets, have seen collaborative networking as great opportunity for sharing knowledge, uncertainties, risks and opportunities. In this context, a VBE is strategic for the creation of virtual organizations, especially because the phase of operation can enable the creation of virtual organizations. But note that there are difficulties for the creation of virtual organizations, such as agility, trust, negotiation and finding partners. Studies have shown that there are few studies that establish a systematic framework for the creation of virtual organizations, from the operational phase of the VBE. With the aid of the EKD methodology, a model of concepts was developed to understand the concepts, roles, benefits and challenges of VBEs for creating virtual organizations. From the comparison between the recommendations of the literature and the current situation of the creation of virtual organizations by VBEs, a process model was proposed. The determination of the model that includes the operation phase of VBE should help in the systematization of knowledge, generating the possibility to visualize the steps of creating virtual organizations as a whole, as well as allowing the researcher to find gaps that may be more explored in future research.

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Performance Management

A Comprehensive Approach for the Management of Virtual Enterprises Including Performance Analysis, Provision of Incentives and Allocation of Income

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Abstract. This conceptual paper focuses a comprehensive business model for service-oriented collaborative networks and Virtual Enterprises. In that context an innovative concept for the operative controlling of enterprises operating in order-specific configured collaborative systems is introduced. This approach includes a variety of methodologies. The main part of that approach considers income allocation based on the realised performance. Therefore a concept for the order-specific performance analysis has been developed. Additionally incentive mechanisms are considered. By the help of that approach new impulses for the operative enterprise management and controlling are available.

Keywords: Production Management, Virtual Enterprise, Performance Analysis, Business Modeling.

1 Motivation

An increasing number of production and supply processes are completed by collaborative systems. The reasons for that development are mainly of financial nature. However, enterprise-spanning cooperations cannot always act without frictions. Thus, an effective business model for service-oriented production and network management is required for the coordination both the cooperation and the value-adding process. Methods for the order-specific partner selection and preparation of offers are already available. However the challenging task of income allocation and process-related performance analysis mostly still remain unclear. This fact constitutes a major problem to be solved. The present contribution addresses these issues and focuses appropriate solutions.

Currently applied approaches of cooperations controlling are usually the classic corporate controlling methods. For this reason, the specific requirements of cooperation management are considered unsufficiently. This often leads to unsatisfactory results. The introduced framewerk and its methods represent an extension of the current controlling instruments. The main advantage is the high degree of adaptability. This allows a flexible applicability for the user, which is not available when standard instruments are applied. That fact represents a significant value added and expands the capabilities of cooperation management significantly.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 147–155, 2013.

2 Initial Situation, Problem Formulation and Research Object

Actors, who track an objective on their own, are by trend less successful than those, who align themselves and cooperate. On this note, cooperation forms an important precondition for evolution, as only those persons involved will survive in the long run and establish oneself in competition successfully, who adjust best to the given environmental conditions and who apply the most effective and most successful survival strategies. Cooperation is a very successful strategy in most of the cases. With regard to economy, similar conclusions can be drawn. As a general problem statement it is obvious that cooperation needs a comprehensive framework for controlling and management. That topic is focused in the next sections.

It is clear that cooperations not only bring benefits but also incur costs. However in the following it is assumed that only cooperations form when the (additional) benefit exceed the (additional) costs. In general, although independent enterprises act successful on the market, cooperation often generates additional capabilities. These allow for an even more successful market participation, provided that those advantages are not compensated by frictional or coordination losses between the cooperating partners.

From a historic point of view, many (successful) types of cooperation and teamwork can be identified within economy. Milestones are the implementation of division of labour in production processes, cp. the example for mass production of pins [1], a consistent improvement in assembly line production within an industrial environment by Ford or the formation and operation of company cooperations in terms of company networks [2] as long-term cooperations [3] or virtual enterprises [4],[5]. Especially since the middle of the 20th century, economical motivated co-operations are studied increasingly from a scientific point of view. Whereas for the time being primarily economic problems took centre stage, referred to seminal publications of Coase in 1937 where questions of in-house production depth have been debated - a topic, which also concerns the formation of cooperations [6], since 1980 also economical and information technology-related questions of cooperation have been discussed increasingly. Especially since 1990, networks, virtual enterprises and supply chains are researched intensely, which meanwhile led to a review of general and basic circumstances and the current work focuses on more specialized problems. The article on hand belongs to this category.

In the context of the given problems explained in section 1it is necessary to localise room for improvement of the given methods or to develop new instruments. Currently, there have hardly been any scientific methods available for researching the existing problems in a specific way. Particularly the tasks after completing a value-added process remain unclear from the scientific point of view in most cases. It is necessary to research possibilities for an improvement of the functional mains operation for manufacturing small enterprises.

The economic environment of important industrial nations, which is characterised by a great dynamic, is affected by divergent interests, as on the one hand, the single enterprises compete against each other and on the other hand, however, they form enterprise networks which take part in the competition as organisational units. Here, the single enterprises as well as the network as the whole construct quest for the maximization of utility, which normally equates the quest for profit maximisation.

Based on that fact, different interests do exist, which need to be consorted in terms of a customer orientation. In this context, customer orientation includes a competitive price as well as the compliance of several consents, e.g. product quality and date of delivery. To reach this target, a permanent monitoring of the value-added process is necessary to be finally able to collect and evaluate the performances of the single enterprises involved in the value-added process after its completion with having regard to appropriate criteria. Against the background of this process subsequently called performance analysis (PA), the problem of the value-added process-related allocation of income (= profit / loss) which is generated by the network participants is of high importance. Undoubted in this context is the relevance of this topic, especially from a practical point of view. Indeed, many enterprises demand clear and flexible standards concerning the allocation income within networks, but for a lack of alternatives, only rough-structured or simple structured and hardly any or no situational arrangements are implemented.

Another problem arises due to the inconsistent and unclear legal framework for order specific configured collaborative networks. Those heterogeneous systems in coincidence with the network managements' point of view are mainly more strategic than operational. Therefor it must be clarified how the interests of an enterprise network as well as those of a single network participants (enterprise division) can be aligned by means of appropriate methods and concepts to ensure their long-term survival and sustainable success. Particularly, possibilities to split up profit / loss on the participating enterprises out of the networked value-added processes in a transparent, righteous and performance-related way need to be developed. In this context, possibilities for an incentive configuration and sanction mechanism for the coordination of interests of groups of actors are considered in detail.

The research project has been accomplished under consideration of a special approach for the coordination and operation of value-added networks. This concept, termed „Extended Value Chain Management" (EVCM) [7] has been developed within the research work for the Special Research Program „Non-hierarchical regional production nets" and is notably analyzing the networking of micro- and small enterprises, which are herein understood as competence cells. Those cells represent elementary organisational units of a non-hierarchical regional production network. According to the definition of the research project they are the "smallest performance unit of the value-added, which cannot be divided meaningfully anymore" [8].

The research project focuses on the organisational form of a competence cell as well as on possibilities to control order specific configured production nets by means of specific measures that a product can be manufactured, which on the one hand totally meets the customer requirements but also maximizes the utility of the enterprises cooperating. In this context approaches for an allocation of income as well as models for an evaluation of accomplished performances and possibilities of an incentive configuration are introduced. With this focussing, the object of investigation has to be ranged into the economic orientated network research with focus on production management. The central control mechanism can be pointed out as major advantage of the approach, which allows for a network management as an entity. Hence, the value-added process can be controlled and coordinated according to the customer requirements and at the same time, the different interests of the network participants can be taken into consideration. Furthermore, the EVCM is a very detailed and for some parts already IT-transformed operator concept, wherein the implementation of profit- and loss allocation can be integrated through an appropriate module. The mechanism of partner selection considers hard and soft-facts [9].

3 Methodologies

The adaptability of models and concepts can be found out on the basis of acceptance by the participating actors. A good model finds a (relatively) broad acceptance, whereas worse approaches are only hardly accepted and are therefore applied to a lesser extent. If an approach will be accepted primarily depends on the affected actors – if they perceive the approach as righteous and fair. At this point the problem arises, that justice and fairness demonstrate qualitative characteristics and are therefore hard to collect. Indeed, fairness and justice can be discussed out of a philosophical perspective, but normally the results do hardly provide any disputatious added value for economic purposes. A fair allocation of income can for example be assumed if the rules and therefore the allocation model, which quantifies the shares of the single individuals, are also considered by them as fair. A rule is then perceived as fair if decision-makers concordantly agree on the application of this standard in advance and if an equal negotiating position for all persons involved can be accepted in this situation. The theoretical foundations form the basis for the development of these models out of an economical perspective as e.g. Network Theory, Decision Theory and New Institutional Ecomonics.

The implemented research projects are based on three individual model pillars with the target to develop a comprehensive and highly adaptable model for an order-related allocation of profit and loss within networked production structures under special consideration of the Extended Value Chain Management-approach with integration of incentive and sanction mechanisms. In this context, the cooperation of small- and micro enterprises has been presumed and is represented through competence cells. By developing that model in form of a reference model it can be adapted to the specific needs for application within a reconfigurable production environment.

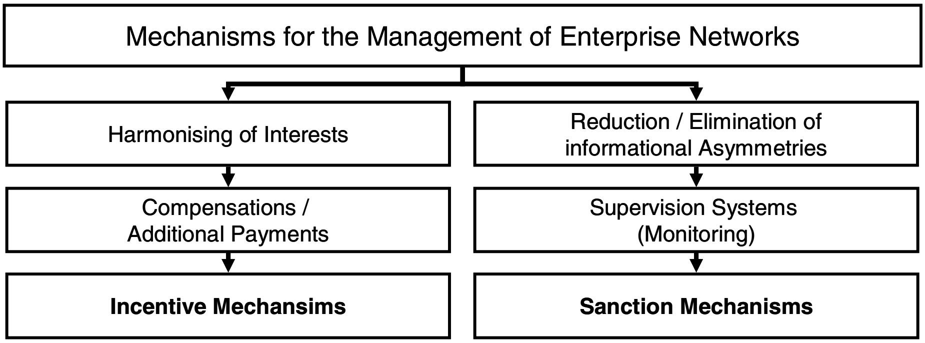

Fig. 1. Mechanisms of the operative controlling

In figure 1 fundamentals behind incentive and sanction mechanisms are illustrated. Within the research methodology, first of relevant economic theories have been checked for its relevance. Here, the assumptions of the New Institutional Economics turned out to be an adequate cover framework [10]. Against the background of networked cooperation structures, the Principal-Agent-Theory in particular becomes very valuable [11],[12]. Within this context and under consideration of the framework of the Extended Value Chain Management-concept, possibilities of an allocation of income are focused firstly. Particularly aspects of justice with consideration of the assumption of profit maximisation of all actors play an important role. For an integration of incentive mechanisms, it has been reverted to the assumptions of the incentive theory, whereas context-specific modellings could be deviated.

Sanction mechanisms on the other hand are primarily derivable from control mechanisms, whereas the control is understood for the purpose of a performance analysis, for which extensive scopes for design are presented. Within the mathematic modelling, concrete suggestions have been made for the implementation of the developed approaches, first of all out of a theoretical perspective. The modelling of the approach of performance analysis can occur on different levels of abstraction. So there is a kind of meta-model or reference model supposable on the one hand, from which a useful approach of performance analysis can be deviated contextually and on the other hand, the deviated approaches have to be enhanced with methods, which allow a use in practice. Within the framework of the research projects, different phases of the phase model have been provided with comparatively detailed methods, so that a useable approach has been developed and simultaneously the demonstration of different approaches occurs, which allow an assimilation of the approach to changing basic conditions. In general, the performance analysis is contained here to a perspective related to the value-added process, whereby a perspective is adopted comparable to the allocation of income and incentive mechanisms, which allow for an aggregation of results of all three model pillars. Here, the focus has always been on the enterprises itself which are a part of a value-added process in form of competence cells as statutory- and economical independently acting organisations.

4 Results of the Research Project

The results of the research work are based on three independent model pillars with interfaces on a quantitative basis. The basic structure is illustrated in figure 2.

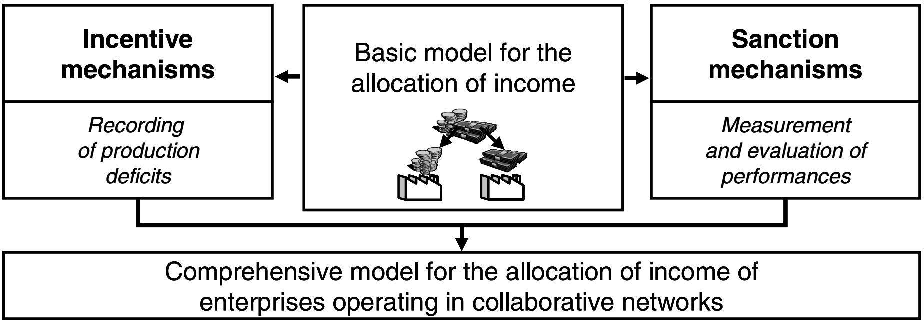

Fig. 2. Interaction of the model pillars

First of all, the issue of methods for the allocation of income has been discussed [13]. In that context a rule-based negotiation model between customer and network representant for pricing has been developed. Consecutively different methods of resolution are deviated and demonstrated. Therefor it had to be determined, in which time frame the allocation of profit or loss is strived among the network participants. As enterprise co-operations within the EVCM-approach primarily operate order specific (for the purpose of a virtual enterprise), an allocation of income among the participating enterprises after the completion of each order was found to be the most reasonable solution. In consideration of those specific requirements, a consistent framework for the allocation of income based on partial models has been intended and completed. Those models are based primarily on fixed calculation rules and are therefore available in a quantified form. In detail, one can distinguish two-component approaches with allocation parameters, approaches with consideration of expectation of profits of the competence cells and three-component approaches with weightings. Here, different sub-models have been developed in turn. One of the components is the allocation of income according to the number of participants, to determine a constant share of income. The share of profit or loss also conforms to the portion of costs of one competence cell as a variable component and finally also according to the income conception for the purpose of an expected minimum-profit to integrate the expectations of the competence cell, as the case may be. The shares of income of the components, which need to be allocated, are either determined by use of an allocation parameter (in case of two components) or through weightings (for three components).

A further differentiation is possible regarding the conversion of allocation mechanisms. A pivotal-/ peripheral approach or a hybrid form is supposable. A peripheral approach signifies that the participating enterprises include the profits out of a value-added process into their quoted price, which means that an allocation of profits will not be necessary. Although this approach is very popular in practice, as this procedure sooner complies with the procedure of a manufacturing process which was not implemented, also severe disadvantages do exist, e.g. the inclusion of hidden earnings which can lead to exorbitant prices. The pivotal approach however allows for an instance, which coordinates the mechanisms of the allocation of profits and losses. This concept comes very near to the philosophy of the EVCM-approach.

For the configuration of incentive mechanisms in collaborative systems, the target for the permission of incentives exists in motivating the receiver of incentives to a specific action desired by the actor who provides the incentive [14]. Here, different incentive mechanisms are supposable, whereas financial incentives dominate within economy. For the accomplished research project, incentives are first of all understood as configured mechanisms originated by the network management, whereby the focus is not on a complete or extensive consideration, but selective problem areas of the (industrial) production are singled out for which possibilities for implementing financial orientated approaches will be demonstrated subsequently. Algorithmic procedures which can be applied for several network configurations stand here in the foreground. In this context, incentive mechanisms have found consideration as a designing or influencing measure. In the case of permission for incentive for competence cells, there is a direct connection to the cash flows between the network participants. So far only selected applications have been discussed and modelled. Hereto belongs for example the permission for application in case of a missing production capacity within the network and the configuration of incentives in case of a lacking financial attractiveness of an order.

Another important part of the whole concept are sanction mechanisms. Sanction mechanisms as an instrument for a coordination of interests of persons involved – EVCM (Principal) and competence cells (Agents) – also cause cash flows between the network participants and are realized in form of control mechanisms through an approach for an order-related performance analysis of competence cells.

For the quantification of sanctions in form of a monetary amount, a comprehensive approach for the order-related measurement, evaluation and analysis of the performances accomplished by the participants of the collaborative system has been developed [15]. The claim of that approach is that in comparison to established concepts of performance evaluation not only measuring and evaluation of performances is included, but also possibilities for their analysis are considered.

The concept includes the procedure in principal based on different phases which either are value-added process-neutral or value-added process-specific. Within the value-added process-neutral phases the performance analysis is arranged and prepared through a determination of relevant performance parameters. In practice numerous parameters can potential be integrated [16]. Here, next to the performance parameters based on numbers, e.g. price, date of delivery, response time and product quality soft factors, like the cooperation performance (quality of teamwork) and confidence climate are part of the analysis as well [17]. The identification of relevant performance parameters as well as significant key figures is realized by a net-balanced scorecard. In order to represent different stages of importance the performance parameters and its evaluations are weighted repsectively. Details for the determinations of the weightings and the aspired target level of proficiency fot the performance parameters are determined as well. As a result, a key figure is calculated by means of an adapted benefit analysis, which gives information about the degree of performance of an enterprise. Based on this key figure, sanctions can be calculated in terms of a decrease of profit, if required and applicable.

Under these circumstances, accomplished performances of the competence cell are determined and evaluated by accompanying the value-added process and finally analysed in form of an aggregated key figure (actual output). In case of an inadequate value performance, which can be identified easily through a comparison of target- and actual performance, the share of profit of the affected competence cell will be reduced, which is on par with a sanction. In case of a loss there will be an additional payment. For demonstrating the connection between the degree of performance and the area of sanction, mathematic functions are applied. Furthermore, this approach has been specified further through the introduction of general applicable weighting functions for the single performance parameters, whereby a universal model framework has been created.

5 Conclusions and Further Research

This contribution introduced an innovative framework for the operative controlling of collaborative systems. That approch is already available in a more detailed manner including clear results and detailed approaches. However the presentation of these concrete mechanisms was not part because of the character of a conceptual papaer. By applying the methods included in the concept introduced, a variety of tools for the allocation of income in combination with incentive and sanction mechanisms are available. The selection of the suitable models has to be made by the particular decision makers themselves depending on the situation occurring. To allow a universal applicability of the models it has been paid attention thereon that a custom made assimilation is normally possible without any further model modification. This especially will be realized thereby that the models could be implemented on a quantitative stage and are therefore easily controllable through selected parameters. It hereby succeeded to expand the operative network controlling with new innovative models and methods of management.

Further research work includes a verification of the assumptions based on empirical data. Furthermore, the existent impairments and limits of modelling are to eliminate. That includes limited number of performance parameters as well as questions of a determination of allocation parameters. For example it is planned to include an ecological performance parameter. Finally after completing the modelling the information-technical implementation and its practical application is planned.

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Equilibrium Traffic Flow Assignment in Case of Two Navigation Providers

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Abstract. Traffic flow assignment system that includes two navigation providers is considered. Navigation providers predict future traffic conditions and provide travel guidance for given original-destination demand and network capacity. Three classes of drivers are introduced. The users of navigation service from the first and the second classes are supplied with the shortest path guidance by navigation providers «Navigator 1» and «Navigator 2» correspondingly. The third class of drivers is characterized by user-optimal behavior without current guidance information about traffic conditions. The main goals of Navigators are to assign the traffic flow of their customers (users) so as to maximize appropriate pay-off functions which depend on original estimation of traffic volume delay and are influenced by decision of both of them. Existence and uniqueness of Nash equilibrium in considered non-zero sum game are proven and an explicit form of Nash equilibrium is presented.

Keywords: Traffic flow assignment, routing, dynamics, Nash equilibrium.

1 Introduction

The impact of information technologies (IT) on transportation processes becomes more and more crucial. Most of the new technologies share attributes of intelligence. Cyber-physical systems incorporate elements from both information and material (physical) subsystems and processes which are integrated and decisions in them are cohesive [1]. Elements of physical processes are supported by information services. Cyber-physical systems are characterized by decentralization and the autonomous behavior of their elements.

We consider three groups of customers (drivers on the streets): two groups which are guided by different providers of navigation and one group which do not use any navigation system. The study is focused on the existence and analytical representation of strategies of navigation providers which form Nash equilibrium. Providers are considered as non-collaborative players in non-cooperative game. They are interesting in higher level of service for their customers which would attract them to buy

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 156–163, 2013.

navigation system. We assume that using fast and efficient algorithms for calculating routs upon request of a user to minimize travel time from origin to destination leads to increasing level of service. Therefore designing the fast algorithms for assignment vehicle is crucial for both theory and practice [2]. The study of a navigator's strategic behavior in traffic flow assignment is important because a lot of drivers in megalopolis can use routes recommended by navigation systems (navigators) to reach their destinations with minimum driving time.

2 State of the Art

Determining the equilibrium traffic flow assignment has been a preoccupation of transport planners for nearly half a century. J.G. Wardrop put forth the definition of the steady state equilibrium of a traffic network in 1952 [3]. Beckmann et al. in 1956 provided an analytical construct of Wardrop's verbal criteria [4]. Within a relatively short period, between 1968 and 1973, several algorithms were identified, analysed and solved computationally [5]. In addition, the linearization method based on the Frank and Wolfe algorithm emerged in 1956 [6].

Since the early 1990s, game theoretic models have been employed in the context of traffic flow assignment and control [7, 8], routing [9] and virtual path bandwidth allocation in modern networking. Then, using game theory framework in routing optimization was continued in the second part of the 1990s [8, 10, 11].

In the first decade of XXI century equilibrium resource assignment models have started to emerge in a field that is quite close to the transportation system – in telecommunication systems [12, 13]. In this way, the results from traffic flow assignment can be used in telecommunication systems and vice versa. That is why in this paper we will follow the results of studies by Altman et al. [14, 15]. We interpret transmitters from wireless networks as providers of navigation (navigators) in traffic flow networks and consider the traffic flow assignment problem as a non-zero-sum game. Pay-off functions are used in the proposed model close to those of Altman et al. [14, 15].

The novelty of the present paper is primarily in the use of a game theory framework and special pay-offs in a game of navigation providers. This study proposes a method for fast calculation Nash equilibrium in a corresponding game of two navigators (players) due to explicit form of the solution. The results might be highly applicable in the sense that computations allow the finding of optimal routes for customers of navigation providers.

3 Traffic Assignment Game of Two Navigation Providers

Consider a traffic flow assignment system which includes two navigation providers who predicts future traffic conditions and provide travel guidance given original-destination demand and network capacity. Suppose there are three classes of users. The first and second class are supplied with the shortest path guidance by navigation providers «Navigator 1» and «Navigator 2» correspondingly and the users also believe that guidance information is 100% accurate. The third class is characterized by user-optimal behavior without current guidance information about traffic conditions.

Transportation network is presented as a directed graph with two nodes (origin and destination) and n arcs (paths) going from origin to destination. The main goals of Navigators are to assign the traffic flow of their customers (users) from origin to destination through n paths so as to maximize their appropriate pay-off functions which influenced by decision of both of them. Due to this influence we can consider a non-cooperative game of two players.

Let's introduce the following notations:

$i -$ index number of the path, $i \in \{1, n\}$;

$j -$ index number of Navigator, $j \in \{1,2\}$;

$F^j > 0 -$ traffic flow volume (quantity of customers) assigned by Navigator j;

$f_i^j \geq 0 -$ traffic flow volume that Navigator j sends on i-th path;

$h_i \geq 0 -$ traffic flow of the users from third class on path i, $H = \sum_{i=1}^{n} h_i$;

$g_i > 0 -$ capacity of i-th path;

$d_i^j > 0 -$ traffic flow level of Navigator j customers delay on path i.

Suppose the total volume of traffic is less then total capacities of paths $H + F^1 + F^2 \leq \sum_{i=1}^{n} g_i$. Define set of strategies of player j as set of vectors $f^j = (f_1^j, ..., f_n^j)$ such that

$$\sum_{i=1}^{n} f_i^j = F^j \tag{1}$$

We assume that each Navigator is able to estimate the level of congestion on each path of transportation network for given strategy of another player and allocation $h = (h_1, ..., h_n)$ of users of the third class. We also assume that the level of congestion for customers of Navigator 1 on i-th path is increasing with respect to sum of total amount of customers f_i^2 of Navigator 2 sent to the i-th path and traffic flow volume of customers h_i divided by capacity of i-th path. Thus we suppose that delay for each customer of Navigation 1 following path i may be estimated as follows

$$d_i^1 = \frac{f_i^2 + h_i}{g_i}, \forall i = \overline{1,n} \tag{2}$$

The same estimation may be applied for delay for each customer of Navigator 2 given strategy of player 1 and allocation $h = (h_1, ..., h_n)$ of users of the third class:

$$d_i^2 = \frac{f_i^1 + h_i}{g_i}, \forall i = \overline{1,n} \tag{3}$$

For estimation of the pay-offs of Navigator *j*, the following utility function is considered that quantifies a trade-off between throughput and delay [16]

$$v_j(f^1, f^2) = \frac{\left(\sum_{i=1}^{n} f_i^j\right)^{\beta}}{del_j(f^1, f^2)}$$

where $del_j(f^1, f^2)$ is the function that characterizes the average delay experienced by the Navigator j and β is a trade-off parameter. Such a utility function is commonly used in the literature in applications that are sensitive to throughput as well as delay [17]. It consists of the ratio between the expected throughput and the expected delay. Thus it captures preferences towards higher throughputs and penalizes large delays. One of disadvantages of this expression is using average delay instead of vector of delay values on each of the paths.

We propose to introduce explicit form of pay-off functions to be maximized by the players which takes into account expressions (2) and (3). Assume that pay-offs are linear combination of corresponding volumes of flows to each of paths weighted with inverse values of delays

$$v_1(f^1, f^2) = \sum_{i=1}^{n} \frac{1}{d_i^1} f_i^1 \tag{4}$$

$$v_2(f^1, f^2) = \sum_{i=1}^{n} \frac{1}{d_i^2} f_i^2 \tag{5}$$

We can see that to maximize pay-off player has to decrease the flow sent to the path with higher delay therefore. Thus it leads to less travel time along this path. Substituting (2) to (4) and (3) to (5) we are getting expressions for pay-off functions of the players as follows

$$v_1(f^1, f^2) = \sum_{i=1}^{n} \frac{g_i f_i^1}{f_i^2 + h_i} \tag{6}$$

$$v_2(f^1, f^2) = \sum_{i=1}^{n} \frac{g_i f_i^2}{f_i^1 + h_i} \tag{7}$$

In these settings, Navigators simultaneously try to assign flow of their customers through more appropriate ways using information about capacity of paths and «base» flows of drivers from third class.

By definition strategies f^{1*} and f^{2*} form Nash equilibrium situation, if for any strategies admissible strategies f^1 and f^2 the following inequalities hold:

$$v_1(f^1, f^{2*}) \le v_1(f^{1*}, f^{2*}) \tag{8a}$$

$$v_2(f^{1*}, f^2) \le v_2(f^{1*}, f^{2*}) \tag{8b}$$

Since functions (6) and (7) are concave in f^1 and f^2 respectively, the Kuhn – Tucker conditions imply the following theorem.

Theorem 1. (f^{1*}, f^{2*}) is a Nash equilibrium if and only if there are non-negative ω^1 and ω^2 (Lagrange multipliers) such that

$$\frac{g_i}{f_i^2 + h_i}\begin{cases} = \omega^1 & for\ f_i^{1*} > 0 \\ \le \omega^1 & for\ f_i^{1*} = 0 \end{cases} \tag{9}$$

$$\frac{g_i}{f_i^1 + h_i}\begin{cases} = \omega^2 & for\ f_i^{2*} > 0 \\ \le \omega^2 & for\ f_i^{2*} = 0 \end{cases} \tag{10}$$

where $i = \overline{1, n}$.

Corollary. Each Nash equilibrium is of the form $(f^1(\omega^1, \omega^2), f^2(\omega^1, \omega^2))$ for some positive ω^1 and ω^2.

In order to find the equilibrium strategies, find ω^1 and ω^2 such that the following conditions hold

$$Q^j(\omega^1, \omega^2) = \sum_{i=1}^{n} f_i^j(\omega^1, \omega^2) = F^j \tag{11}$$

Due to the properties of payoff-functions the following lemma can be proved.

Lemma. The system of non-linear equations (11) has a unique positive solution $(\omega^{1*}, \omega^{2*})$.

Due to Theorem 1 and Lemma, it becomes possible to obtain the explicit form of optimal strategies for Navigators in the game of traffic flow assignment. For this purpose, optimal values of ω^1 and ω^2 have to be found from the equations: $\sum_{\omega^2 < \frac{g_i}{h_i}} \left(\frac{g_i}{\omega^2} - h_i \right) = F^1$ and $\sum_{\omega^1 < \frac{g_i}{h_i}} \left(\frac{g_i}{\omega^1} - h_i \right) = F^2$.

To find the solution in an analytical form, we have to assume that there not exist such $s, l = \{1, n\}$ that $\frac{h_s}{g_s} = \frac{h_l}{g_l}$. Then without loss of generality, it can be assumed that

$$\frac{h_1}{g_1} < \frac{h_2}{g_2} < \ldots < \frac{h_n}{g_n} \tag{12}$$

In the performance of these conditions the following Theorem 2 has appeared.

Theorem 2. Nash equilibrium in a game of two Navigators with pay-offs (6) and (7) is achieved by the following strategies using

$$f_i^{1*} = \begin{cases} \dfrac{g_i F^1 + g_i \sum_{r=1}^{k_1} h_r}{\sum_{r=1}^{k_1} g_r} - h_i, & if \ i \le k_1 \\ 0 \ , & if \ i > k_1 \end{cases} \tag{13}$$

$$f_i^{2*} = \begin{cases} \dfrac{g_i F^2 + g_i \sum_{r=1}^{k_2} h_r}{\sum_{r=1}^{k_2} g_r} - h_i, & if \ i \le k_2 \\ 0 \ , & if \ i > k_2 \end{cases} \tag{14}$$

where k_1 and k_2 can be found from the following conditions:

$$\varphi_{k_j} < F^j \le \varphi_{k_j+1} \tag{15}$$

where

$$\varphi_t = \sum_{i=1}^{t} g_i \left(\frac{h_t}{g_t} - \frac{h_i}{g_i} \right) \quad for \quad t \in \{1, n\} \tag{16}$$

and $k_j = n$ in case $F^j > \varphi_n$.

Results of corollary, lemma and theorem 2 allows us to formulate the following theorem.

Theorem 3. A game of two navigation providers in the performance of (12) has unique Nash equilibrium (f^{1*}, f^{2*}) which can be found from (13) - (16).

4 Conclusion

In a megalopolis, many drivers can use routes provided by different navigation systems (navigators) to reach their destinations with minimum driving time. Therefore, navigators are interested in providing their customers with a higher level of service compare to that of other competitors. The novelty of the present paper is primarily in the use of a game theory framework and special pay-offs in a game of navigation providers. This study proposes a method for fast calculation Nash equilibrium in a corresponding game of two navigators (players) due to explicit form of the solution. The results might be highly applicable in the sense that computations allow fast finding optimal routes for customers of navigation providers. The explicit form of Nash equilibrium has been demonstrated.

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Appendix

Proof of Theorem 1. We proof this theorem for Navigator 1. For Navigator 2 the proof is analogical.

Function v_1 is linear with respect to components f^1, that means it is both convex and concave. Such a fact allows us to apply the Kuhn–Tucker theorem. The Lagrangian corresponding to minimization of $-v_1$ subject to the constraints (1) and non-negativity constraints on f_i^1 is given by

$$L^1 = -\sum\nolimits_{k=1}^{n} \frac{g_k f_k^1}{f_k^2 + h_k} + \omega^1\left(\sum\nolimits_{k=1}^{n} f_k^1 - F^1\right) + \sum_{k=1}^{n} \eta_k^1(-f_k^1) \tag{17}$$

In differentiating the Lagrangian with respect to f_i^1 and equating the derivative to zero, we obtain (stationarity)

$$\omega^1 = \frac{g_i}{f_i^2 + h_i} + \eta_i^1 \tag{18}$$

Lagrangian multipliers are non-negative due to non-negativity of g_i, f_i^1 and h_i. Now, let us employ complementary slackness condition $\eta_i^1 f_i^1 = 0$. Such an equation means that at least one of the multipliers is equal to zero. Therefore, in case $f_i^1 > 0$ it is necessary $\eta_i^1 = 0$ and we obtain the first part of expression (9). In case $f_i^1 = 0$ the value of $\eta_i^1 \geq 0$ and we obtain the second part of expression (9). ■

Proof of Theorem 2. We prove the theorem for Navigator 1. For Navigator 2 the proof is absolutely analogous.

First note $\widehat{Q}^1(\omega^2) = 0$ for $\omega^2 \leq T$ where $T = \max_{i\in\{1,n\}} \frac{g_i}{h_i}$ as above, $\widehat{Q}^1(\omega^2)$ is strictly positive and decreasing in (0,*T*). Let $k_1 \in \{1,n\}$ be such that $\frac{g_{k_1}}{h_{k_1}} > \omega^2 \geq \frac{g_{k_1+1}}{h_{k_1+1}}$ where $\frac{g_i}{h_i} = 0$ when $i = n+1$. Then, $\left[\frac{g_i}{\omega^2} - h_i\right]_+ = \frac{g_i}{\omega^2} - h_i$ for $i \in \{1, k_1\}$ and $\left[\frac{g_i}{\omega^2} - h_i\right]_+ = 0$ for $i \in \{k_1+1, n\}$. So, $\widehat{Q}^1(\omega^2) = \sum\nolimits_{i=1}^{k_1}\left(\frac{g_i}{\omega^2} - h_i\right)$.

Since $\widehat{Q}^1(\omega^{2*}) = F^1$ we have that $\omega^{2*} = \frac{\sum_{r=1}^{k_1} g_r}{F^1 + \sum_{r=1}^{k_1} h_r}$. Because $\widehat{Q}^1(\omega^2)$ is strictly decreasing on (0, *T*) we can find k_1 from the following condition $\widehat{Q}^1\left(\frac{g_{k_1}}{h_{k_1}}\right) < F^1 \leq \widehat{Q}^1\left(\frac{g_{k_1+1}}{h_{k_1+1}}\right)$.

Since $\sum\nolimits_{i=1}^{k_1}\left(g_i \frac{h_{k_1}}{g_{k_1}} - h_i\right) = \sum\nolimits_{i=1}^{k_1+1}\left(g_i \frac{h_{k_1+1}}{g_{k_1+1}} - h_i\right)$ the integer k_1 can be found from the following equivalent condition

$$\varphi_{k_1} < F^1 \leq \varphi_{k_1+1}$$

Therefore, the two last results imply Theorem 2.

Integrated Large-Scale Environmental Information Systems: A Short Survey

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Abstract. The installation and operation of instrument/sensor networks has great importance in monitoring the physical environment from local to global scale. Nowadays, such networks comprise vital parts of integrated information systems that are called Environmental Information Systems (EIS). Such systems provide real time monitoring, forecasts and interesting conclusions extracted from the collected data sets that are stored in huge databases. These systems are used as the main source of data for model parameterization and as verification tools for accuracy assessment techniques. This paper comprises a short survey aiming to highlight the significant role of existing Environmental Information Systems (ELIS) consisted of instrument/sensor networks that are used for large-scale monitoring of environmental issues regarding atmospheric and marine environment. The operating principles of these systems, their usefulness, restrictions and their perspectives in the environmental sciences, are studied and described.

Keywords: Environmental Information Systems, Instrument/sensor networks.

1 Introduction

The role of the Environmental Information Systems (EIS) is widely accepted and known. Although there are many different definitions about EIS (Avouris and Page, 1995; Checkland and Holwell, 1998) all of them, share major common components in their architecture that include among others databases, monitoring modules, Geographical Information Systems (GIS) and the visualization of complex environmental data. In this study, we define as Environmental Information Systems (EIS) the integrated systems that use networks of instruments/sensors in order to collect and combine different kinds of data using automated procedures and providing high-quality products and services. These systems collect time-series of data and provide products at different spatial scales that are used to further monitor and forecast atmospheric, land and marine environment parameters as well as weather and climate changes. The most modern EIS uses indispensably, Environmental Sensor (or instrument) Networks (ESNs) as part of their structure because their installation and operation is proven fundamental for the monitoring of the physical environment.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 164–171, 2013.

Thanks to recent technological advances in microelectronics, wireless communication technology and informatics, new advanced sensors have been emerged/evolved that are operating in clusters/arrays of devices utilizing wireless network. The development of sensor/instrumentation networks involves various research scientific fields, such as sensing, communication and computing areas (e.g. Chong and Kumar, 2009). These advances have led to the development of a huge number of networks at different spatial scales that measure, collect and store a wide range of environmental parameters. Nowadays, the modern ESNs are capable to record with high accuracy a wide variety of parameters in near real time and save the data for later recovery. There is a continuously increasing interest in ESNs establishment as modern networks have capabilities that geoscientists could hardly consider of twenty years ago. ESNs have been gradually evolved into integrated information systems that can be called EIS (according to the above mentioned definition) and provide real-time monitoring, forecasts and archive data of many different products and parameters from the initial collected data sets. The datasets of such systems are used as data sources to feed models with initial parameter values and as verification data pools for accuracy assessment of the satellite imagery. Another application area of EIS is in decision making, where along with other kinds of data (e.g. satellite data, socioeconomic parameters, census data) can provide an informational background in order to manage problems, suggest solutions and best practices for a sustainable management of the environment.

This work comprises a comparative study aiming to record and highlight the role of the existing EIS that use instrument/sensor networks along with other kinds of data for large-to-global scale monitoring of environmental issues of the atmospheric and the marine environment as well as weather and climate. There are examining characteristic examples of large scale instrument/sensor networks that are basic parts of EIS, where along with additional sources of data (like satellite datasets), are used as integrated information systems to measure, identify, monitor, analyse and forecast a vast series of atmospheric parameters (like CO_2, O_3, particle matter and solar irradiance), weather, climate and their impacts (e.g., cloud systems, lightning, rainfall, air and surface temperature, humidity, winds) and marine environment (salinity, water quality, sea surface temperature among others).

2 Basic Operating Principles of Environmental Sensor Networks

The ESNs can be separated into three general categories relating to the spatial scale: local, regional and global (Hart et al., 2006). The local scale networks tend to cover local and strictly defined regions, measuring specific parameters through a network of interconnected nodes, via like Radio Frequency (RF), internet or acoustic waves. The sensors are usually placed in space according to the scientific or operational needs. Any set of sensors· stand for a cluster that gathers measurements (Chong et al., 2003) where the sensors of a cluster form a particular topology either “star” or “peer-to-peer” (Buratti et al., 2009). The types of sensors can be passive (e.g. acoustic, seismic, IR, magnetic) or active (e.g. radars, lidars) (Chong et al. 2003). There are also many different types of sensors according to the parameters, they record. The sensors are also categorized, in relation to their size, shape and their mobility because they can be stationary (e.g. seismic sensors), mobile (e.g. on robot vehicles) (Chong et al., 2003) and buoys (e.g. Forecast at sea, monitoring sea surface). Additionally, the communication among sensors can be wired, or wireless; using broadband or narrowband connectivity and the energy needed from each sensor is proportional to its size (Chong et al., 2003). In general, a cluster communicates with a server through a gateway, wireless or wired connection. The gateway is a network node equipped for interfacing with another network that uses different communication protocols. The way that information is transferred from the portal of the server differs, depending on the distance between them. When the distance is local, wired or wireless internet or RF signals for data transmission are used. If the distance gate to server is long enough, the transmission of information is achieved via satellite communication. The next "stop" of the information flow is the router. A router is a device that forwards data packets between computer networks, creating an overlay internetwork. The information comes out of the router and enters the server. In the most common use, a server is a physical computer (a computer hardware system) dedicated to run one or more services (as a host) and to serve the needs of the users of other computers on a network. The server then either sends the data collected from the sensors in a database that stores and keeps records for subsequent processes and investigations, or sends it to a user to further process them (Figure 1). There is an option to enter the data into a user interface for the information sent to the data station. User interfaces allow the users to handle the information of the system's database and visualize the selected data and products [graphical user interface (GUI)]. The last "stop" of the information flow in the network is a computer or a network of parallel-connected computers, which processes the total data available to the data station and those that might have been processed by the user or a user interface.

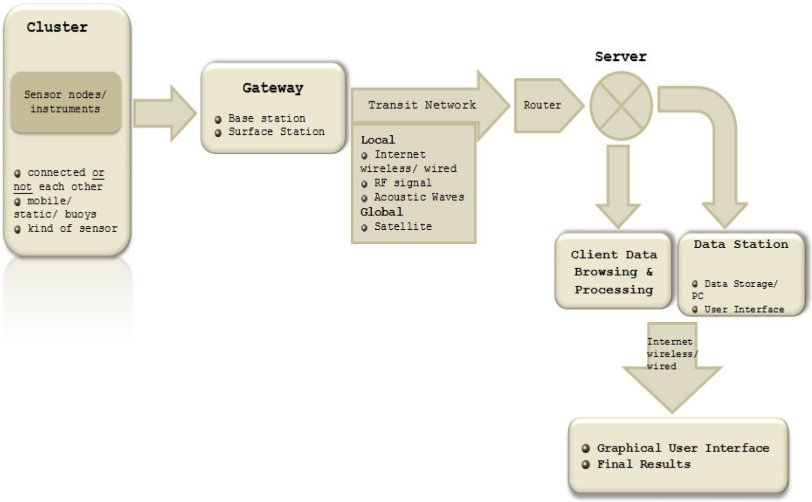

Fig. 1. A schematic flow chart of operation of environmental sensor networks

3 Examples of Existing Systems

3.1 Atmosphere

The environmental sensor networks monitor phenomena in the atmosphere usually dealing with air quality and measure quantities of chemical compounds (organic and inorganic), greenhouse gases, dust and particle matters in the atmosphere. It is well known that the role of the atmosphere and the sun radiation is vital for the earth natural environment, the flora, the fauna and the human lives. Changes in the atmospheric components affect - among others - the incoming solar radiation, the upwelling radiation and finally the energy balance on the Earth with unpredictable consequences to weather, climate and sustainability of many species. Environmental Information Systems has been very important and can further improve our knowledge regarding the variations of atmospheric components at large up to global scale. Regarding the Table 1, the "EuNetAir" comprises a Cooperative network based on advanced chemical sensors and sensor-systems at low-cost, including functional materials and nanotechnologies for low-cost air-pollution monitoring through field studies and laboratory experiments, to transfer the results into preventive real-time control practices (Penza, 2012). The main scope of this network is a cleaner air in Europe with reduced negative effects; targeting to outdoor air pollution control and indoor energy efficiency in buildings. It fosters the technology of new sensing cost-effective chemical sensors in the European countries (Penza, 2012).

Table 1. Examples of EIS that are referred to atmospheric parameters

Name of the System	Parameters	Year
Cost Action TD1105 – EuNetAir	CO_2, H_2O, NOx, SO_2, H_2S, VOCs, PM, PAH, O_3, etc.	2011
EARLINET	aerosols	2000
GAPS (Global Atmospheric Passive Sampling Network)	Persistent organic pollutants (POPs)	2004
GAW - Global Atmosphere Watch	e.g. greenhouse gases (CO_2, chlorofluorocarbons, CH_4, O_3, N_2O, CO, NO_x, SO_2, VOC), ozone, UV, aerosols	2012

Another noteworthy system is the "EARLINET" (Table 1). This system is an aerosol lidar network, established in 2000, with the main goal to provide a comprehensive, quantitative, and statistically significant data base for the aerosol distribution on a European scale. Because of the unpropitious effects of aerosols on human life, it is important to achieve an advanced understanding of the processes that generate, redistribute, and remove aerosols in the atmosphere, through EARLINET system that has the capability for accurate and timely measurements and monitoring. The "GAPS" Network refers specifically to Persistent Organic Pollutants (POPs) in air (e.g. Breivik et al., 2002). Measurements of POPs are integrated with other to assess temporal trends and for investigating regional and long-range transport of POPs and other priority chemicals (e.g Breivik et al., 2002). The "GAPS" project initiated at 2004 in global-scale and it is operating currently at more than 50 sites around the world. Reliable scientific data and information on the chemical composition of the atmosphere and its natural and anthropogenic changes are measured and monitored through cooperation among institutions and organizations of many countries worldwide, within the "GAW" (Global Atmosphere Watch) program (e.g. Plass-Dülmer et al., 2002). To achieve the programme's goals, a network of hundreds of instruments and sensors are used all around Earth. It is mentioned that some of collected datasets of the "GAW" network are coupled with satellite measurements, which results in a more complete picture of atmospheric composition and processes on global scale that provides complimentary checks of instrument calibrations. Summarizing, "EARLINET" is a system focused on aerosols that are measured using a network of lidars. In opposite, the "EuNetAir" system uses many different types of sensors and networks, combining many different data and parameters of a wide variety of atmospheric components including aerosols. Another focused network in a specific category of components is the "GAPS" network that is referred as above mentioned to the POPs. Finally, the "GAW" programme can be included in the category of "**system of systems**" because uses many different data sets from many different systems worldwide, having as objective to collect data and products from many different sources for a better understanding and monitoring of the atmosphere and the marine environment.

3.2 Marine Environment

The EIS for the marine environment monitor and deal with a plethora of data and parameters that extends even in meteorology. The sensors of these systems are being designed to have the ability to measure physical, chemical and biological parameters that control the marine life. Phytoplankton, water temperature, optical depth, deposition of particle matter and chemical compounds, turbidity and height of waves are only just some of the parameters that these network systems monitor.

The "GOOS" is a collection of ocean observing and information delivery system ("system of systems") for observations, modeling and analysis of marine and ocean variables to support operational ocean services worldwide (e.g. Worth et al., 2001). This system provides high-quality descriptions of the present state of the oceans, including living resources, continuous forecasts of the future conditions of the sea for as far ahead as possible, and the basis for forecasts of climate change. Satellite instruments, free floating buoys and profilers are used - among others – in order to measure parameters like sea surface temperature, salinity etc.

The "IOCCP" comprises (e.g. Telszewski, 2012) a global network for the development of globally acceptable strategies, methodologies, practices and standards, homogenizing efforts of the research community as well as integrating ocean carbon programs and activities aiming at a sustained global observation network for marine biogeochemistry.

Table 2. Examples of EIS regarding to the marine environment

Name of the System	Parameter	Year
GOOS - Global Ocean Observing System	e.g. temperature, salinity, atmospheric pressure, oxygen, carbon dioxide (CO_2)	1991
IOCCP - International Ocean Carbon Coordination Project	Dissolved organic carbon, alkalinity, pCO_2, pH, particulate carbon	2005
NOOS - North West European Shelf Operational Oceanographic System	e.g. tides, storm surges, mean sea level change, surface temperature, salinity, dissolved oxygen, nutrients, chlorophyll	2006

The "NOOS" system is aiming to develop and implement online operational marine data and information, to provide analysis, forecasts, and model-based products describing the marine conditions and to establish a marine database that proves time series and statistical analyses (Holt, 2003). Main measured parameters include discharged loads, water level, waves and sea surface temperature. The forecasted parameters include total water net transports, seal level and wind currents.

Summarizing, the "GOOS" system is fully autonomous, having its own observation networks that provide a global view of the ocean system. It comprises a network system of sub-systems, each of which is working on different and complementary aspects of establishing an operational ocean observation capability. It is consisted of many different observation platforms that measure initial data in order to collect, monitor, describe and forecast the state of the oceans.

The "IOCCP" system on the other hand, has one clear objective, the ocean carbon observations. It's a global scale system that focuses on specific ocean parameters.

Finally, the "NOOS" system is a large scale system that covers the European North West Shelf (NWS), providing reliable descriptions of the actual marine conditions on the NWS area, through many different kinds of variables about the specific marine environment. The system has its own instrumentation network and its final scope is to develop and implement ocean observing and prediction services for the NWS area, by delivering real time operational data and products.

At this point, it is mentioned that there are some similar systems to "NOOS", like Baltic Operational Oceanographic System ("BOOS") and others that operate in regional scale and their data are used from broader scale systems such as GOOS that belongs to the category of "system of systems".

4 Conclusions

This study comprises a short review regarding the Environmental Information Systems that use indispensably instrumentation/sensor networks in order to collect environmental information. There are described the main basic operating principles and then it focuses on EIS for Atmosphere and Marine Environment; providing basic knowledge about the parameters that they record and the services that they provide.

We present systems that operate in the large to global scale and we have mentioned that at global scale there is an approach to combine many systems that are established at regional and large scale. The combined use of regional and large scale systems and their recorded parameters can be further integrated into central databases that provide with the philosophy of a global information system, valuable information, products and services at global scale. The integration of information from many different regional/large systems to a central "global nature" system can define this, as "system of systems". Additionally, there is an increasing tendency to develop such systems by unifying smaller scale ones and creating global monitoring systems for a better understanding of Earth's environment.

The EIS uses instrumentation/sensor networks that record and process simultaneously vast types of parameters in large-to-global scale, associated with the atmosphere, the climate and the marine environment. The technological advances in many fields like sensing, telecommunications and computing can be integrated with the geosciences, resulting in fully automated systems that can record, collect and store a wide variety of parameters. The initially measured data and parameters can be further analyzed providing many valuable final products and services. The large scale monitoring systems can operate not only as databases but also as monitoring and forecasting systems, providing with this way plenty of services to the end users according to the goals and the needs for wide environmental issues. It is mentioned that EIS can provide a wealth of information not only to science but in public too, through data sending to decision making and risk management systems. This is another important contribution of such systems with beneficial effects to the sustainability of the environment as well as the quality of human lives, properties and their economic activities. We have also to mention, that such systems can help importantly to a sustainable and environmentally correct of the reindustrialization in local up to national and international level, through planning and management of air and water pollutants.

Acknowledgements. This work was supported by the "Transnational enhancement of ECOPORT 8 network" (TEN ECOPORT) project with code SEE/D/ 0189/ 2.2/X. project co-financed by the European Union within the South East Europe Transnational Cooperation Program.

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Effective Construction Process Monitoring and Control through a Collaborative Cyber-Physical Approach

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Abstract. The objectives of this research are: monitoring of project progress during execution, assessment project health on demand, to identify and make timely recommendations for corrective action in response to anticipated schedule delays. Implementation of this information in flexible process modeling approaches, like process configuration method enhances an alternative process planning. The paper proposes a solution in collaboration with cyber-physical system CPS based on RFID technology to minimize manual inputs and enhance data acquisition. Furthermore, it enables planers anticipating and identifying schedule delays and exceptions early or even before they happen. Analysis of the real-time data collected on site and actual vs. scheduled deviation will be transformed into a meaningful classification. This paper presents a comprehensive solution to integrate the outcomes of analysis real-time data into a knowledge base for updating the entire progress, handling exceptions and supporting efficient process alternative modeling.

Keywords: RFID, CPS, Process Monitoring and Control.

1 Introduction

The efficient process planning in construction project is still confronted with insufficient information about the current process and necessary changes in the process flow realized in project execution. In many field practices, the planners still rely on manual process methods to collect information during project execution. Thus, the information of actual construction process is incomplete, error-prone and not available on time. Indeed, the information problem has 27% of disturbance-causes in construction project [1]. Furthermore, the missing integration of the information in a flexible process modeling hinders an alternative process planning and causes process delays. To ensure an effective continuous information flow, communication, and collaboration among all involved actors in project execution, a cyber-physical approach is proposed. The suggested solution enables coupling the real world with the virtual one together to produce an environment where the physical and digital objects interact in real-time. Radio Frequency Identification (RFID) technology is used as coupling technology for identification of construction site resources.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 172–179, 2013.

The objectives of this research are: (1) monitoring of project progress during execution, (2) assessment project "health" on demand, to identify and make timely "recommendations" for corrective action in response to anticipated schedule delays and (3) implementation of this information in flexible process modeling approaches, like process configuration method enhances an alternative process planning.

At this, the paper proposes (1) a mechanism to minimize manual input by enhancing data acquisition and collaborative interaction of virtual model with physical environment, (2) an approach to identify schedule delays (exceptions) early or even before they happen and (3) monitoring project "health" and analyzing real-time data. Thereby, the focus will lay on analysis of collected data, determination of actual-schedule date deviations and suggest a classification approach of classes in comparison with project thresholds, priority of an activity (belongs to the critical path of the project) and the floating time of an activity.

Finally, a comprehensive solution to integrate outcomes of analyzed data into a knowledge base will be presented for updating the entire process progress, handling exceptions execution and supporting efficient modeling of process alternative.

This work discusses primary the prefabricated components of Fiber Reinforced Polymer that can be used in modern bridge construction and their lifecycle (shipping and on site assembly). Since, these components have a high initial material cost which makes the overall project cost very sensitive to errors. Therefore, this work is driven by the "need" for accurate records of components and their status on construction site. The presented research is part of the ongoing FP7 European Project Trans-IND (New Industrialised Construction Process for transport infrastructures based on polymer composite components).

2 Background

Recently, several researches have been investigated the integration of physical construction components and their virtual models using RFID technology. However, the early research in construction industry was focused on RFID applications for concrete handling, cost coding, material control and tool tracking onsite [2]. Later, a new tracking architecture based on an embedded system for tracking construction asset by combining RFID and ultrasound signal is introduced [3]. Product data management (PDM) systems and near field communication (NFC) technology is developed in framework of FORBAU project to provide the construction project progress data to all involved actors [4]. Studies were made to measure the construction project progress by proposing a control model based on automated data collection form work-site [5] and a framework for automated monitoring system for steel structure construction [6]. Another approach suggested a solution according to knowledge management system comprising three components: RFID data component, knowledge base, and optimization component. Thereby, the core of the knowledge base is formed by ontology, which describes in a formal matter the contents and relations relevant for modeling on-site processes [7]. One of the current research work proposed a solution based on Real-Time Location Sensing (RTLS) system to enable a Cyber-Physical System (CPS) for information exchange [8]. Although this approach has a promise results; the expense of such a solution hinders a wide application in construction industry. Finally, the potential integration of RFID technology is evident by the Institute of Construction Informatics to control the dynamic construction process throughout coupling of flexible process models and the physical construction using cheaper passive RFID tag [9].

3 Cyber-Physical System (CPS) Approach

From a constructional point of view, CPS can be defined as a tight coupling between virtual models and physical construction to enable data bidirectional coordination [8]. Basically, the CPS architecture (as in fig. 1) encompasses the virtual models, physical entities and interfaces in both directions (cyber to physical interface and v.v.) based on data acquisition technologies like RFID. CPS enables bidirectional coordination between physical construction components and their virtual model in real-time. Hence, CPS is not only a part of the passive identification process but also a part of the active response and collaborative procedures as it is closely integrated with the control system. It endorses the challenge of ensuring accurate and timely update of information during construction process.

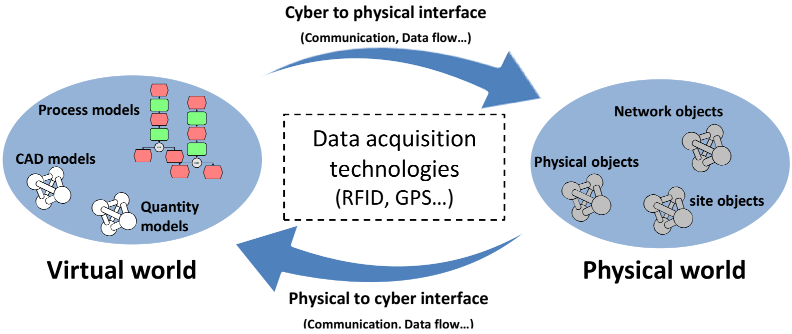

Fig. 1. Principle CPS architecture: interaction between virtual and physical world problem via data acquisition technologies (like RFID system, GPS, Sensors…)

3.1 Data Acquisition Technologies

The process of collecting data can be automated by emerging Automatic Data Capturing (ADC) technologies (RFID, GPS, Barcode, Laser scanning, etc.). It represents the technical part of CPS. In construction industry, these modern technologies are still under development, and the feasible applications are available only in few prototypes. Since RFID has relative advantages over other technologies, it is used to generate and aggregate information about real world objects (i.e. Products, equipment, shipments and personal information). RFID can facilitate progress measurement through the set of captured data and monitoring of project's status.

The RFID tag can be classified mainly as passive, active or semi-active. The passive tags receive power to transmit data from the reader. They have a cheap price, small data storage capacity and short read range. The active tags use a built-in battery to transmit data. Typically, they are expensive, have high data storage capacity, and a long reading range [10]. Thanks to their excellent features for the identification of static or even moving products, machines, and crew in harsh environment, Ultra High Frequency (UHF) RFID systems can be used in this proposed system.

3.2 Site Organization to Leverage Collaborative Data Acquisition Technology

To allow a continuous monitoring of all relevant components and resources throughout all construction phases, a methodology is required for detecting these physical objects, their positions, and their states undisturbed, automated and in real-time. This methodology bases on organizing the construction site to leverage collaborative RFID technology. Figure 1 illustrated approach considers three characteristic layers of job site: (1) Event layer representing where the construction processes take place, (2) Network layer for the mapping of events from the event layer to network configurations to make them tractable and (3) construction site layout layer; it links the network devices to their corresponding physical locations.

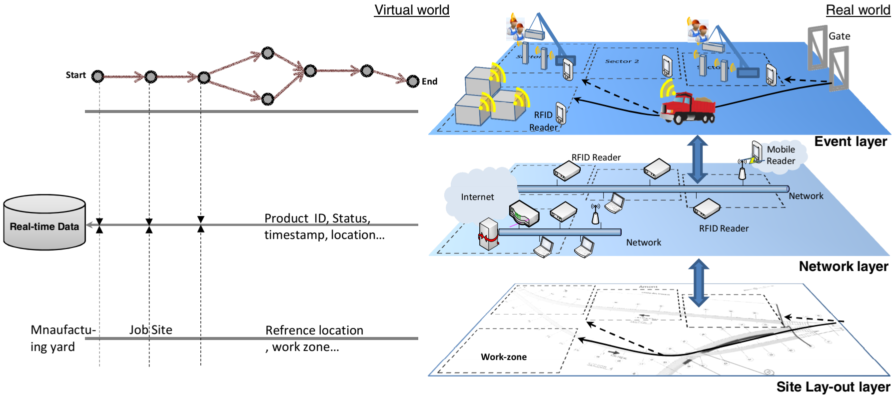

Fig. 2. A concept system for embedded UHF RFID technology based on RFID reader

Breaking down the construction site into work zone enables predefined entrances of the construction site, stores and lay down areas, and constructed facility places. At this, the components status can be easily updated at the job site gate, store or lay down areas, cranes at constructed facility site, etc. These places are mounted with RFID reader (stationary and/or mobile). Accordingly, the data (Product ID, timestamp, product status, location, etc.) can be gathered automatically at each process level, or semi-automatically by the foremen, who can also add their comments. Therefore, the suggested system keeps the process information continuously updated. Lastly, the collected real-time data will be handled in a knowledge base. This site origination solution leverages collaborative data acquisition technology and can dramatically minimize the time to update the state of each object towards automated data collection on construction site.

4 Real-Time Monitoring and Progress Determination

Real-time monitoring is a continuous process that takes place during the whole lifecycle of the construction phases. It links the field where physical objects are processed on the proposed CPS to the virtual one via RFID, which provides a stream line of data (IDs, time, location…) for all resources on site; therefore a real-time status update is on hand. Several research works were made to manage and transform raw data into meaningful events that can be understood by the applications. The real-time monitoring process requires a harmonization of construction process and collaboration of CPS which can be summarized in following sub-processes:

- Managing RFID data: Generally, the major steps for managing RFID data are data capturing, data filtering, and event processing and integration onto an application which was discussed in detail in previous work (cf. [9], [11]).
- Identifying related construction process from the virtual part of CPS: The entire construction project is described by a set of construction processes or activities depending on the level of description; each process needs to be accomplished within a defined period of time. These processes can be extracted according to Work Breakdown Structure (WBS) of the project. To identify the processes affected by a triggered event, the updated resources within a certain process window containing the current processes and the next direct successors will be detected. Then, the formulated relationships between processes and resources allow the identification of the corresponding processes.
- Deriving process progress: To derive the current progress of the identified processes. A few indictors corresponding to RFID application scenarios are applied. These indicators depend on the process duration, process dependencies and the required resources. Thereby, the underlying metric and the available information of the resources influence how detailed the process progress can be specified. On the next level of detail, the exact start and end time can be indicated. A further detailed specification provides information about the certain process state during its execution.

Key Performance Indicators (KPIs) are used to measure the progress of the assembly process of prefabricated components on site and. KPIs commonly aim to evaluate the success and the performance of a company. In this approach, KPIs are considered to determine the progress of ongoing assembly processes. Two indicators are discussed:

- The components availability: Each element (prefabricated elements, palettes…) is associated with a RFID tag. While elements move through different phases (logistic and/or on-site) the corresponding RFID tags are tracked by RFID readers. The retrieved information consists of Tag-ID, the Reader-ID and the current reading Timestamp as well as reader's position. This information will be stored and regularly updated into a knowledge base. The querying of an Element –ID and its last location in well predefined construction site (Fig. 2) can concern the availability of this element and its current status [9].
- Process time: It is an important indicator for process progress tracking. Estimating the process time is a complex task. However, the approximate process time can be estimated by identifying the start and end dates for each activity. The events dates are determined when the objects changed their statues. These dates are considered

as start and end of the related activity. For instance, beam assembly process starts as soon as the beam state changed from beam-stored into beam- in assembly and it ended as its status changed into beam-mounted. The aggregated dates are used for estimating the whole process time and hence the progress of these processes.

5 Real-Time Data Analysis and Classification

This step aims to detect process deviations and achieve a continuous comparison of actual with planned performance. Here, the accomplished detection of deviations is for both prediction and actual values at different levels of detail (process or even activity). The process in this case can be defined as a set of activities. The comparison comprises the resource (as build, as planned) and the date variations of current process. Based on deviation values, the outputs can be categorized into three classes according to the project thresholds, the activity priority (belongs to the critical path of the project), and the floating time of an activity (Fig. 3). These classes are:

- Class1: early, on schedule “or even very close to”➔ no or accepted risk detected.
- Class2: nearly on schedule ➔ risk or potential risk detected.
- Class3: late (i.e. activity on critical path of project)➔ problem detected.

Depending on these outputs the process states will be derived, detecting delays in project execution and planning for alternative which is discussed in the next section.

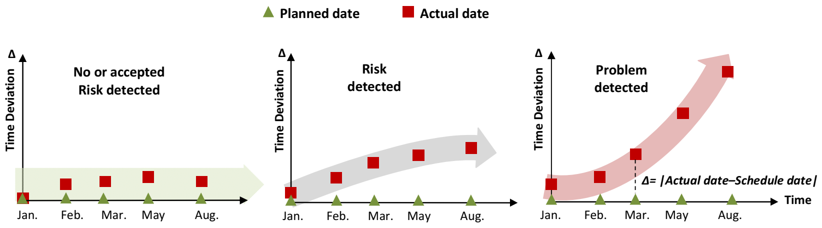

Fig. 3. Outputs of analysis real-time monitoring data of project activities “actual vs. schedule”

6 Construction Process Monitoring and Control

Real-time monitoring of construction processes is necessary to anticipate and identify schedule delays and exceptions at the early stage and even before they happen. Nevertheless, the analysis of these data facilitates the assessment of project health and to make timely recommendations for corrective action in response to these exceptions. Because of construction project nature, some exceptions (risks) can be realized early at the planning phase. However, the realism of the risk assessment increased as project proceeds (i.e. considering a new risk and omitting others). This work proposes a comprehensive solution (Fig. 4) for construction process monitoring and control in real-time and a mechanism to add corrective action during execution in collaboration with well-known flexible process modeling method. This solution comprises the following three main components:

- The real-time monitoring represents data aggregation and analysis that was classified above. These results can be derived in more specific identification and assessment steps (beyond as-build/as planned assessment) (cf. [12]).
- The second part is a suggested mechanism to add suitable treatments and recommended actions. These treatments can be an Ad-hoc solution, or configurable fragments (preplanned treatment) added to the process model as proactive treatment and to configure such configurable fragments as reactive treatment based on continual monitoring of process execution [10]. Hence, the treatment is a standardized process description that offers enough flexibility to be used in a different context. And the configurable fragments in the course of the process model express the uncertain parts of the process. Recent research work proposes to use templates that are a type of configurable fragments within the process models. These templates are generic and supposed to provide the flexibility needed in the process model [13], [14]. The real-time monitoring of ongoing activities can support the configuration of such templates by selecting the most suitable fragment for each variation point.
- Finally, all alterations are documented, the process models are updated to the project knowledge base and the monitoring cycle is resumed. Knowledge base roles are to manage the entire process model, formulate dependencies in a logic-based manner and to derive additional information required for filtering events, identifying risk types, configuring process fragments.

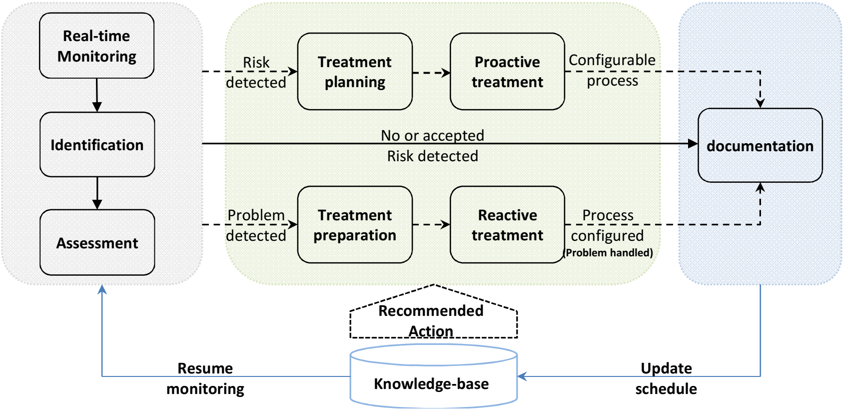

Fig. 4. Comprehensive approach based CPS for real-time monitoring control changes

7 Conclusions

The paper showed significant opportunities of using the CPS based RFID. It enhances the real-time construction process monitoring and aids an early decision making and process control. Moreover, the proposed site organization to leverage collaborative RFID system can minimize the manual inputs of data and lead to automation of data acquisition. The analysis of real-time data collected on site can give a clear view of project progress. Furthermore, it facilitates the transform of these data into meaningful classifications that can be understood by the applications. The direct application of this classification is to control the construction process in real time. Hence, the comprehensive real-time monitoring and control solution promises a flexible modeling method. That method is based on a mechanism to configure the recommended actions. Thereby, configurable process templates are used to respond to the frequently changes in construction site conditions.

Acknowledgments. This research is partially funded by EU-Project (FP7 no. 229142) Trans-IND. This support is gratefully acknowledged.

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Collaboration Related Processes

Supporting Processes for Collaborative SaaS

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Abstract. Software-as-a-Service (SaaS) is becoming a very powerful strategy for develop more flexible software solutions and to shorten their time-to-market. Typical SaaS providers are SMEs, which have several limitations to keep competitive. The essential motivation of this work is to provide better means to allow groups of SaaS providers (a Virtual Organization - VO) to work collaboratively towards more valuable SaaS solutions that are composed of individual and shared SaaS providers' services. However, working collaboratively requires handling plenty of issues in many dimensions. This work provides a comprehensive and consolidated list of reference processes that SaaS providers should deal with along the (VO) life cycle of a collaboration. This helps them to better plan and manages their activities and involved assets in a collaboration.

Keywords: Collaboration, Business Process, Software-as-a-Service.

1 Introduction

The adoption of strategic alliances focused on highly intense collaboration has been seen as a sustainable alternative to increase enterprise competitiveness through innovation and productivity [1]. Collaborative Networks (CN) has emerged as a prominent paradigm allowing companies to keep focused on their skills and to aggregate competencies with other companies in order to offer products with higher value to meet businesses [2]. CN can provide the basis for capacity elasticity and workload allocation flexibility in dynamic and adaptive value chain networks.

ICT represents one of the most important sectors in the nowadays knowledge and increasingly service-oriented economy, and has become vital to leverage enterprises competitiveness [3]. However, it is important to consider the typical profile of ICT companies. In Europe, for instance, there are more than fifty thousand SMEs within the ICT sector [4]. It is well known that SMEs have many limitations, such as in terms of human and financial resources, marketing, scalability, time-to-market, best practices and innovation. Therefore, it is crucial to develop sustainable models for ICT companies that are aligned to that reality.

Within this context, cloud computing and Service Oriented Architecture (SOA) paradigms have introduced a new outlook on systems design, development, integration and servitization [5]. Following this trend, a number of architectural and supporting business models start to be widely adopted, such as SaaS (Software-as-a-Service) [6]. SaaS is an architectural and availability model of software that is

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 183–190, 2013.

accessed on demand via Internet and that is paid per use. In this model companies no longer buy traditional software packages' licenses but remotely invoke ('rent') specific software services from providers instead. Although not mandatorily, in order to take more advantages of the software features provided by SOA, several SaaS solutions are developed under this paradigm, where a SaaS solution is then composed of a set of (decoupled) software services [7].

Regarding the ICT companies that have been investing in SOA and SaaS-based solutions, on one hand the adoption of these models can open new business opportunities. On the other hand this does not solve those limitations by itself as companies usually remain working alone, developing services by their own and for their use only, keeping them deployed at their local silos [8]. The underlying motivation of this paper is to explore the premise that ICT SMEs sustainability can be highly enhanced if they collaborate more with other companies - even being competitors - in the form of sharing services and business strategies with the aim of composing and offering more value-added services-based solutions to the market.

CN appears as an adequate scientific foundation to pave a collaborative work among ICT SMEs in that perspective. In this paper, the envisaged business scenario refers to making such companies sharing their individual (interoperable) services in order to compose more flexible SaaS solutions to better cope with market needs. This scenario has been called as "Collaborative SaaS" [9]. In the light of CN paradigm, this means creating a Virtual Organization (VO) to attend to a concrete demand for or to prospectively develop a new SaaS solution, where the VO members are the ICT companies which own the involved services of that solution.

A number of works in the literature use to generally state about the importance of ICT companies to more intensely work in a collaborative way. However, no one say how to do that in a precise and comprehensively way. Even larger companies that do that use to make it in an *ad-hoc* manner and very much focused on their reality regarding their long-term and know partners. The fact is that working collaboratively - and even more in such Collaborative SaaS scenario - is not a mere wish. There are many organizational, legal, financial, technological among other issues to cope with to approach this problem. This is especially difficult considering that companies are naturally heterogeneous and that their independence and autonomy must be kept along the collaboration.

In this sense, this work provides a comprehensive list of the business processes that SaaS providers should deal with along a collaboration towards having a SaaS solution. In a previous work [9] authors provided a preliminary list of collaborative processes for Collaborative SaaS. This article now presents the consolidated and formalized version of this list, the processes' related practices and the positioning of each process within each phase of the VO life cycle. A list like that is an important instrument offering a more solid basis to SaaS providers about the impact of these processes on their current practice. As such, they can be better prepared for supporting the processes, for better managing resources and efforts in each VO / collaboration phase as well as for implementing processes' related practices.

This article is organized as follows: section 2 depicts the essentials of research methodology applied in this work as well as of the literature review. Section 3 presents the list of collaborative processes and example of practices. Section 4 discusses about the main findings of this research.

2 Basic Research Methodology and Literature Review

This research corresponds to a qualitative and applied work, strongly grounded on revision of literature. The literature review was mostly conducted applying the SLR methodology [15] over *IEEExplore, ACM Digital Library, Compendex/Engineering Village* and *ScienceDirect* scientific databases collecting papers published in journals and conference proceedings between Sept 2000 and Sept 2012. This was complemented with *ad-hoc* searches, also looking at works developed in the software industry. From an initial and rigorously filtered list of 278 works that were found out, 11 works were taken as the core theoretical referential source of collaborative processes [11-13] [14-19], regarding their scope and depth in the processes description.

An inductive method was applied as the research strategy aiming at creating a generalized but preliminary list of collaborative processes from particular instances (related works) and from empirical evidences.

It could be observed that Collaborative SaaS is a new area and no very directed related works were found out. Therefore, that list had to be compiled and adapted to that as well as fit in along the VO life cycle. It is important to clarify that reference models as CMMI or ISO/IEC 15504 [10] are devoted to software improvement processes and for the acquisition model, and not to collaborative processes and service-oriented model. On the other hand, being very consolidated models, they were used as the basis for the elaboration of the processes' base practices.

A selected international working group composed of 24 experts on the areas of collaborative processes/systems and services was formed to refine and evaluate the compiled processes list. This was carried out along three rounds of interactions via a web site created for that. Intermediate and final refinements were conducted by the authors, also based on their experience in the involved areas. This has also involved a final consolidation of the resulting list in order to check redundancies (i.e. different processes' purposes dealing with equivalent concepts), synonyms (i.e. different words but with the same meaning) and semantics misleading (i.e. definitions of processes that were in fact more related to other process' definition). A number of supporting books were also taken into account for that 'normalization', [20] in more particular.

3 Collaborative Processes

With the processes compiled with 'normalized' names and purposes, they were analyzed and categorized within and according to the phases of the VO life cycle reference model [20]: *creation, operation, evolution* and *dissolution*. Due to the more amplitude, the processes within Operation and Evolution phases were organized into subcategories, regarding their more intrinsic nature. They were also prioritized in terms of which ones have to be primary supported. The prioritization (P) level was divided into 5 categories: *essential (5)*, *very important (4)*, *important (3)*, *low important (3)* and *likely unnecessary (1)* to be supported only if they are indeed necessary for the particular case. Table 1 resumes the consolidated list of 42 processes required to support Collaborative SaaS. The prioritization was built based on experts' opinions. This prioritization should be seen as a reference and, as any qualitative classification, has some degree of subjectivity. Depending on local conditions and culture, strategic planning, working methods, among other aspects, this can change and so can be deployed differently. It might be said that this corresponds to the 'why', 'what' and 'when' to do the collaboration.

Table 1. Consolidated list of Processes for Collaborative SaaS

Phase		**P**	**Processes**	**Purpose**
Creation		4	Business Opportunity characterization	Involves the identification and characterization of a new collaboration opportunity of a new SaaS collaboration.
		3	Selection of performance indicators	Performance indicators to be used in the monitoring must to be defined by the SaaS collaboration group.
		4	Partner Search	Identification of potential partners, and their assessment and selection to be a SaaS provider.
		4	Partner Selection	Setting up SaaS partner's section criteria and selection supporting method.
		4	Negotiation & Risk Analysis	Activities and supporting tools to assist partners during the negotiation processes and risk analysis assessment towards the SaaS collaboration.
		5	E-Contracting	Final formulation of contracts and agreements as well as the contract signing process itself, before the SaaS collaboration can effectively be launched.
		4	Collaboration Planning	Determination of a rough structure of the potential SaaS collaboration, identifying the required competencies and capacities, structure of the task to be performed as well.
Operation & Evolution	QoS Management Processes	4	Trust Management	Promotion the establishment of trust relationships and levels among SaaS participants.
		5	Governance Management	Management activities and supporting tools for the SaaS collaboration policy management, operational rules and bylaws, regulation, and control of the network structure.
		3	Measurement and analysis	Developing and sustaining a measurement and analysis capability of the SaaS collaboration that is used to support management information needs.
		3	Decision Support Management	Management activities and supporting tools for decision support, using KPIs in the SaaS collaboration.
		2	Process and Product Assurance	Provides appropriate conformance guidance and objectively reviews the activities and SaaS work products of work efforts within the collaboration to ensure.
	Strategic collaborative processes	5	Strategic Management	Formulating, and evaluating functional decisions that will enable a collaboration to achieve its objectives.
		3	Customer Relationship Management	Managing the interaction with SaaS customers with the collaboration, using enterprises data and information.
		2	Organizational Innovation	Selection and deployment of innovative and measurably improvements of the SaaS collaboration's processes
		5	Collaborative Strategy	Investment in strategies to improve the SaaS collaboration, to develop provider competence and to improve the general network.
		5	Reconciling Individual and Collective Interests	Achieving trade-off between individual partners' missions and collective interest.
		3	Simulation	Generation of scenarios about implementation decisions evolving SaaS and collaboration.

Table 1. *(Continued)*

Operation & Evolution	Project Processes	3	Collaborative Project Management	Establishment and managing Collaborative SaaS projects and the involvement of the relevant stakeholders.
		3	Requirements Management	Managing the requirements of the SaaS project's products and to identify inconsistencies between those requirements and the project's plans and work products.
		2	Requirements Development	Producing and analyzing customer, product and product component requirements.
		4	Risk Management	Identify potential problems so that risk-handling can be planned and invoked as needed along the collaboration.
		3	Quantitative Project Management	Managing project's processes to achieve the project's established quality and process-performance objectives.
		4	Partnership formation project	Negotiation of roles and responsibilities, deliverables and payments related with SaaS collaborative project
		2	Resources Management	Plans and manages the acquisition, allocation, and reassignment of all resources needed to prepare, deploy, operate, and support the collaboration.
	Technical Processes	5	Technical Solutions	Design, develop and implement solutions to the committed requirements between SaaS and collaboration.
		4	System design and task partitioning	Modularity, interface definition and task interdependencies in a SaaS development.
		4	Support Institutions Management	Management activities for identifying and integrating Support Institutions into the SaaS collaboration.
		5	Performance Management	Activities and tools of planning, monitoring, rating and rewarding collaboration actors based on the KPIs.
		3	ICT Management	Management activities and supporting tools for managing easy-to-access and operational infrastructure that will allow collaboration actors with different applications.
	Administrative, Legal & Financial	3	Collaboration Launching	Refine the SaaS collaboration plan and its governance principles, to formulate and model contracts and agreements and to put the collaboration into operation.
		3	Collaboration Agreement	Setting up the terms in which the collaboration will take place.
		2	Marketing Management	Management activities and supporting tools that will support the strategic formulation process, including the marketing and branding activities
		3	Financial Management	Planning income and expenditure, and making decisions that will enable the enterprises survive financially.
		2	Accounting Management	Activities to guarantee the enterprise financial health and ensure the effective and efficient and use of the resources.
		3	IPR Management	Agreement about the terms of the Intellectual Property Rights within the collaboration.
Dissolution		3	Collaboration inheritance	Management of inheritance information after collaboration dissolution.
		3	Partners assessment	Sharing the analysis results is dependent on the network and the collaboration rules and practices.
		3	Checking contract	Finalization the collaboration contract terms.
		2	Security access cancellation	Ending the services access between the enterprises.
		2	Legal issues	Finishing the legal issues on the use of virtual companies since they imply cooperation agreements.

Once identified each process should be more formally specified in order to be more properly understood and used. This would correspond to the 'how' to do the collaboration. This work has applied the ISO/IEC 15504 standard for that. A PRM (*Process Reference Model*) describes the implementation mechanisms of every single process, providing: *process' domain and scope*, *process purpose*, *process outcomes (PO)* and *base practices (BP)*. BPs contains the list of indicators that should be used to achieve process' purpose, including some optional notes. POs can be seen as the checklist to evaluate if BPs were properly implemented.

A PRM and related BPs should be seen as a referential basis and so they should be expressed at a relatively abstract level allowing a further particularization for collaborative companies. ISO/IEC 15504 was also used as a basis for the BPs and then adapted to the Collaborative SaaS scenario. Table 2 shows a PRM of one of the 42 elicited collaborative processes. It refers to the process 'collaborative strategy', which is performed in the operation ('OPE') phase of the VO/collaboration life cycle, it is the first ('.1') process in this phase, and that has seven BPs. The complete list of PRM for all processes can be found at: http://www.das.ufsc.br/~maiara/Collab_SaaS_MM.pdf.

Table 2. Process, Purpose, Outcomes and Base Practices

Process ID	OPE.1
Name	Collaborative Strategy
Process Purpose	The purpose of Collaborative Strategy is to select and deploy improvements to the SaaS Solution.
Process Outcomes	As a result of successful implementation of this process: 1) Improvements to SaaS Solutions known; 2) Improvements analyzed; 3) Goals, strategies and plan defined; 4) Goals, strategies and plan implemented.
Base Practices	**OPE.1.BP1**: Research and identify possible improvements to deploy in the SaaS Solution. [Outcome 1] **OPE.1.BP2**: Analyze if the improvements are aligned with the business strategy. [Outcome 2] **OPE.1.BP3**: Analyze how the proposed change generates value for the customer. [Outcome 2] **OPE.1.BP4**: Analyze what investment is required and if the needed investment will generate an acceptable return. [Outcome 2] **OPE.1.BP5**: Analyze what would be the impact of the improvement on the current business. [Outcome 2] **OPE.1.BP6**: Implement activities for improvement.[Outcome 4] NOTE 1: When the improvement involves innovation, it is strongly recommended to use a Model of Innovation Management.
Sources	[21] [22] [16]

4 Discussion and Conclusions

This article has presented a comprehensive list of the collaborative processes that are generally required when groups of SaaS providers decide to work collaboratively aiming at providing a given SaaS solution as a Virtual Organization. Processes are detailed and formalized in way to help companies in their implementation and management along the VO / collaboration life cycle.

This list should be taken as complementary to the traditional transaction-based business processes that companies use to execute in their daily business life.

One of the most important usages of that list is to give awareness to SaaS providers about what, how and when to do in a collaboration. As such, they can help companies in making less difficult the ‘shifting process’ of transforming collaboration as a process routine and value adding instead of an exception and sporadic action, as usually happens in the companies, SMEs in particular.

Although comprehensive and it had been validated by a group of international experts, the processes list cannot be seen as definitive. A number of works in the literature has brought up valuable outcomes on collaboration among companies but essentially focused on more consolidated sectors, as manufacturing, and sometimes targeting to specific problems. Collaborative SaaS, on the contrary, is a new scenario, having a number of open points and challenges. As such, it is natural that the list evolves as long as such form of collaboration gets more mature and companies start using them more intensely as a basis for continuous process improvement. Therefore, this list should be seen as an initial contribution, as a starting point. Even though, it should be adapted to the current or envisaged SaaS digital business ecosystem, considering aspects as business strategy and local conditions, capacity and maturity models, organizational change management, trust building, companies’ performance evaluation and reputation management, financial impact, selection and use of proper implementation ICTs, interoperability, security, SLA management and services deployment, among many other. All this costs and takes time to be implemented and to evolve.

It is important to highlight that the processes list and related PRM does not cover other macro phases of a SaaS life cycle. It assumes that a sort of services are registered and made available in a proper and standard-based way so diverse composite SaaS solutions can be assembled on top of this. The provided list copes with the processes involved in this ‘assembly’ and basic provision. Other phases, as services conception, design, implementation, fully provision and maintenance, are not supported as they were out of the scope of this specific research.

Next main steps of this research refer to its expansion in general. Firstly but gradually, to enlarge that list in order to also comprise those mentioned SaaS macro phases. Secondly, to evaluate at which extent companies can enhance their organization for more efficient creation and provision of SaaS solutions if they become members of long-term alliance, as VBE – Virtual organization Breeding Environment [20]) and Federation [23].

Acknowledgements. This work was supported by CNPq and Capes Brazilian research funding agencies.

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Context-Aware Process Modelling through Imperative and Declarative Approach

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Abstract. Business process models can help to improve process visibility and shared understanding, particularly across internal and external stakeholders. By supporting knowledge transfer and enhancing documentation, they aid compliance and ultimately improve software quality. However, many current process modelling approaches and tools require significant learning on the part of users and resultant models may often be prone to errors. The use of such approaches also demands a certain level of domain expertise in both the business and IT domains. Hence, the need to accommodate a wider user group for business process models, including those, often end users, who are not IT experts. Context-aware process modelling allows end users to identify a business process model from a process repository according to different context information. In this paper, we develop a new approach to help end users for building up potential process models using PVDI (process variability through declarative and imperative). A real world case is used to explain and verify our approach.

Keywords: Collaborative process modelling, Declarative process modelling, Context-aware process modelling, Virtual business process modelling, and Virtual collaborative process modelling.

1 Introduction

As many organisations have reached higher levels of business process management maturity, they tend to collect and actively use large numbers of business process models [1]. Enterprise software vendors and business process management consultancies have also built a larger number of business process reference models for requirements analysis, communication, automation, compliance, etc. Such collections of industry-strength business process models and collaborative business process models include thousands of activities and related business objects such as data and business artefacts.

The questions such as, how to manage such large collections of process models and how to reuse them to facilitate the development of new collaborative process models, provides new challenges and opportunities to the area of business process management. Context aware process modelling is one approach to store different process models in a process repository, to represent a process models, and to identify

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 191–200, 2013.

process models from a process repository only once while specifying the differences depending on specific context categories (such as business domain, business industry, country, business role and so on.)

Context awareness is an essential role for the dynamic appearance of structures and the dynamic linguistic representation of components. In this paper, we focus on providing dynamic collaborative business process structures according to the context information. Collaborative process structures embrace context awareness aspects of both the context driven flow of collaborative business processes and contained activities. In addition, relations among activities and other business artefacts are context dependent.

We introduce a new approach to facilitate end users to build their collaborative business process models. From our experience in building collaborative business process models, there are always alternative collaboration process models. How to completely present all possible models and how to select potential suitable collaboration process models are the research problems we try to solve in this paper. We have used both imperative and declarative process modelling approaches to solve the problem.

1.1 Related Work

The context awareness business process model is used to achieve reusability and consistency. Some initial approaches of the consideration of contexts within business process models can be found within [2, 3, 4]. Saidani et. al. present how to perform business process modelling using context aware information during all modelling stages [4]. The steps of supporting the context aware process modelling include context elicitation, context categorisation, context adaptation and measure, and business process instantiation. In [5] the authors concentrate on the context-relevant adjustment of configuration variants of the technical execution of business processes; whereas in [6] the authors deal with the situations which affect the flow of business process models. These are initial efforts on context-aware business process modelling. They did not consider structural differences and how context methods can actually change the flow of these models. Further, these aspects primarily concentrate on business processes within companies and they primarily focus on their context-driven flow.

The context awareness aspects which are developed within our work consider the context-driven differences in the structural appearance of business process models and focus on various levels as well as context-driven terminologies for business artefacts. Furthermore, our proposal does not focus on any specific application of contexts and neither on any specific context categorisation; rather it contemplates context-driven differences in general on an abstract level.

Paper [7] and [8] present a methodology for automatically generating business processes which bring a declarative perspective to introduce a variability framework for BPM. The authors use temporal logic to formalise partial orders among activities of a process. The choice and customization is open for the adaption. We adopt PVDI (process variability through declarative and imperative) from [7, 8] to general variable collaborative process models in our context-aware process modelling.

The rest of the paper is organised as follows: Section 2 provides a motivational case. The proposed imperative and declarative approach is explained in Section 3. An evaluation of our approach is then described in Section 4 by using our motivational case. Last, the conclusion and the future work are drawn.

2 Case Study

In United Kingdom, there are 7,500 companies in the plastics industry, each of these companies produces this plastic by different ways, e.g. extrusion, thermoset processing, injection moulding and few other more, but the way they run their day transaction is same.

Figure 1 illustrates a simplified version of the general and visible way of any plastic company process. The simplified version shows the collaboration between various companies. A company requests a tonne of plastic bag to be made Plastics Ltd, the company receives the purchase order (A), checks the availability of the needed raw materials (Polyethylene, recycled products) (A2), also check account history of the customer.

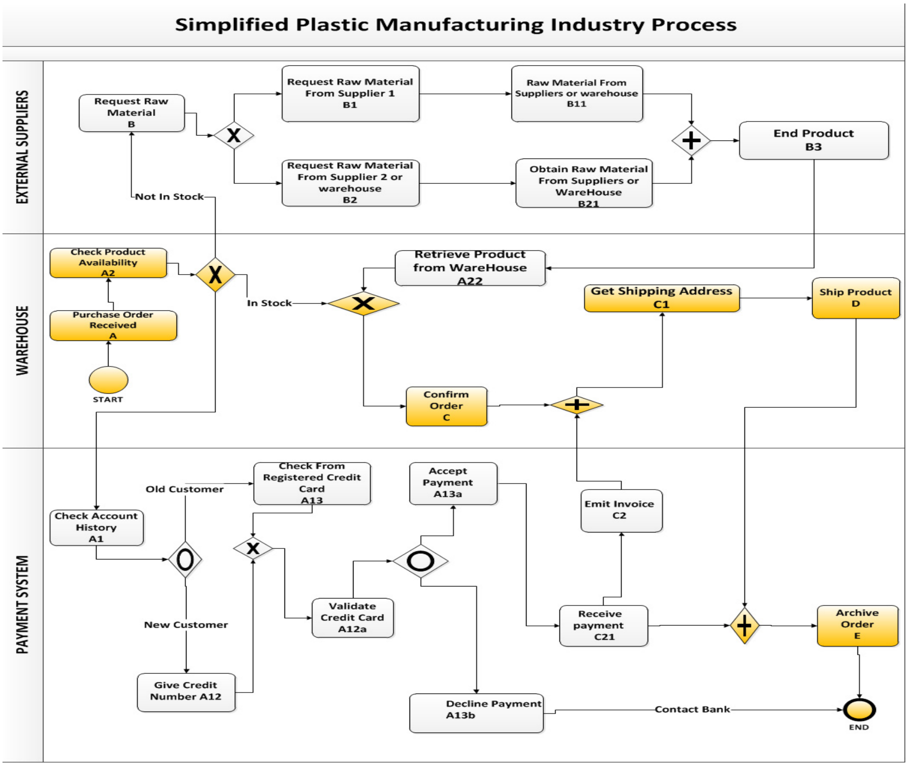


Fig. 1. PMI Process Model

The stock level determines whether Plastic Ltd requests more raw materials from their suppliers (B1), (B2) to manufacture more of the plastic bag. If the stock level is enough, then the tonne of plastic bag is retrieved from the warehouse (A22 and the order is confirmed (C). Next, all ready to be shipped to the given address (C1). Before the plastic bags can be shipped off, the payment is needed to be confirmed by the account systems.

Within the account systems, a record of companies and credit card (A13), are kept in a secured database, which different a new customer and old customer, a new company has to give its company details, also its credit card number (A12), which will be automatically validated (A12a), for every transaction. An accepted payment A13a will precede the confirmed order to be shipped off (D), but a declined payment will automatically end the process and the company will be notified.

The case provides changeable business processes according different business situations. In the following sections, we show how the collaboration process can be configured.

3 Configuring Imperative Process Models

Imperative process modelling takes an `inside-to-outside' approach: all execution alternatives are explicitly specified in the model and new alternatives must be explicitly added to the model [11]. Imperative process modelling provides sequential information what the process flow should go. In an imperative process model the model explicitly specifies all valid execution paths. On the other hand, *declarative process modelling* takes an `outside-to-inside' approach: constraints implicitly specify execution alternatives as all alternatives that satisfy the constraints and adding new constraints usually means discarding some execution alternatives [11]. Declarative process modelling provides the rules what the process should not do. In a declarative process model the system is constrained by conditions for valid code paths. There could be an infinite amount of valid paths and enumerating valid paths may be impossible.

In this section, we introduce our approach of how possible process models are built according to different guides in different contexts. The three steps are followed.

1. Based on an as-is process model and the case study to abstract logic and temporal dependencies of the imperative process model (see Section 3.1).
2. Identify frozen group which are core parts of business and identify close area which are possible to change and flexible (see Section 3.2).
3. Use PVDI (process variability through declarative and imperative) to verify all potential collaborative process models (see Section 3.3).

3.1 Logical and Temporal Dependencies

Logical and temporal dependencies are defined as a set of rules which creates a component that depends on a specific set of pre-conditions. It is mandatory sometimes to remove the activity when those pre-conditions no longer hold. Logical dependencies help to prevent errors in configuration [9], which the requirements, dependency and prohibitions rules must be met.

Definition 1 (Requirements). Let A and B are activities, Requires: A →B represents that if activity B is chosen during configuration, then activity A must be chosen.

Definition 2 (Dependency). Let A and B are activities, Depends: A→ B means that if activity B is not chosen during the configuration, activity A must not be chosen.

Definition 3 (Prohibition). Let A and B are activities, Prohibits: A → B that if activity A is chosen during configuration, activity B must not be chosen, vice-versa.

Temporal dependencies define whether a particular activity has to be performed before or after another activity, depending on the exact service module to be executed at a given time [10].

Definition 4 (Precedence). Let A and B are activities, Before (A)→ B denotes that if activity B must be occurred before activity A occurs.

Definition 5 (Direct Precedence). Let A and B are activities, iBefore (A) → B signifies that activity B must be occurred directly before activity A.

Definition 6 (Succession). Let A and B are activities, After (A)→ B acts for execute activating B after activity A

Definition 7 (Direct Succession). Let A and B are activities, iAfter (A) → B describes that activity B executes immediately after activity A.

Further examples of logic dependencies and temporal dependencies of the PMI process are provided in Section 4.1.

3.2 Frozen Group and Closed Area

Constraints are set of valid valuations drawn from a process, which must be TRUE. The constraints are needed to be known, in further understanding of this approach, frozen group and closed area are need to be known, from this constraints the variability of a process can be built.

A *frozen group* is a specific area which the given designed template may not be modified. Every node from the start and end paths in a frozen area are mandatory to be selected in the template [8] and is frozen which is not subject to changes.

For example, the frozen group of the PMI process is the darken flow in Figure 1, which are the primary activities details of the PMI company which cannot be altered, Figure 2.

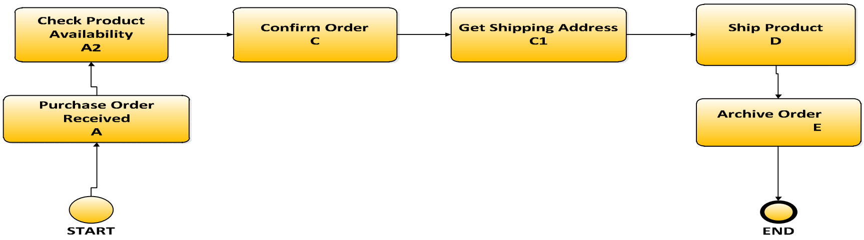


Fig. 2. Frozen Area of the PMI process

A *closed area* (CA) is imperative specification that provides possible modifications that is, it may allow changes to the elements of the business process. It is a selected area constrained between the incoming and exactly one outgoing flow to and from it, in which every nodes are mandatory between to select [8]. The closed areas are normally classified by different functions of different internal or external partners.

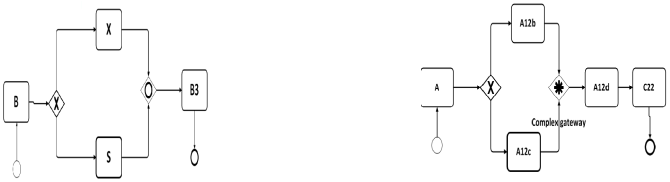
For example, the set of constraints developed over set activities within PMI group, related to the 3 parts, $PMI_{payment}$, $PMI_{warehouse}$, and $PMI_{exteranl\_supplier}$ are shown below

a) $PMI_{payment} = \{ A, A_{12}, A_{13}, A_{12a}, A_{13a}, C_2, C_{21}, E \}$
b) $PMI_{warehouse} = \{ A, A_{22}, C, C_1, D, F \}$
c) $PMI_{external\_supplier} = \{B, B_1, B_2, B_{11}, B_{21}, B_3\}$

3.3 Different Process Variability Approaches

Variability is abstraction in which organization preserve its standard business processes but also allows other templates to be built, customized and adapted on the exciting processes. The goal of variability is to support processes to be re-usable and flexible; the current three variability approaches are namely: imperative variability, declarative variability, and Process Variability through Declarative and Imperative Technique (PVDI).

Imperative variability is an approach in which variables may or may not be added to an existing template at design time. The imperative view on variability within the PMI process is shown in Figure 3a and 3b which explains the variability within the external supplier and the payment system respectively, the warehouse section has no variability that is it cannot be modified.



(a) Simplified Possible Model 1 (b) Simplified Possible Model 2

Fig. 3. Two Simplified Possible PMI Process Variants

In Figure 3a, activity (B) notes 'Request Raw Material' activity, (X) describes the 'Forward Sub-Order' sub-processes from different warehouses and S represents the 'Request Raw Material' sub-processes from different suppliers. The new possible variants (X_1), (X_2) for sub-process (X), (S_1), (S_2) for sub-process S may or may not be added to the initial template depending on the reference process and context information [9].

In Figure 3b, the variants in the payments systems are as follows: (A_{12b}) represent the 'Cheque Payment' activity; (A_{12c}) describes 'Invoice Number'; A_{12d} represents 'Validate Cheque or Invoice Number'; and (C_{22}) represents 'Refund'. Each activity or sub-processes can be replaced according to the process execution. Using imperative modelling approach, such variants need to be pre-defined and be configured according to certain mechanism.

Declarative variability is a brand new way of designing business processes where the basic principles or requirements of a process in a template are defined; variants are created and validated from the template.

PVDI is a relative new technique that allows a high degree of process variability while preserving the main business goal of a process [8], while preserving the designed templates. Groefsema et al [7, 8] provided a new approach to making a business process more flexible, it combines the properties of imperative, declarative variability and newly developed process modelling environment with graphical elements.

When end users want to build a process model for their situational needs, they provide context information which a mate-level process model can be identified. They can select the main parts or frozen parts of business activities or sub-processes and identify the flexible parts or close area. Logic and temporal dependencies can be created according to guides. Based on the frozen group, close areas, and logic temporal dependencies, the activity floating will be generated according to our logic and temporal dependencies. Until all constraints (frozen group, close areas, and logic and temporal dependencies) are satisfied.

4 Evaluation

In Section 3, we introduce the principle of how to configure the variable process models. In this section, we provide logical temporal dependencies from the PMI case and one example of variable sub-processes because the page limitations.

4.1 Logical and Temporal Dependencies for the Case

In executing the processes in Figure 2, there are sets of rules that must be known, it is necessary to note that the logical and temporal dependencies are formalised during the configuration which is shown in the Table 1.

Table 1. Logical and temporal dependencies for the PMI case

Logical Dependencies		
RULE	FORMALISATION	EXPLANATION
Requirements (Before)	Requires:B11 → B1 Requires B21 → B2 Requires:C2 → C21	Activity B1 (‘Request Raw Material from Supplier 1’) is only *required* after Activity B (‘Requires Raw Material’)
Dependency	Depends: A12a → A12 Depends: C21 → A22 Depends: C2 → C21	From payment system, Activity A12a ('Validate Credit Card') *depends* on Activity A12 ('Give Credit Card ')
Prohibition	Prohibits: A13a → A13b	From the payment System, Activity A13a ('Accept Payment') *prohibits* Activity A13b('Decline Payment') or vice versa.

Table 1. *(Continued)*

Temporal Dependencies		
RULE	FORMALISATION	EXPLANATION
Precedence	Before (C or B) →A1 *(This rule must conform to the Country's Business Law, might be vice-versa for certain countries*). i.e. A1 →(C or B)	Activity A1 ('Check Account History in Payment System') must done must be executed *first before* Activity C or B ('Confirm Order in Warehouse system or Request Raw Material in the Supplier System respectively').
Direct Precedence	iBefore (C) →A22 iBefore (A12a) → A13 or A12	In the Warehouse System, Activity A22 ('Retrieve Product') is executed *directly before* Activity C ('Confirm Order')
Succession	After (A) →A2 After (C21) →C2 After C2→C1 or D	In the Warehouse System, Activity A2 ('Check Product Availability') is executed *after* Activity A ('Purchase Order Received').
Direct Succession	iAfter (A12a)→(A13a v A12)	In payment System, Activity A12a ('Validate Credit Card') is executed *directly after* activity A13a ('Accept Payment') or Activity A12 ('Give Credit Number')

4.2 Process Variability

Within the PMI process as shown in Figure 1, two variants were discovered through cross examinations of the possibility of flexibility within the PMI process. We split Figure 1 into two parts, namely *suppliers section* and the *payment section* which all of these parts are tested, ignoring the warehouse section because it is a closed area, i.e. every node in this section is mandatory to be selected [8]. The suppliers and payment sections called variant 1 and variants 2 respectively maybe or may not be implemented into the simplified PMI process in Figure 1, depending on the business needs.

The external supplier sections is can be said to be flexible and easy to re-use i.e. if there are needs to request a raw material from more than two suppliers or other warehouses own by the company, the diagram is re-modelled to show the possible variants 1 with new configurations shown in Figure 4.

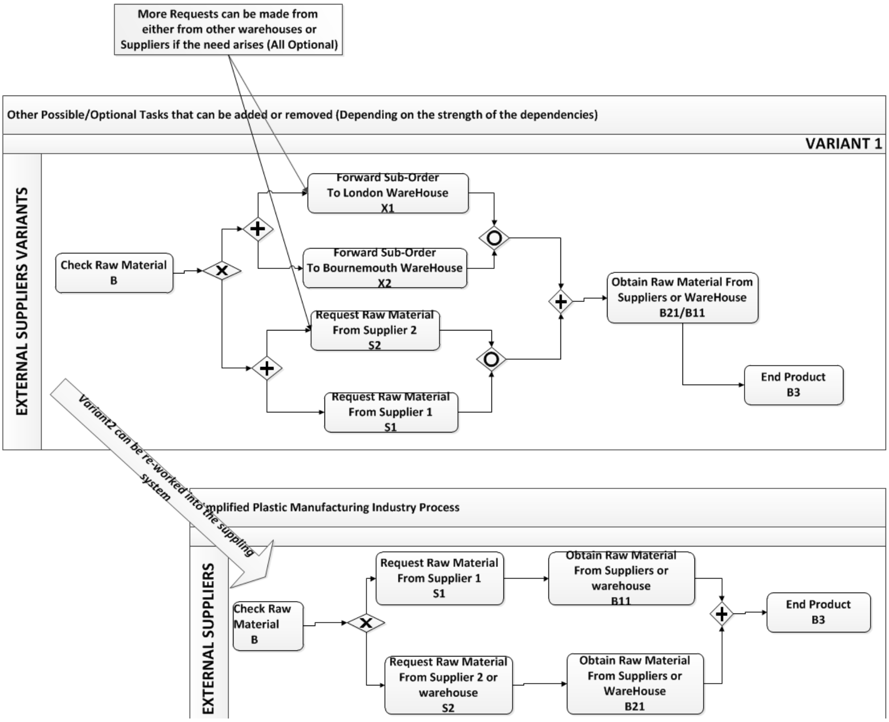


Fig. 4. Imperative Views on Variability within the External Supplier

5 Conclusion

Context-aware process modelling has been conceptually discussed and partially implemented in our previous work [12, 13]. This paper has presented a new approach to guide end users for building their collaborative business process models or collaborative process models using both declarative and imperative modelling methods. The aim of the approach is to provide process visibility for different business situations. We are fully exploiting the context aware process modelling method which not only provides process model visibility, but combines with workflow pattern based model building approach to build a solid process model for the end users.

Acknowledgements. This work is made possible by the support of the Natural Science Foundation of China (NSFC) under Grant No.61150110484, ESSENTIAL: Enterprise Service deSign based on ExistiNg software Architectural knowLedge.

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Transformation of Models in an MDA Approach for Collaborative Distributed Processes

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Abstract. This paper studies the specification, mapping and the transforming of behavioral aspects of Open Distributed Processing Information Language, within the context of Model Driven Architecture. In order to specify the executable behavior of a system and to make the processes of the Information executable and controllable, the Reference Model for Open Distributed Processing can be used as a meta-model for behavioral specifications. In the Information language the behavior is specified in terms of schema dynamic, processes, actions, state and the relationships between these concepts. In this work we describe how behavior process can be generated exploiting the benefits of a MDA approach. We define the behavior models by using UML profile and their transformations into BPEL artifacts.

Keywords: RM-ODP, Information Language, Behavioral Concepts, BPEL Language, UML Profile, MDA.

1 Introduction

The Reference Model for Open Distributed Processing (RM-ODP) [1-2] provides a framework within which support of distribution, networking and portability can be integrated. It defines a framework comprising five viewpoints, viewpoint language, ODP functions and ODP transparencies. The five viewpoints, called enterprise, information, computational, engineering and technology provide a basis for the specification of ODP systems. The first three viewpoints do not take into account the distribution and heterogeneity inherent problems. This corresponds closely to the concepts of PIM (Platform Independent Model) and PSM (Platform Specific Model) models in the OMG MDA architecture.

In this context we use in this paper the BPEL (Business Process Execution Language for Web Services) (BPEL4WS or BPEL for short) to specify process behavior based on actions, time and states in the context of ODP systems. The BPEL is an XML-based standard for defining how you can combine Web services to implement business processes [8]. It builds upon the Web Services Definition Language (WSDL) and XML Schema Definition (XSD). This article specifies the

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 201–208, 2013.

behavior processes by the activity diagrams, and generates the corresponding BPEL and computational files to implement that process. This capability is used to highlight some benefits of the Object Management Groups (OMG) Model Driven Architecture (MDA) initiative: raising the level of abstraction at which development occurs; which, in turn, will deliver greater productivity, better quality, and insulation from underlying changes in technology.

The paper is organized as follows. Section 2 introduces, both BPEL and the core behavior concepts (time, action, behavior and process). Section 3 describes and specifies the behavior by the activity diagrams. In Section 4, we define the mapping from the concepts of behavior Information language to BPEL concepts and we present the syntax and the structure of a BPEL Behavior process. We focus on behavioral constrains. A conclusion ends the paper.

2 Preliminaries

2.1 BPEL

Web services are a set of technologies allowing applications to communicate with each other across the Internet. Among the technologies used are the Extensible Markup Language (XML) [8], the Web Service Description Language (WSDL) [10] and the BPEL, also known as BPEL4WS, built on IBM's WSFL (Web Services Flow Language) and Microsoft's XLANG (Web Services for Business Process Design). It combines the features of a block structured process language (XLANG) with those of a graph-based process language (WSFL). BPEL is intended to describe a business process in two different ways: executable and abstract processes. An abstract process is a business protocol specifying the message exchange behavior between different parties without revealing the internal behavior of any of them. An executable process specifies the execution order between a number of constituent activities, the partners involved, the message exchanged between these partners and the fault and exception handling mechanisms.

A composite service in BPEL is described in terms of a process. Each element in the process is called an activity. BPEL provides two kinds of activities: primitive activities and structured activities [13].

2.2 The Behavioral Concepts in Information Language

The individual components of a distributed system must share a common understanding of the information they communicate when they interact [3-5]. Some of these items of information are handled by many of the objects in the system. To ensure that the interpretation of these items is consistent, the information language defines the semantics of information and the semantics of information processing in an ODP system in terms of a configuration of information objects, the behavior of those objects, and environment contracts for the objects in the system.

The information specification comprises a set of related schemata, namely, the invariant, static and dynamic schemata.

An invariant schema is a set of predicates on one or more information objects which must always be true. The predicates constrain the possible states and state changes of the objects to which they apply. ODP also notes that an invariant schema can describe the specification of the types of one or more information objects that will always be satisfied by whatever behaviour the objects might exhibit.

A static schema is a specification of the state of one or more information objects, at some point in time, subject to the constraints of any invariant schemata.

A dynamic schema is a specification of the allowable state changes of one or more information objects, subject to the constraints of any invariant schemata.

We consider the basic set of modeling concepts necessary for behavior specification:

- Action: a model of something that happens in the real world. An action in the information viewpoint is associated with at least one information object.
- Interactions: an action always takes place with the participation of the environment of the object. Objects can only interact at interfaces.
- Behavior of an information object: a collective behavior composed of the actions in which the objects participate in fulfilling the roles of the system, together with a set of constraints on when these actions may occur, it may be interesting to specify which actor initiates that action.
- Process: identifies an abstraction of the behavior that includes only those actions that are related to achieving some particular sub-objective within the system. Processes decompose the behavior of the system into steps.

We represent a concurrent system as a triple consisting of a set of behavior, a set of process and a set of action. Each behavior is modeled as a finite or infinite sequence of interchangeable behavior and actions. In figure 1, we define a model to be the ODP information viewpoint specification. That is, a set of information objects, and their relationships and behaviour.

The concept of time dependence is given in "Specification concepts" (RM-ODP 2.9), we define the semantics of OCL precondition and postcondition by applying the minimal sets of instances after execution of operation [14] [16].

```
context  Time inv :
forall(o:InformationObject ,t:Time | t.instant ->notEmpty implies o.state ->notEmpty)

context Precondition inv :
Forall (prec: Dynamicschema.Precondition , o : InformationObject|exists( s : State) |
o.mappedTo = prec and o.state_start = s)

context  Postcondition inv :
forall (postc: dynamicschema.Postcondition , o :  InformationObject | exists(s : State) |
o.mappedTo = postc and a.state_end = s)
```

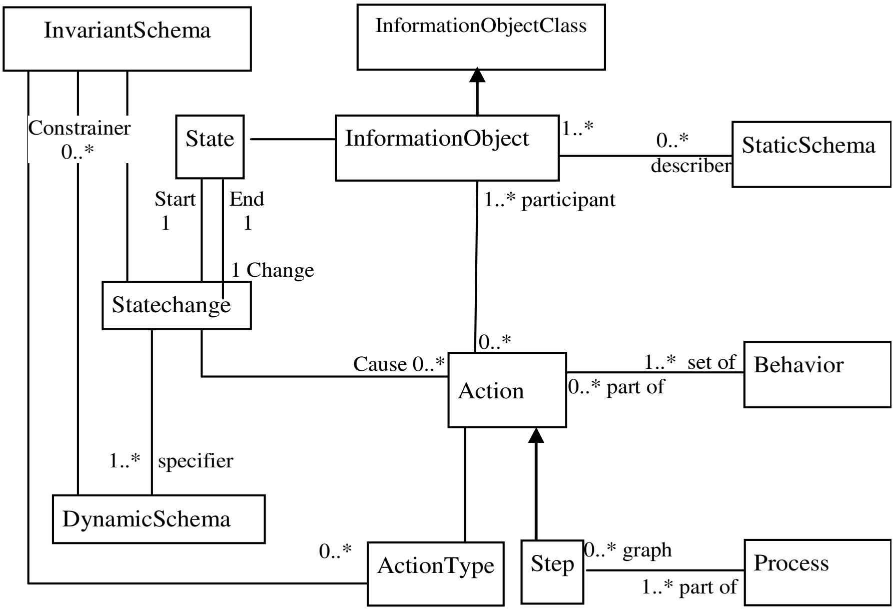

Fig. 1. Core Behavior Concepts

3 UML Profile for Behavior Process

Taking an object-oriented approach, the Unified Modeling Language (UML) is often used to model the relevant aspects of the behavior. In UML, an object is an entity with a well-defined boundary and identity that encapsulates state and behavior. State is represented by attributes and relationships. The behavior of UML object expressing an ODP information object is expressed by state machines. The scope of this article is mainly centered on stereotypes. Stereotypes are a way of categorizing elements of a model. We can combine a set of these stereotypes in a Profile. A UML Profile is used to define a specific set of extensions to the base UML in order to represent a particular domain of interest.

This section introduces a UML Profile which supports modeling with a set of semantic constructs that correspond to those in the Business Process Execution Language for behavior in Information language (see table 1).

Table 1. Behavior concepts to UML mapping overview

Behavior Concepts	Profile Construct
Process	<< process>> class
Behavior	Activity graph on a <<process>> class
Action	<<metaclass>> signal
Role	<<partner>> class
static Schema	<< metaclass >> statemachine
Invariant Schema	<< metaclass >> constraint
dynamic Schema	<< metaclass >> package

In the UML profile, a process is represented as a class with the stereotype <<Process>>. The stereotype «IV_Process» extends the metaclass Activity with multiplicity [0..1]. It is intended to capture the semantics of a Process in the RM-ODP information language. The attributes of the class correspond to the state of the process (variables in BPEL 1.1). The UML class representing the behavior process is shown in Figure 2.

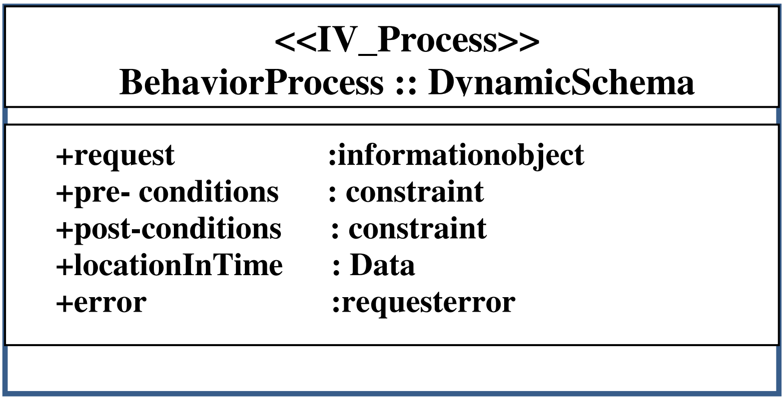

Fig. 2. UML Profile for the Behavior Process

4 Generating a BPEL Process from a UML Model

The Model Driven Architecture (MDA) [15] provides an approach for specifying a system independently of the platform that supports it; specifying platforms; choosing a particular platform for the system; and transforming the system specification into one for a particular platform.

4.1 Mappings between UML and BPEL

The UML profile for automated behavior processes expresses that complete executable BPEL artifacts can be generated from UML models. Table 2 shows an overview of mapping from the profile to BPEL covering the subset of the profile introduced in this article [15].

Table 2. UML to BPEL mapping overview

Profile Construct	**BPEL Concept**
<< process>> class	BPEL process definition
Activity graph on a <<process>> class	BPEL activity hierarchy
<<process>> class attributes	BPEL variables
Hierarchical structure and control flow	BPEL sequence and flow activities
<<receive>>,<<reply>>,<invoke>>activities	BPEL activities

BPEL is an XML representation of an executable process which can be deployed on any process motor. The atomic element of a process BPEL is an "activity", which can be the send of a message, the reception of a message, the call of an operation (sending of a message, makes an attempt of an answer), or a transformation of data.

A process BPEL defines, in XML, the activities realized by the framework of the behavior process execution. In the following we describe its structure and syntax.

```
< IV_behavior >
        < roles />                →  definition of the actors
        <containers/>           →  definition of the containers of the data
        <invariant schema />          →  A set of predicates which must always be true.
       <static schema />   →  A configuration of information objects.
        <transitioncondition>
            <dynamic schema />      →  A state changes of one or more information objects.
        </transitioncondition>
 </IV_behavior >

    <IV_process >
      < partners />                    →  definition of the partners (actions)
      <containers/>                    →  definition of the containers of the data
       <sequence />
          <receive />                  →  reception of a request
           <assign />                  →  transformation of the data
           <invoke />                  →  call of an action
           <reply />                   →  sending of an answer
     </sequence>
   </IV_process>
```

```
<schema>   name = "nameschema"
   <process name ="process"/>
   < action  name =  "action"/>
       <constraint type ="pre-conditions"/>
      <constraint type ="post-conditions"/>
 </schema>
```

4.2 Transforming the Process Specification into BPEL

Model transformation is the process of converting between two models describing different aspects or levels of detail of the same thing: UML model files which can be opened and modified with tools [12], and XML files containing the XMI version of the UML models and which are exported by them. In figure 3, we can see that this corresponds to the UML models, or the XMI output of these tools [8-9].

Figure 3 uses a UML Activity Diagram to show the overall process of transforming the files; the information specification is related to a computation independent model (CIM); The information and computational specifications together form a (set of) platform independent model(s) (PIM).The main stages are:

1. Specifying the UML model (CIM)
2. Exporting the UML Diagrams to XMI (PIM)
3. Generating the BPEL process, Actions, and behavior files(PIM)
4. Creating a Database Information Object
5. Deploying these on the BPEL motor (PSM).

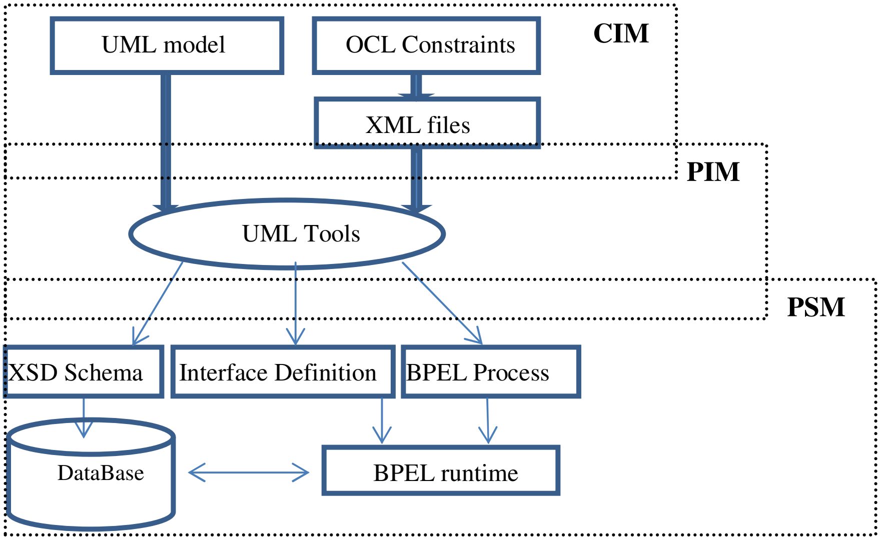

Fig. 3. Developing a process

5 Conclusion

This work introduces the modeling, mapping and transformation of behavioral aspects of Open Distributed Processing (ODP) Information Language, within the context of Model Driven Architecture (MDA). In particularly, we have demonstrated how to model a UML profile for automated behavior processes with UML to BPEL translator. The profile allows developers to use UML skills and tools to develop behavior processes using BPEL. This approach enables service-oriented BPEL components to be incorporated into an overall system design utilizing existing software engineering practices.

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Models and Metamodels I

Reference Model for Operation and Reconfiguration of a Network for Subway Construction

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Abstract. The Construction is an industry that depends on interorganizational relationships to enable its product. Most of the projects are held from networks, especially those for large scale projects of infrastructure, with flexible relationships for cooperation, and the *modus operandi* of virtual enterprises. However, there is a lack of studies on the analytical approach of networks considered their life cycle and the operation and reconfiguration phases for these large projects. The paper aims at developing a Reference Model for the phases of operation and reconfiguration of a construction network, specifically a subway infrastructure project. The model used a development process and is represented with the EKD Methodology (Enterprise Knowledge Development). A Case Study was used as reference. The Model enables the coordination of network activities from the perspective of collaboration. Other research opportunities emerge aiming at obtaining advances in scope and scale, considering this Case Study as an initial effort.

Keywords: construction, operation, reconfiguration, collaborative networks.

1 Introduction

Construction projects are inherently complex and dynamic, especially when considering the execution or operation phase in which a highly fragmented supply chain takes place [1], [2]. For large scale projects this complexity is also increased, demanding an extended network of people and resources within various functions and organizations. But the actual project management held by the construction industry is still traditional and leads to an environment with conflicts and wastes, the reason to consider the sector as inefficient [3].

Most of the managerial developments addressed to the construction industry are isolated initiatives. These initiatives are very relevant, but they do not have a systematic capacity to solve the managerial problems faced by the construction industry – most of the projects are unique with a great number of unpredictable events [4]. If we also consider the shortened time extensions and limited budgets [5] this capacity is even reduced, claiming to more systematic and integrative approaches.

Collaborative Networks have emerged in a great variety of ways [6], [7] and these value added alliances are becoming key ingredients to success, with the construction

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 211–219, 2013.

sector having a strong potential to benefit from the adoption of these new business modes of operation [8]. Also, adaptable and rapidly changing information and communication technologies (ICTs) support new patterns of work, focusing on cross-disciplinary, collaborative work [5], [8]. Moreover, the support of ICTs encourages the use of virtual business modes of operation as a result of a desire to improve market position, gain competitive advantage, and the need to add value [9]. The Virtual Enterprise (VE) concept is as a form of Collaborative Network – briefly described as a temporary alliance of enterprises supported by computer networks [6].

This temporary aspect is the main driver to make the association of a Construction Project with a Virtual Enterprise. It is important to emphasize that "in fact, the Construction industry has adopted the modus operandi of a VE for decades" [8]. The main insight gained from this association is to consider that both have a delimited Life Cycle, in which there are different phases that should be carefully considered when wishing to manage them effectively [5], [7]. For [7], the phases of a Network Life Cycle are: creation, operation, evolution and dissolution.

In this context, this paper aims at developing a Reference Model for the phases of operation and reconfiguration of a construction network, specifically a subway infrastructure project. Through the next sessions the literature review, the development methodology, the Data Collection and the Reference Model developed are discussed, followed by the Conclusions.

2 Literature Review

To conduct this research some topics of interest are necessary to serve as conceptual discussion for the reference model of the construction network.

Operation and Reconfiguration. The classic business phase "produce" in the construction case is "construct". The operation phase is the one characterized by the value generation, the consolidation of the business project initialized.

The reconfiguration or evolution happens because the initial deals are not maintained through the time (due to non predictable events), so they should continuously be revised. The initial partners will be reorganized, to maintain the relationships – the comprehension and proximity between these partners is of special importance [10]. The operation phase is considered the most important one in the network life cycle and the reconfiguration phase occurs in parallel with this stage [7].

Deeply analyzing, the knowledge areas considered to fit in the scope of activities held during operation and reconfiguration phases of construction projects are: 1) Performance Measurement; 2) Planning and Control; 3) Knowledge Management; 4) Resources Management; 5) Supply Chain Management (SCM), and; 6) Information and Communication Technologies (ICTs). But these activities are performed in a collaborative environment, with some discussion as follows.

Collaborative Networks in Civil Construction. A Collaborative Network is a group of autonomous heterogeneous entities geographically distributed (organizations and people) that have different operation environments, culture, capital, and targets to achieve common or compatible goals, with the support of computer networks [6]. VEs are kinds of Collaborative Networks.

It is important to emphasize the difference between a Virtual Enterprise and a Virtual Organization. For the first one, the shared focus is the project at hand and the second one implies a conventional organization whose control is centralized [8]. The collaboration network approach of this paper is based on the temporary relations with focus on the project – construction project held as Virtual Enterprise. For the Performance Measurement of these VEs, the development of performance indicators based on the network benefits provides a tool to analyze the evolution of the collaborative processes and the individual performance of members [11]. The Management of Virtual Enterprises in terms of Planning and Control demands methods and models used for the coordination of the project activities. Initiatives as described in [5] and [12] can help at achieving collaborative planning strategies. Knowledge Management should provide effective sharing knowledge among operations with similar functions and geographically scattered [13], constitute ways and means of generating construction innovation [2] and improve communication and establish consistency among members, using a dedicated knowledge base [8]. But also very important is the capture and reuse of the project knowledge, that can be performed by post project reviews [13]. Human Resources are the main factor in Resource Management, dealing with the search for allocation of core competencies to achieve a culture for creation of knowledge value in which technological resources – team work, capital, intellectual capital and change management – are mixed up according to the business needs [14]. For Supply Chain Management the trust among participants of the chain, between leaders and their teams [8] and also in the intra/inter-organizational dimensions [15] are of special importance. The chain operates in a dynamic environment in which agents, tasks and materials in process are strongly related to each other [16].

Information and Communication Technology - ICT, together with Knowledge Management are the most discussed issues when referring to transactions in collaborative environments. Several proposals, models, architectures have been developed to meet these requirements of Virtual Enterprises [6], [7], [17], [18], [5].

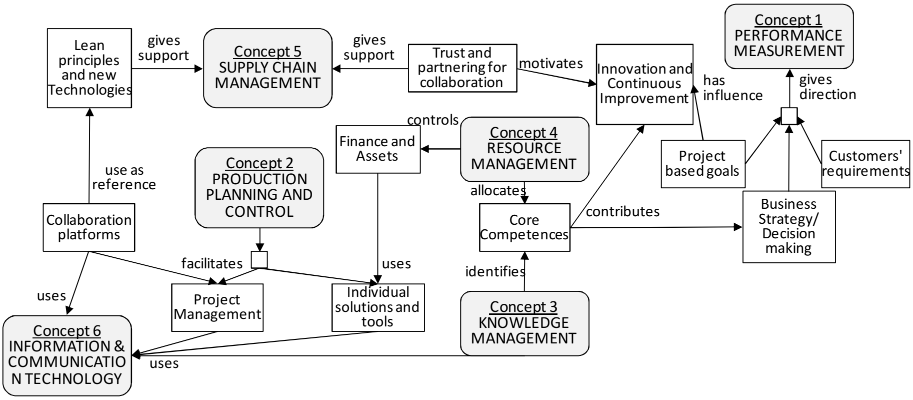

Fig. 1. Concept Model for construction collaborative networks: activities held during the operation and reconfiguration phases

Fig. 1 shows how these discussed aspects are related, serving as a conceptual reference for the reference Model. It is emphasized that some papers were found giving references for the creation and dissolution phases for construction networks. Reference Models for the operation and reconfiguration phases of these networks were not found in literature. The study performed by [8] is a generic approach mostly based on knowledge management.

3 Methodology

As the main result desired by this research, a Reference Model is a standardized model recognized and approved by the interested parts and a model that can be used for the development or evaluation of other specific models [19]. For the elaboration of the Reference Model presented, the following steps were performed, based and adapted on [20] and [21], illustrated in Fig. 2. The first step is "Problem identification and planning". It involves the diagnosis of the problem observed in the research object (the network for the subway construction), definition of the modeling goals and planning of the Data Collection as a support for the next steps. The second step is the "Model Elaboration". Used for mapping the state of the art knowledge about the problem, delivering its reference framework (conceptual issues), then evaluated and refined. The third step is the "Reverse Analysis". It suggests a model elaboration from the perspective of the actual reality, delivering the As-Is Model. The fourth step is the "Definition of change" with a descriptive analysis of the changing possibilities from the As-Is Model to achieve the To-Be Model. The fifth and last step is the "Model Documentation" that contains a description of the represented Entities from the To-Be Model, linked to the possibilities identified in the changing definition and the modeling goals, delivering the Reference Model to be implemented.

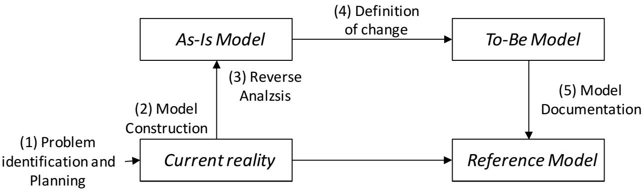

Fig. 2. Elaboration Process of the Reference Model.

The developed Models follow the EKD (Enterprise Knowledge Development) Methodology [22]. Three models from the methodology are used in this research – the Concept Model, the Actors and Resources Model and the Process Model.

The problem identification was stated in the introduction section and the conceptual reference is the result of the literature review. The development was done within a Case Study in a subway construction, following the literature indications [23]. This Case Study was the base for the current reality, the definition of change and the Reference Model further described.

4 Data Collection

This section contains the description of the Subway Construction characteristics, its current reality and the change definitions base for the Reference Model developed.

The Subway Construction. The actor responsible for the subway construction is a Consortium of two big Brazilian Construction Companies. Both Companies have a wide know-how in infrastructure works. This Consortium is a strategic alliance that earned a concurrence process opened by the Government (state level). The concurrence stated the core competences desired, and only a few companies in Brazil were able to participate (all of them using the Consortium form). The final price was the criteria for the governmental choice. The Government is the main Consortium customer. The total construction will deliver twelve kilometers of subway in the most important metropolitan area in Brazil, with an initial budget of 10 billion dollars. It is a strategic construction due to integration possibilities with other public transportation options. The Consortium is responsible for the most expensive part of it.

The main phases for the construction performed are: 1) installation of construction site and support facilities, 2) trenching for equipment entrance and exit, 3) manufacturing of pre-fabricated components, 4) equipment operation for the tunnel opening (Shield), 5) excavation of wells and stations construction, 6) installation of permanent way and systems, 7) finishing and demobilization of equipment. Each part of these phases is a set of stages to be completed, demanding a wide variety of services and competences, part of them contracted by the Consortium – no more than 25% of the total budget. A current reality is described mostly discussing the processes and the actors and resources necessary to complete the stages.

Current Reality. Considering a processes perspective, each construction stage demands a proper "production order" to be initialized. To give this order, there is a common decision process applied to each stage during the construction execution. This decision process is mainly a set of checking issues: first it is checked the project's (design and specifications) completeness, second it is checked the availability of the actor/resource involved in that stage (including contracted partners) and third it is checked if the previous construction requirements are complete. For each decision loop, a contractual change can be necessary. The production order is given only if all checking issues have no problem and the contracts were changed (when necessary). This necessity for checking is mainly due to the poor quality of the projects (details and specification) and the poor quality of the plans – this second basically consequence of the first. The projects and macro plans are supplied by the Government. Through the time, this checking process leads to many reconfigurations of activities, actors and resources, and in the majority of cases, the project is delayed. It is necessary a good coordination between the process and the actors and resources involved in each stage.

The network was started by the Government, with the concurrence process. The two companies set the Consortium to construct with proper Resources (private capital) and Resources from the Government (public capital). The company responsible for the project was also contracted by the public entity. The Consortium subcontracts about another 50 companies for the most diverse services or supplying.

It is necessary to emphasize that the most important criteria for verifying the core competences desired for the construction was the experience of the Engineers and the Companies in the construction of subways. Consultants are generally also contracted.

All actors are called Organizational Units (Government, Consortium, Companies, and Subcontracted Companies). Each Organizational Unit has at least one role to play inside the project. The Resources are also related to these Organizational Units.

Definition of Change. The Definition of Change is basically an association between the current reality verified and the conceptual reference stated by the literature review.

To assist the performance measurement, it is necessary to consider the final user of the construction as the main customer – the perspective of the business strategy. The measured issues can be used for decision making. Partnering, collaboration and trust must be encouraged among actors, as a requisite for knowledge management. Also, for planning and control, the individual solutions used by each network actor can have interface with a common system to ensure the information, project, plans and knowledge sharing. A collaboration platform can be seen as an appropriate ICT functionality, influencing also the resource and supply chain management.

5 The Reference Model

The Reference Model is composed of two sub-models. The Process Model (Figure 3) represents the process for decision making within the operation and reconfiguration phases (having trust as the main background), and minimizing the necessity of checking and changing contracts. It can also be considered an activity model, considering the flow of activities performed during the construction. The important reference is the organization of construction phases, not the decision flow. As an actual reality was the main approach to be improved, the decision making process was the main focus.

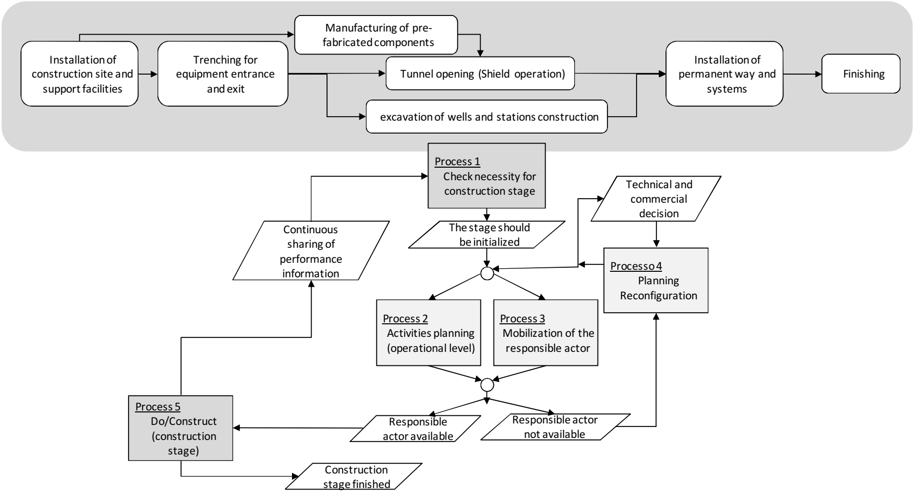

Fig. 3. Process Model for operation and reconfiguration of a network for subway construction

The Actors and Resources Model (Figure 4) represents a generalist framework reflecting the requirements discussed in the Definition of Change. It states clearly the consolidation of the Virtual Enterprise, the collaborative emphasis supported by the collaboration platform and the discussed issues for operation and reconfiguration of these networks.

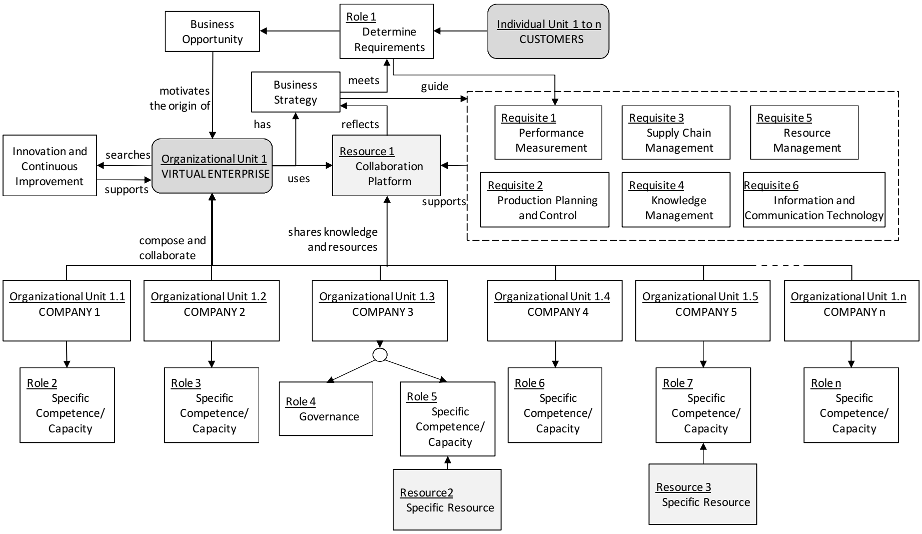

Fig. 4. Actors and resource model for operation and reconfiguration of a network for subway construction

6 Conclusion

The Reference Model contributes to the operation and reconfiguration phases of construction networks, especially those of large scale projects. It denotes a better allocation of actors and resources, supporting a better coordination and organizational control – the main challenges for managing the large construction projects.

The operation and reconfiguration phases, considering collaborative networks, still demands practical and academic efforts to compose the agenda of managers and researchers. It is necessary to focus on the decision making processes' quality to enhance efficacy and effectiveness of projects and networks. The absence of qualified personnel for managing large scale projects was verified within the Case Study. The allocation of competences based only in experience as seen, decreases the possibility of value enhancing by innovation and continuous improvements for these projects.

The Reference Model development assists the knowledge systematization. The aim is to identify aspects, practices, configurations that can be replied to other subway constructions, serving as reference for the public and private interested organization/institution. It can be used as a new approach for Public Management. It demands a paradigm disruption in terms of configuration and contractual relations, requiring the "trust" as a principle inside public projects.

The model can be adapted to other construction works of infrastructure (bridges, roads, stadiums, dams), considering its proper requirements for configuration, its own processes and the network characteristics. This model presented has the limitation of being based only in one case study. As no previous reference models for operation and reconfiguration phases of construction networks were found in literature, it is also not possible to make any comparisons. This is the reason it is considered an initial effort.

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Towards a Capability-Based Decision Support System for a Manufacturing Shop

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Abstract. To succeed, long term organizations must compete efficiently and out-perform their competitors in a dynamic environment. To survive in this competition, identification, classification and management of organizational capabilities are vital. This paper presents a methodology for developing a system to store, manage, and maintain intra-organizational capabilities for decision making processes on resources, processes and strategies for business opportunities. The proposed methodology is explored in an educational manufacturing cell.

Keywords: Capability, structural modeling, decision support system.

1 Introduction

The rapid growth of the global market encourages organizations to have a clear understanding of their area of expertise in order to maintain a competitive advantage. Some professionals and researchers refer to these areas of organizational expertise as capabilities [1]. Javidan, 1998[2] in his supplementary definition for core competency, believes that, the first step in successfully identifying and exploiting enterprises' core-competencies is creating a universal model for the competency, capability and organizational resources. Capability is seen as the enterprise's ability to exploit its resources. For better exploitation of the resources, information about activities which are realizable at the resource and the knowledge about how the resource and processes can work together are useful and essential issues.

Substantial improvements have been made on constructing decision support systems for the resources allocation process as well as on strategy selection regarding partnerships in the case of a new business opportunity for an organization or network of organizations. The existing decision support systems are found to be looking at resources and processes information separately [3]. The primary aim of this paper is to present a methodology for developing a system to store, manage and maintain intra-organizational capabilities used to develop a decision support system focusing on resources allocation and their related processes accompanied with a strategy selection for a new business opportunity of an enterprise.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 220–227, 2013.

2 Capability-based Decision Support System

Capabilities refer to the company's ability to use its resources. Conceptually and empirically, Javidan's [2] capability definition is adopted by many of the researchers in this area. In manufacturing, a capability can be described as a set of information associated to the available resources and corresponding processes that could be performed by those resources, as well as the knowledge about how these resources and processes can be effectively, efficiently, and economically used [5].

The focus on capability as a key concept for decision making processes was first promoted in the managerial scientific literature with qualitative approaches of proficiency management [6]. However, since then, other scientific fields have integrated this significant notion with quantitative approaches, proposing decision support systems that brought up interesting results. A starting point for the integration of the concept of capability in the field of information and knowledge managerial science for decision making process has been proposed in [7], where the authors developed a model for manufacturing capability to support concurrent engineering. The formalization of the capability-related concepts covers different types of industrial decision processes. For instance, [8] proposed an approach for employing a capability model to support virtual enterprises; [9] proposed an approach to utilize a capability model to support global manufacturing co-ordination decisions; [5] developed a model to create and maintain knowledge for decision-making, where manufacturing strategy is described as knowledge related to processes and resources (knowledge model). Further research work on manufacturing capability and decision support systems focused on different contexts can be found at [9] [10].

Contribution to Collaborative Networks (CNs) – CNs can bring several benefits but their implementation needs many attractive and compelling essential sub functions that have to be clearly defined at different levels of abstractions. Capability modeling is a good starting point for responding many of these questions in this context, such as:

- What can organizations do?
- How can organizations exploit their resources?
- How to measure the organization's willingness to do collaboration?
- How can we boost VO and VBE performance?
- What is the comprehensive tool for partner selection in VO and VBE?
- What is the tool to do better collaboration?

Certainly many other relevant questions may be asked in relation to capability modeling in CNs context.

3 Research Methodology

The research methodology adopted in this work is sub-divided into three parts as shown in Fig. 1. Between "Preliminary study and problem definition phase" and "Design and development phase" there exists a "Verification block". The adopted modeling approach is based upon object-oriented analysis and design techniques. The Unified Modeling Language (UML) is employed as a graphical modeling language, which enables system developers, analyzers, and stakeholders to design and visualize the relevant concepts.

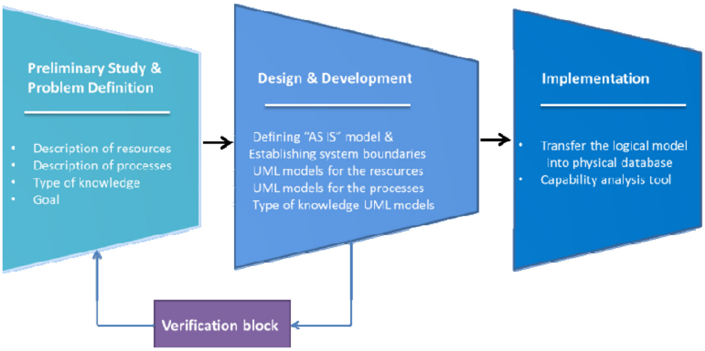

Fig. 1. Research Methodology

The "Verification block" allows to iterate between the "Preliminary study problem definition phase" and "Design and development phase". A capability management system is developed in the "Implementation phase" and an application architecture for the desired decision support system is proposed for the case of a shop floor. The proposed methodology is evaluated in case of the Computer Integrated Manufacturing (CIM) laboratory of the Eastern Mediterranean University (Fig. 2).

4 Preliminary Study and Problem Definition Phase

The EMU-CIM laboratory was designed for both educational and research purposes. The laboratory consists of three stations: Station 1 is a machine tending station, which holds a CNC milling machine and a five-axis vertically articulated robot designed to work in industrial training facilities. Station 2 is an assembly and quality control station, which has one robot. This robot has a pneumatic gripper and works in connection with the peripheral station devices such as a ball feeder, a gluing machine and a laser-scan micrometer device. Station 3 is an automatic storage and retrieval system (AS/RS), which contains 36 storage cells and a robot with the ability of taking and placing the work pieces. A conveyer integrates the 3 stations performing the material transport within the cell. The overall system is running under a supervisory host control consisting of a set of station IPC's, a PLC for controlling the conveyor and a host computer that allows management of the cell orders, employing the OPEN CIM software.

Fig. 2. CIM laboratory of Eastern Mediterranean University

Several operations can be executed in the EMU-CIM Lab. For illustration, the assembling operation, deals with two work pieces; A and B. The system starts with a command from the host computer to the AS/RS for loading the work pieces A and B onto the conveyer. When the parts reach the "assembly and quality control" station, the station's robot takes the parts and puts them in the ball loading position; where four balls are loaded using the robot. At that time, the robot takes the sub-assembly and puts it into the assembling station. The gluing machine starts to work and injects the glue in the desired points on the sub-assembly, and then the robot places part B into the subassembly. The product returns to the AS/RS system via the conveyer and its associated station's robot.

5 Design and Development Phase

Defining "As Is' Model and Establishing System Boundaries. The design and development phase started with an "As Is" model using UML use case diagram, a classical tool for creating connections among users and stakeholders of a system. This model explains the system at high level. Although UML is widely used in the ICT area, its adoption in mechanical and industrial engineering sectors is still somehow limited. Therefore, more than pursuing advanced modeling aspects, this phase of the project was mostly concerned with the integration of these classical modeling techniques in the shop-floor engineering and assessing its use.

Fig 3 shows the main use cases of the system, which have interaction with relevant actors: Machining, Assembling, Quality Control, Execution System, Handling and, Maintenance. It requires three types of actors: Supervisor, Operator and Servicer.

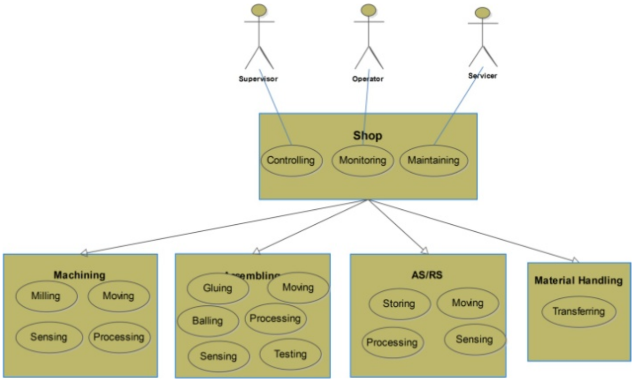

Fig. 3. Shop use case diagram

General Manufacturing Capability Model. The generic manufacturing capability model in the top-level diagram [3], [11] includes the main classes and their relationships. In this model, a facility comprises one or many resources, processes, and knowledge. Among these, there are associated relationships. The key role of the associations between classes shows that resources perform processes, and knowledge constrains either one or both resources and processes. Any event of a process is related to one or many instances of the resources features that specify the pre-condition and post-condition of that particular process.

Each resource feature can relate to one or multiple different processes. Knowledge elements "regulate" the use of resources and processes.

Process Modeling. UML activity and sequence diagrams are used to represent the manufacturing processes of the shop-floor and its stations. Fig. 4 shows an example of activity diagram.

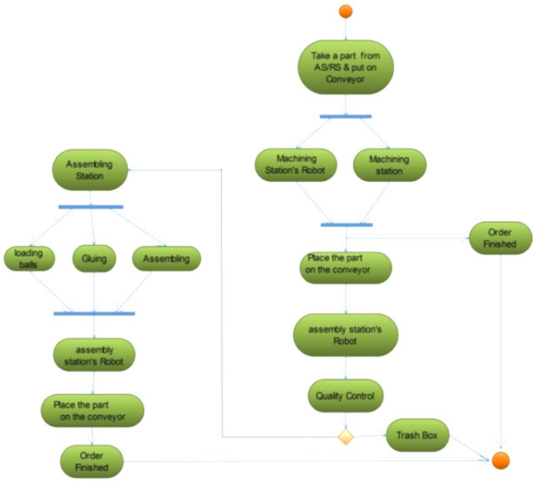

Fig. 4. Shop activity diagram

Fig. 5 shows a sequence diagram for the shop-floor case describing the levels of communication in the system. It represents the activities and processes related to each scenario, followed by the sequence of messages to be performed on each scenario depending on their need or specification. The rectangles represent a manufacturing process and each of the columns illustrates a manufacturing activity.

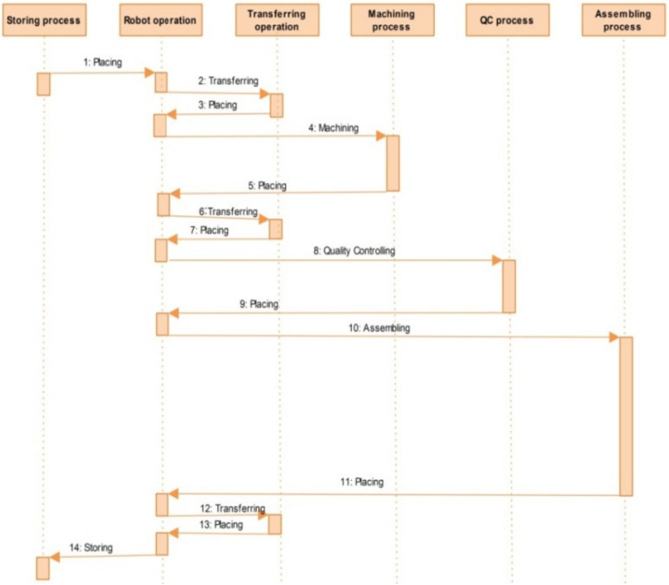

Fig. 5. Shop sequence Diagram

Resources Modeling. UML object diagrams are used to represent "forward and reverse engineering" object relationships of a system, static view of an interaction, understanding object behavior and their relationships.

The object diagrams of the shop-floor involve the machining, assembling and AS/RS stations that realize the added value processes utilizing the station's resources. The material flow between the stations is realized by a conveyer. Meanwhile, data flow between stations is integrated using a host computer. Each of the stations uses several resources, with the material flow between the station's resources realized by a station's robot.

Type of Knowledge Modeling. Manufacturing knowledge is an important part of the intended capability-based manufacturing management system. Therefore, it is necessary to follow a structure that allows the access and storage of the wide range of manufacturing knowledge [11]. To define these knowledge structures it is necessary to explain what process and resource knowledge the manufacturing facility has and how they can be represented. Graphs, texts, tables, diagrams, formulas are some of the examples for explicit knowledge. While patterns, storytelling, video-clips and sketches are instances of tacit knowledge representation. Knowledge related to manufacturing processes and manufacturing resources are structured using different representation groups: explicit process knowledge, tacit process knowledge, implicit process knowledge, explicit resource knowledge, tacit resource knowledge and, implicit resource knowledge [12].

6 Verification Block

The verification block relies on the generation of data file using the results of "Preliminary study and problem definition phase" and then comparing the generated data file using the developed UML diagrams from the "Design and development phase" in order to understand whether the designed model meets the problem definition or not. XML is used to encode the exchange of information between the "Preliminary study, problem definition phase" and "Design and development phase" data files. The data file generated at the "Preliminary study and problem definition phase" consist of three groups of information:

1. Supporting data structures: (a) measurement units (time units); (b) statistics (standard deviations, average, state time, running time); (c) model references (model name, user, date, time,).
2. Manufacturing data structures: (a) element name; (b) element class; (c) resources (machines, labors, etc.); (d) operations lists; (e) events lists; (f) element failures; (g) daily schedules; (h) element busy time; (i) element idle time.
3. Objects negotiation data structures: (a) message name; (b) start message element; (c) end message element; (d) start messaging time; (e) end messaging time.

As the system's models are executed at "design and development phase", the UML diagrams are transformed into a new data file. After the consistency rules are applied to the both data files, the matching environment that captures the differences between two data files is ready for verification process. Discrepancies between the phases can be easily captured in the machining environment (i.e. the differences between the messages, events, operations, etc.).

7 Implementation

Transferring the Logical Model into a Data Base. JDeveloper is used to map the logical UML models into the Object Store© data base.

Capability-Base Decision Support System. To support capability-based decision making processes, a Capability Analysis Tool (CAT) was developed. Fig. 6 illustrates the main components of CAT. Involved processes are briefly described below. The numbers in the figure stand for the index of each process.

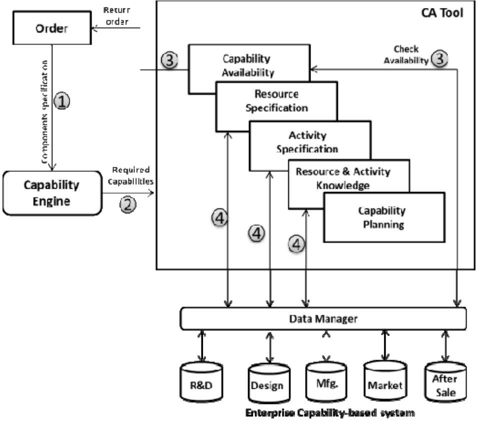

Fig. 6. Capability analyses Tool Architecture

- Step I: the order related component specifications (feature-based) are loaded into the "Capability Engine" to generate the required capabilities for the order (1).
- Step II: when the system wants to know availability of the required capabilities within the enterprise, the CA Tool is triggered and acquires capabilities which, newly generated on the previous steps are sent to the CA Tool (2).
- Step III: the CA Tool checks the enterprise capabilities and if the required capabilities are not available within the enterprise, the CA Tool returns a corresponding message to the order (3). This constitutes the base to identify the need for a collaborative partnership with other enterprises.
- Step IV: if the required capabilities are available in the enterprise, the information related to resources, activities and corresponding knowledge are obtained from the system (4). The CA Tool suggests appropriate capability plans for the required capabilities by invoking the information and knowledge of Step III.
- Step V: with the CA Tool results, the potential required information and knowledge for the order is highlighted and ready for the decision making process.

8 Conclusion

In this paper a capability-based decision support system for a manufacturing is structurally modeled using a case study of Computer Integrated Manufacturing laboratory of Eastern Mediterranean University. The research methodology of this contribution is divided into three phases, namely; “Preliminary study, problem definition phase”, “Design and development phase”, and “Implementation phase”. An Object-oriented analysis approach is used as the modeling approach and UML used as modeling languages. A Capability Analysis Tool is developed as decision support systems for resource allocation and process and knowledge selection in case of a new business opportunity of the manufacturing system appears. An experimental system has been implemented using the object-oriented database Object Store© and the Visual C++ programming environment. The developed experimental system offers four benefits, in that they a) enhance the organizations willingness to collaborate, b) boost the organization’s competitiveness, c) facilitate appropriate decision-making, and d) finally help to integrate the entire organization.

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Technical Components and Requirements Model for Supporting Collaboration in the Product Technology Transfer Process

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Abstract. During the product technology transfer process, the high level of communication, coordination and cooperation among the members involved in this activity is necessary. Making use of a collaborative environment is essential for managing this process and the project. In this sense, the paper presents the technical components and requirements model to support developing this environment and assist the collaboration and product technology transfer. The Enterprise Knowledge Development (EKD) methodology was used to develop the model. The proposed model was based on literature and in seven case studies conducted in small and medium-sized high-technology firms. As a result, this paper shows a group of functional and non-functional requirements as well as the goals that the information system should have to allow the communication and the exchange of information in transfer projects involving collaboration. Furthermore, this research contributes to the information system development that supports these projects.

Keywords: product technology transfer, collaboration, technical components and requirements model.

1 Introduction

Collaboration is considered an important instrument for the development and success of the entrepreneurial firms by providing competitive advantage, given that the links between the enterprises are knowledge and technology transfer factors which support innovative processes [1], [2].

Participating in a collaborative network is an organizational solution for those firms that do not have certain skills or know-how to develop a new product. According to [3], acquisitions and use of new technologies from an external source can contribute to the operational success of the firms.

One mechanism to obtain this expertise is the product technology transfer process. This process involves a range of technological knowledge, scientific basis for specific processes, knowledge and competences through and interactive process in which different stakeholders absorb, assimilate and exchange knowledge in a social or

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 228–235, 2013.

physical context [4], [5], [6]. This iterative process not only transfers knowledge between organizations, but also facilitates the creation of new knowledge and product solutions [7], [8].

The technology transfer is not an easy activity due to the risks and problems that may arise during the product development, committing the time to market, generating excessive costs and functionality issues [9], [10]. Throughout the process is necessary to have a high level of interaction among stakeholders in terms of communication, coordination and cooperation [11]. This interaction reduces the chaos in the innovation process increasing the probability of developing a successful innovation [12] However, according to [13], the communication and the coordination of the activities are some challenges of this environment, requiring different project management methodology from traditional approaches and a much more robust information system (IS) to support the project [14]. In this way, the paper purposes a technical components and requirements model that supports a collaborative environment to transfer technologies.

This paper is organized as follows: Section 2 presents the literature review on collaborative networks and product technology transfer. Section 3 describes the research methodology. Section 4 presents the technical components and requirements model proposed by this research. Finally, Section 5 provides the conclusions and futures researches.

2 Literature Review

Collaborative Networks. A collaborative network is an alliance formed by several entities that are autonomous, geographically distributed and heterogeneous with regard to the operating environment, culture, social capital and goals, but they share information, resources and responsibilities to jointly plan, implement and evaluate the activities in order to achieve common and compatible objectives [15], [16]. Besides, the members of networks use information and communication technology to coordinate and support the activities [17].

Collaborative networks promote technological development through the creation, generation and dissemination of knowledge, supporting the learning between Organizations, the sharing of technological skills, allowing firms to transfer knowledge and technology that they would not be able to develop [18], [2]. These networks are already recognized as a way for firms to survive in dynamic environments, where technology, society and markets are constantly changing. Collaborative networks are considered a way to create value because they generate new capabilities for dealing with uncertainty, need for innovation, competition and mass customization [16].

According to [19], these networks allow the individuals involved in the knowledge transfer develop a common understanding required for the receiver fully understands the function of knowledge provided by a source. Social ties can help a firm to explore new scientific and technological knowledge.

Product Technology Transfer. The product technology transfer is a process that manages the acquisition, handling, and incorporation of tangible and intangible objects originating from external product-based sources, in order to commercialize an innovation or meet the needs through the synergistic combination of resources.

The integration of different technologies into products at the end of the technological development represents the interface between technology and product development [20]. This interface is a critical activity because it can affect the scope of the project, lead-time, cost and quality of a new product [10].

According to [21], the transfer of technology provides some benefits such as: opportunity to place students in industry, access to industry for both fundamental and applied research, improvement in new technology implementation, new product development and spin-offs, cost savings, access to the university's physical facilities and the expertise of its staff, gained technical knowledge, quality improvement, new markets and, manufacturing and lead time reduction.

For technology transfer through collaboration be successful is necessary communication, sharing information, developer-user partnerships and early user involvement, credibility of parties, capacity to transmit and receive information [22].

3 Methodology

This research was developed in three phases: the literature review, the case study and the information system modeling.

Phase1: the literature review was conducted on collaborative information system and product technology transfer inserted in the areas of inter-organizational networks and management of technology and innovation. The databases used were: Science Direct, Web of Science, Compendex, and Emerald.

Phase 2: the case study was based on seven Brazilian small and medium-sized high-technology firms, according to classification criteria of the European Observatory for SMEs (1995). This research investigated small and medium-sized high-technology firms because they have been considered important to the technological and economic development of countries worldwide, as well as the revitalization of outlying regions [23], [24], [25].

Semi-structured interview with Research and Development managers was used as an instrument of data collection. E-mail communication was also used to clarify doubts and supplement the model. The interview script aimed to understand the characteristics of the firms and the information system used to support the collaboration and the product technology transfer. Some of questions were: 1- which markets does the firm serve? 2- how many products were launched in the last five years? 3- what are the goals of the system? 4- Which are the important requirements regarding functional and non-functional requirements?. This paper is part of a larger research that was conducted between August 2011 and September 2012.

The case study allowed us to understand the information system used by them and also identify the requirements that the system should have. Furthermore, opportunities for information system improvements were identified. These improvements came from literature review. This phase helps to develop the proposed model.

Phase 3: the information system requirements modeling was based on the EKD (Enterprise Knowledge Development) methodology. In this phase, the data of the firms and the literature review contributed to the development of the proposed model. For this, the data was arranged in a table allowing identifying information presented by firms and that have not been referenced in literature. The opposite also occurred.

EKD provides a systematic and controlled way of analyzing, understanding, developing and documenting an enterprise and its components, by using Enterprise Modeling [26], facilitates learning and organizational communication, develops a structured description of the business for analysts to discuss, determines the objectives and requirements of the systems, and produces a document called a knowledge repository which can be used to reason about the business, to discuss changes and components of the information system and, to trace the decisions [27].

4 Proposal of Technical Components and Requirements Model

The Technical Components and Requirements Model presents properties that should compose a future information system and clarify the potential of the information technology to improve business process. According to [27], the components of this model consist of the information system goals (measurable or non-measurable properties, focus, views, or directions); functional requirement (functional property information system) and non-functional requirement (political constraints, operations, information security etc.). Figure 1 shows the technical components and requirements model which guides the product technology transfer.

The information system plans and controls the project development (Information System – IS Goal 1.4), improves communication (IS Goal 2), supports management decisions (IS Goal 3), acquires information (IS Goal 4), exchanges information (IS Goal 5), keeps people updated on the project (IS Goal 6), provides information to the customer (IS Goal 7), manages data and information (IS Goal 8), manages production (IS Goal 9), accelerates the information identification (IS Goal 10), develops collaborative platform (IS Goal 11), ensures communication among the teams (IS Goal 12), and manages project portfolio (IS Goal 1) in terms of managing time (IS Goal 1.1), and human (IS Goal 1.3) and financial resources (IS Goal 1.2).

To manage the project portfolio (IS Goal 1), the system should enable visual management (IS Functional Requirement 5), send e-mail notification (IS Functional Requirement 3), allow the use of different project management methods (IS Functional Requirement 4), enable documentation of system functionality (IS Functional Requirement 6), and generate indicators (IS Functional Requirement 1) which support project progress evaluation (IS Functional Requirement SI 2).

To manage time (IS Goal 1.1), human (IS Goal 1.3) and financial resources (IS Goal 1.2), the system should generate reports in pdf (IS Functional Requirement 11).

To plan and control the project development (IS Goal 1.4), the system should control the deadlines (IS Functional Requirement 7), register tasks (IS Functional Requirement 8), re-plan the deadlines (IS Functional Requirement 9), enable project progress evaluation (IS Functional Requirement 10), and keep people updated on the project (IS Goal 6).

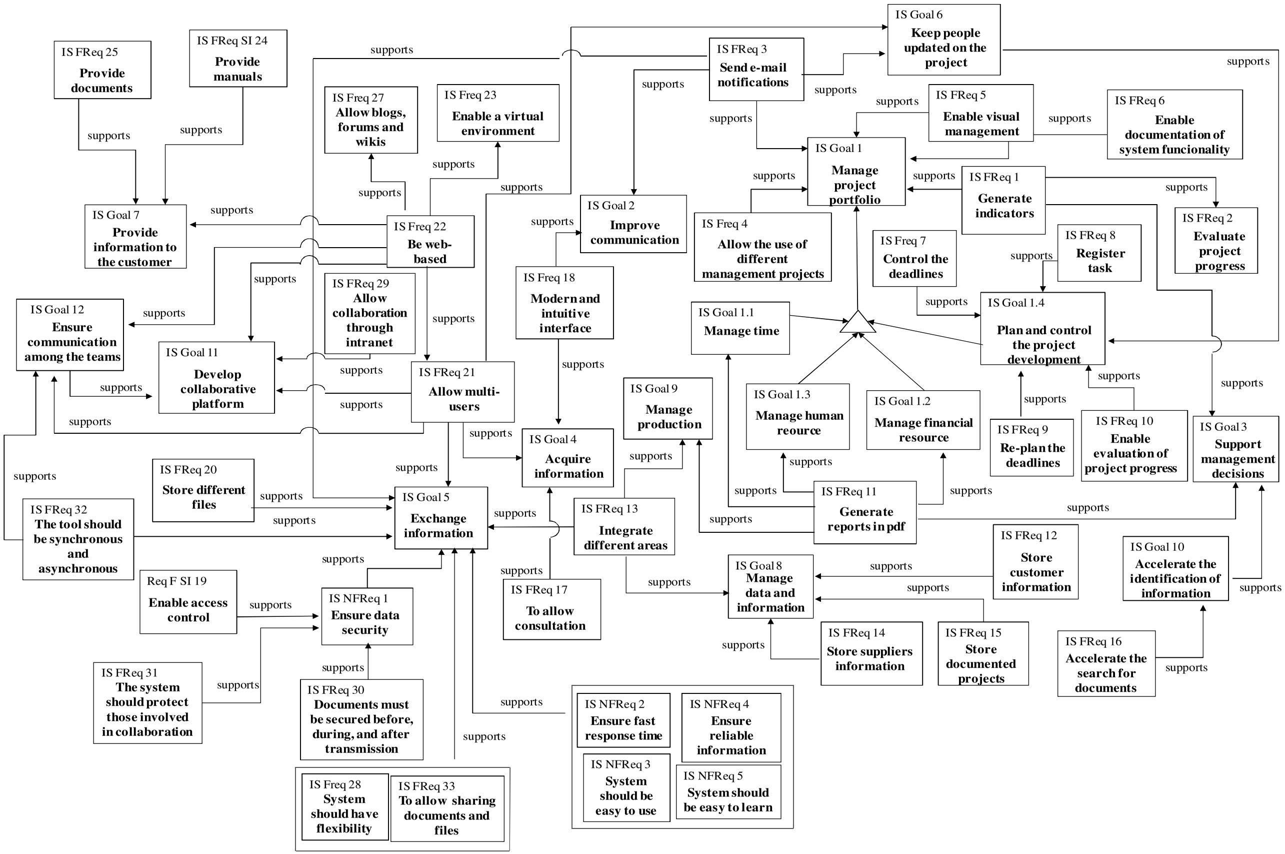

Fig. 1. Technical components and requirements model

To improve communication (IS Goal 2), the system should send e-mail notification (IS Functional Requirement 3) and have a modern and intuitive interface (IS Functional Requirement 18).

To support management decisions (IS Goal 3), the system should generate reports in pdf, (IS Functional Requirement 11), generate indicators (IS Functional Requirement SI 1), and accelerate the information identification (IS Goal 10).

To acquire information (Is Goal 4) the system must have a modern and intuitive interface (IS Functional Requirement 18) which allows multi-users (IS Functional Requirement 21) and performs consultation (IS Functional Requirement 17).

To exchange information (IS Goal 5), the system should store different files (IS Functional Requirement 20), the tool should be synchronous and asynchronous (IS Functional Requirement 32), allow sharing documents and files (IS Functional Requirement 33), have flexibility (IS Functional Requirement 28), send e-mail notification (IS Functional Requirement 3), and allow multi-users (IS Functional Requirement 21).

To allow multi-users (IS Functional Requirement 21), the system should be web-based (IS Functional Requirement 22) providing a virtual environment (IS Functional Requirement 23), blogs, forums and wikis (IS Functional Requirement 27), and should ensure data security (IS Non-Functional Requirement 1).

To ensure data security (IS Non-Functional Requirement 1), the system should enable access control (IS Functional Requirement 19), protect those involved in the collaboration (IS Functional Requirement 31), documents should be protected before, during and after transmission (IS Functional Requirement 30). Furthermore, the system should ensure fast response time (IS Non-Functional Requirement 2), reliable information (IS Non-Functional Requirement 4), be user-friendly (IS Non-Functional Requirement 3), and easy to learn (IS Non-Functional Requirement 5).

To keep people updated on the project (IS Goal 6), the system should send e-mail notification (IS Functional Requirement 3) and allow multi-users (IS Functional Requirement 21).

To provide information to the customer (IS Goal 7), the system should be web-based (IS Functional Requirement 22), provide documents (IS Functional Requirement 25) and manuals (IS Functional Requirement 4).

To manage data and information (IS Goal 8), the system should store suppliers information (IS Functional Requirement 14), store documented reports-projects (IS Functional Requirement 15), store customer information (IS Functional Requirement 12), and integrate different areas (IS Functional Requirement 13).

To manage production (IS Goal 9), it is necessary to integrate different areas (IS Functional Requirement 13) and generate reports in pdf (IS Functional Requirement 11).

To accelerate the information identification (IS Goal 10), the system should expedite document search (IS Functional Requirement 16).

To develop a collaborative platform (IS Goal 11), the system should be web-based (IS Functional Requirement 22), allow multi-users (IS Functional Requirement 21), and allow collaboration through intranet (IS Functional Requirement 29).

To ensure communication among the teams members, the system should be web-based (IS Functional Requirement 22), allow multi-users (IS Functional Requirement 21), and be synchronous and asynchronous tools (IS Functional Requirement 32).

5 Conclusions and Future Research

Technology and innovation have been considered essential factors for the competitiveness of the most Organizations. In this way, the firms are under pressure to have the capacity to develop new technologies with lower cost and time-to-market. However, developing all skills and know-how to generate an innovation is increasingly difficult since the technologies change rapidly and firms often do not have the right person at the right time. Therefore, technology transfer is essential, mainly for SMEs, since they have limited resources and managerial competences. Furthermore, these firms tend to use external networks to leverage their resources.

Considering such scenario, managing information and knowledge, as well as interaction and communication are important factors for the success of the technology transfer and collaboration. One way to be efficient and effective at these points is using an appropriate information system. Based on this along with the needs of business research and literature, the paper presented the technical components and requirements model to support developing a collaborative environment and assist the collaboration and product technology transfer. Consequently, this paper contributes to improve the collaborative project management. The proposed model presented part of the reality and organizational need with regard to the requirement of a collaborative information system to manage the transfer of technology. Furthermore, the model considers practices recommended in the literature. The next step suggested by this research is that future researches develop and test the information system based on the model proposed in such a manner that the system can help firms use information and knowledge as strategic resources to create innovations and improve competitiveness.

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Models and Metamodels II

A Meta-Model for Cooperation Systems

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Abstract. Today's enterprise information and cooperation systems are numerous and diverse. Users have problems of information overload, task interruption and media discontinuity. A unification approach of existing systems would be supportive to overcome these issues by reducing the variety and thereby the complexity. A process of unification starts with the comprehension of existing systems belonging to the virtual environment, by modeling them. The second step is the unification on the model layer followed by the last step, the design of the user interface. This paper will present the first step, a meta-model for cooperation systems, which applies concepts used in professional groupware systems as well as social media platforms. Major elements and concepts of cooperation systems will be identified to provide a basis for the unification of the virtual environment.

Keywords: cooperation system, meta-model, conceptual model, unification.

1 Introduction

The virtual environment of knowledge workers consists of cooperation systems, social media, and personal as well as enterprise information systems. It tends to grow and become complex. With increasing diversity of those systems, complexity for users increases equally. This complexity leads to problems of information overload [1], task interruption [2] and media discontinuity. Although groupware research [3] has yielded a number of productive and successful systems, it appears that the current social media trend [4] provides tremendous alternatives to traditional cooperation support systems such as email or shared workspaces. The shift from document links to people links was already observed in 1998 [5], so that today's groupware systems such as Lotus Notes, BSCW [6], and SharePoint blend with current social media platforms such as Facebook, and Twitter [7]. Furthermore, new kinds of systems like Yammer, Jive, and Cisco WebEx Social arise.

Nowadays, numerous systems exist side by side with overlapping functionality and disjoint contexts. However, discussing which system might be more appropriate for particular cases, does not help users to overcome this challenge. Even professionals are overwhelmed with this situation, so that a future-oriented approach is to accept the diversity of existing systems and utilize them in one single interface which provides the user every needed function.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 239–246, 2013.

In this paper, we present the first step of the unification approach: A coherent model which illustrates that social media systems apply the same basic concepts as other collaborative systems, but with a different adoption, thus creating a different user experience. The major elements and concepts of cooperative systems will be identified to provide a basis for the comparison and later on the integration of existing systems. The presented meta-model helps to reflect the features of groupware systems as well as social media platforms with the aim to identify the building blocks of those systems and to understand in which respect they overlap or differ from each other.

2 Background

Conceptual information models provide application modeling in a direct and natural way by offering semantic terms, such as entity, activity, generalization, aggregation, etc. [8]. There are several generic modeling techniques, such as (Extended) Entity-Relationships Models [9], UML [10], Telos [11], and ConceptBase [12]. They are generic and developed for the purpose to support developers and system architects with the design of a respective system.

One of the earliest model of information systems, the Zachman framework [13], focuses on architectural models. Other CSCW models focus on concepts and basic building blocks of existing systems [14, 15]. These models cover the basic concepts, but they are neither intended to classify systems nor to discuss with users. Thus they explain the concepts, but they do not assess the different characteristics of these concepts. Two further models are presented in [16] and [17]. The presented conceptual models are very detailed, but they do not help to focus on one aspect. They rather focus on an architectural perspective. The reference architectures proposed in [18, 19] identify several layers as well as architectural components and support to cooperate in virtual enterprises (VERAM). The basic services realize access to the underlying data structures which implement the concepts identified in this paper. The modeling framework ARCON helps to understand, design and implement collaborative networks [20]. Although many models exist, they do not help to focus on how the basic underlying concepts are perceived by users. The presented model approach tries to stay coherent and comprehensive. Applied models support cooperation processes between professionals and users.

3 Meta-Model of Cooperative Systems

Cooperative work is characterized by people and artifacts as well as communication between people and activities performed by people on artifacts [21]. Cooperative systems (groupware and social media) support activities of this kind. The proposed model uses the two entities (artifact and person), and establishes relationships between themselves and one another, resulting in a condensed model of cooperation systems (cf. Fig. 1). Although this model applies an extended entity-relationship model notation, it is not intended to model the database structure in the backend of particular systems. It rather tries to cover the mental model [22] users are developing from just viewing the graphical user interface while working with the system and using its functions.

A cooperation system is modeled by a quadruple $\mathcal{C} := (\mathcal{P}, \mathcal{A}, \mathcal{R}el, \mathcal{R}ul)$ with a set of *People* and a set of *Artifacts* as well as a set of *Relations* and a set of *Rules*.

People $\mathcal{P} := \{p_1, p_2, \dots, p_n\}$ are natural persons, who use a system, i.e. users. Instances of a person can be single persons but basically representatives of a type of person, called role. A role contains certain characteristics, such as the right to perform particular activity. Author, admin, manager, and owner are exemplary roles. Everything that is not a person is belonging to the set of artifacts $\mathcal{A} := \{a_1, a_2, \dots, a_m\}$. Instances of an artifact can principally be every working artifact that is virtually represented by the system. The whole system itself is an artifact, documents of different data types or attributes of documents can be artifacts. This depends on the intended granularity of the model.

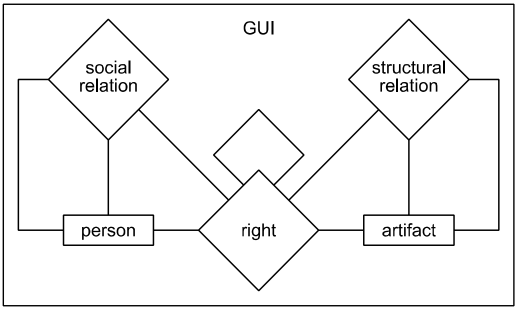

Fig. 1. Meta-model of Cooperative Systems

In the set of the relationships $\mathcal{R}el := \{R_1, R_2, \dots, R_o\}$, the model includes three types of relationship: social, structural, and rights.

The relationship between two artifacts is called structural relation. This relation establishes an structure of content. It namely structures the artifacts by relating one to another, e.g. “a folder contains a file” indicates a structural relation between these two artifacts. A social relation is the analogous relation between two persons. It establishes a structure of persons. This relation can be symmetric, e.g. “Alice is a friend of Bob”, or asymmetric, e.g. “Alice is following Bob. Social relations between roles are inherited to the individual persons.

Every entity (person, artifact) can own the right to change either an entity or a relation. A person has particular rights to perform certain activities on artifacts. For example, the authorship of an artifact gives a person the right to edit the artifact. Furthermore, a person can change a social relation (e.g. becoming friend of another person), a structural relation (e.g. saving a file in a certain folder), or a right itself (e.g. inviting a person as an editor to a document). Rights of artifacts performing activities on persons are less common. Persons primarily are the active part of the system and artifacts are supposed to be passive objects. Nevertheless, artifacts are becoming active in terms of notifications and other kind of system performed processes.

Persons and artifacts can have the right to change social relations, structural relations, or rights themselves. A change of a social relation for example is to follow another person, or accept a request for friendship. An example for a change of a structural relation would be to move a file into a shared folder. A change of rights themselves would be to invite a person to a shared folder, which give this person access rights to this particular folder.

The set of rules $\mathcal{R}ul := \{\varphi_1, \varphi_2, \dots, \varphi_p\}$ is modeling dependencies of relations. Rights can be derived from roles of persons, social relations, or structural relations. Social relations determine rights, e.g. a friend of an author has the right to read the artifacts the author created. Structural relations determine rights, e.g. every member of a shared folder has access to all subfolders and containing files.

The model mainly focuses on the internal context of a cooperative system, but the interface between user and system must not be forgotten. Therefore, the model is framed by the graphical user interface (GUI) to clarify the importance of the interface. Moreover, an appropriate GUI is essential to provide features of cooperative systems, e.g. presence and awareness, and make them accessible to users.

Fig. 2 illustrates the basic symbols of the proposed meta-model: persons, artifacts, and the various types of relations. Although it is possible to model everything with the generic symbols, it seems to be more comprehensible to differentiate between different persons and different artifacts, if necessary. Therefore we added a simple artifact (file, document), which holds information and an advanced artifact (folder, container) to apply structural information, like a folder hierarchy. Beside the symbols for entities, Fig. 2 also illustrates the symbols for relations. First, it shows the structural relation between two artifacts, second the social relation between two persons and third the right between respective entities (person, artifact) or between entities and relations.

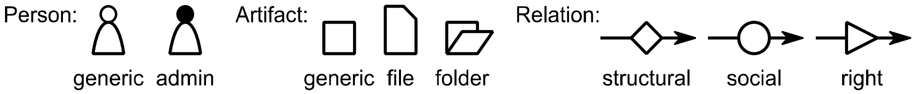

Fig. 2. Symbols of the cooperative system meta-model

4 Model Application and Evaluation

In the following the conceptual differences between cooperation systems will be identified by instantiating the above mentioned meta-model. Every aspect will be completely covered to establish a classification. As aforementioned the instances of the model do not try to model an internal database structure or a technical architecture of a particular system. The instances depict the mental models which are gathered during system usage. The focus is on the two following aspects: The different characteristics of social relationships and the different metaphors of information exchange in virtual environments.

4.1 Social Relationships

Cooperation always happens between multiple people, therefore cooperation systems support multiple users (co-located or distributed). Cooperation always implies a relationship between cooperation partners. This relationship is mapped to the application logic of the system. To cover the variety of real world relationships, there is a variety of virtual relationships implemented in different existing systems. In the following a classification of virtual relationships is given by presenting the distinguishing attributes. In general we identified three basic types of relationship: friends, followers and groups (cf. Fig. 3). But there are hybrid forms combining the features.

Existing classifications emerged from a graph theory and social network analysis perspective. Virtual relationships of users can form chains (process oriented), stars (egocentric, dominant member), hierarchies (organogram of a company), and networks (project oriented) [23]. But every system which supports relations between users can be applied to form the above mentioned types. These types rather describe the usage or the user group of one system, but it does not encounter the core of the character of social virtual relationships.

A **friend network** is applied in Facebook. Its virtual network $\mathcal{N} := (P, R)$ consists of a set P of persons and $R := P \times P$ an undirected relation between two persons. Two persons p_i and p_j are friends if and only if $(p_i, p_j) \in R \wedge (p_j, p_i) \in R$, with p_i, $p_j \in P$ and $p_i \neq p_j$. In other words, a friendship is mutual if both persons agreed; the relation of a friend network is symmetric and irreflexive. In Fig. 3 (1) persons A, B, and C are friends.

A **follower network** is applied in Twitter. Its virtual network $\mathcal{N} := (P, R)$ consists of a set P of persons and $R := P \times P$ a directed relation between two persons. A person p_i is follower of a person p_j if and only if $(p_i, p_j) \in R$, with p_i, $p_j \in P$ and $p_i \neq p_j$. Person p_j is a so called followee of person p_i. The relation is irreflexive. In Fig. 3 (2) persons A and B are following each other, B is following C and C is following A.

A **group network** exists in Facebook groups, Yammer networks, or folders in shared workspace systems. The attached functions differ from concept to concept, but the underlying base concept remains the same. One abstract artifact is linked to people who interact or share something. The relation between persons is no more direct; it is indirect via an artifact, e.g. discussion thread, files.

The group network $\mathcal{N} := (P, G, R)$ consits of a set P of persons, a set G of groups, and $R := P \times G$ a relation between persons and groups. A person $p \in P$ is member of a group $g \in G$ if and only if $(p, g) \in R$. The relation R is called bipartite, because persons and groups do not have a relation among themselves. In Fig. 3 (3) persons A, B, and C are members of the folder f and thereby they have an indirect relation via this folder.

Group networks that are not bipartite also exist. A network $\mathcal{N}' := (P, G, R, S)$, with P, G, and R analogous to the group network $\mathcal{N}$. Additionally a relation $S := G \times G$ between groups exists. With it a group hierarchy could be established. A group $g_i \in G$ inherits its members to a group $g_j \in G$ if and only if $(g_i, g_j) \in S$. All p_i with $(p_i, g_i) \in R$ are members of group g_j too, but not vice versa. An example for this type of group network is the shared workspace metaphor.

Hybrid networks contain several of the above mentioned features in parallel. For example, Facebook has a combined friend and group network. Furthermore, being a fan of a celebrity applies to a follower network. In Fig. 3 (4) persons A and B are friends, C is following A, and B and C are sharing a folder f.

By observing existing systems the above classes of networks were discovered. The dimensions of relations are as follows. *Reciprocity* indicates whether a relationship is mutual (friends) or one-way (follower). *Directedness* indicates whether a direct relationship exists (friends) or an indirect one via an artifact (groups, shared folders). *Visibility* denotes whether a relation is visible to just one person (lists, circles), visible to every involved person (private groups), or visible to everybody (public friendship). *Cardinality* indicates whether a relation involves only two persons (friends), or several persons (group). The found network types are not convertible into each other without loss of information.

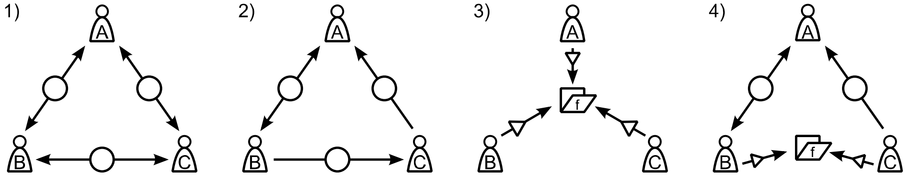

Fig. 3. Four classes of social relationships and virtual networks in cooperative systems: 1) Friend network, 2) Follower network, 3) Group network, and 4) Hybrid network

4.2 Information Exchange

If the network of people is the basic social structure of cooperative systems, the exchange of information is the base concept in terms of activities within these systems. Independent of performing communication, cooperation, or coordination, every activity can be reduced to steps of information exchange. Within this concept, we differentiate between two sub concepts: Sending and sharing.

Sending includes every activity which transfers the sent artifact to the communication partner, i.e. it is copied. Fig. 4 (left) illustrates an instance of a communication system. Person *A* owns a folder *o* (outbox) which contains a created message *m*. While *A* is sending *m* to person *B*, a copy of *m*, is saved in the inbox (*i*) of *B*. This is a typical procedure in e.g. email. As opposed to this, sharing includes every activity which only affects the rights from a particular person to a particular artifact. The same situation as before with sharing (cf. Fig. 4 right): Person *A* saves message *m* in the conversation folder *c*. If person *B* has already joined this conversation, the right to read *m* can be derived. If not, the activity of person *A* leads to the change of the right person *B* has in respect to the conversation.

Sending concepts can be found in messaging and chat systems, like email, but they are not bound to communication. Sending a file attachment definitely belongs to cooperation and applies to the sending concept too. Sharing concepts can be equally found in communication and cooperation scenarios. Facebook and Twitter, for example, apply this concept in their support how people communicate. The users are able to store messages on their server and people share different containers, e.g. walls, where messages are aggregated. People can post messages to these containers, i.e. they share a message, in contrast to send a message to a specific person. In cooperation scenarios the sharing concept is more obvious. A shared folder like we have in Dropbox indicates that several persons have access to it and can store files for the others.

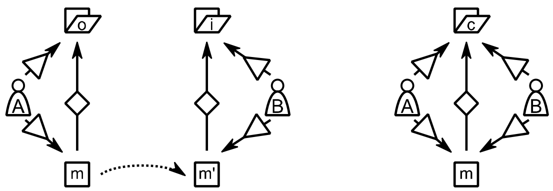

Fig. 4. Two classes of information exchange in virtual communities: Sending and sharing

These two concepts exist in different forms and can be characterized by several dimensions. *Reciprocity* indicates whether a communication is bilateral (conversation) or one way (broadcast). *Directedness* indicates whether a message is directed to a person (push) or whether it is not directed, e.g. stored in a folder (pull). *Visibility* denotes whether a conversation is visible to just two persons or a group (private) or visible to everybody (public). *Cardinality* indicates how many persons are involved.

5 Conclusion

This paper presents a meta-model of cooperation systems enabling the instantiation for different collaborative applications and thus their comparison. We have illustrated the classification of social relationships and people networks as well as the difference between the concepts of sending and sharing. The comparison has shown that the basic concepts resemble by a variety of different systems, only differing in their appearance. We believe that this paper contributes to a more systematic understanding of the core elements of collaborative applications. This work is just the first step for a unification approach of several cooperation systems. Our meta-model and with it the modeling language sets the basis for a precise understanding of cooperation systems, their comparison and their integration.

Our next steps will focus on further applications of the model with the aim of further refinement and validation. Thereby we aim to bridge cooperative use cases to technical systems and further to the design of user interfaces.

This work of this paper has been partially funded by the European Commission under the Seventh Framework Programme as part of the GRANATUM project.

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Cybernetics of the Collaborative Networks Discipline

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Abstract. Collaborative Networks (CNs) research, like any other developing discipline, needs a roadmap facilitating the integration of previous results into a theoretical foundation. CN researchers argue that the required theoretical foundation must consolidate the existing body of knowledge, and provide grounding to define how to invoke results of other relevant disciplines. The authors have previously proposed the 'Cybernetics of the Collaborative Networks' (C2N) as a field of CN-research intended as a unified theory of CNs, formalising, synthesising, harmonising and systematising individual CN-related results addressing management and control problems in CNs. This article aims at further extending the concept of C2N and answering the question: what is a unified evolving theory of the CN discipline itself? To model the *discipline-as-a-system*, we use Beer's Viable System Model (VSM) and introduce three basic components of the CN discipline as a viable system. A 'co-evolution mechanisms' for the discipline is proposed and a cybernetic model of co-evolution is applied to the CN discipline.

Keywords: Collaborative Networks, Cybernetics, Unified Developing Theory, Evolving Discipline.

1 Introduction

'Cybernetics of the Collaborative Networks (C2N)' was previously proposed as a field of research intended to address complexity management and control problems in CNs [1]. C2N can be thought of a field on its own, which re-interprets old and new theories, and point at the need for genuinely new results for designing / creating and managing complex CNs. The aim of this previous research was to understand how various theories contribute to the management of CNs, so that the Network evolves and remains viable in the long term. As part of this endeavor, the authors developed a model (called the co-evolution path model), discussing the evolution of a CN in light of the evolution of the Network's environment, so as the Network can remain relevant, competitive, and viable.

The idea of this paper is to look at the evolution of the discipline itself, *i.e.*, how the discipline of CNs evolves? After all, a discipline can also be considered a system (of concepts, axioms, theories, scope definitions, paradigms, *etc.*), and it is relevant to ask: how does discipline development ensure that it remains relevant on the long

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 247–256, 2013.

term? What we set out to discuss, is a theory of the evolution of the CN body of knowledge. This theory is to describe the evolution mechanisms of the CN body of knowledge, but is open for further development by CN practitioners and researchers.

The or interdisciplinary aspect of CNs manifests when researchers not only apply models, methods and theories of management and control, engineering, linguistics, cognitive science, environmental science, biology, social science, artificial intelligence, systems thinking and cybernetics, but also create a synthesis of these. Such a synthesis would be the source of a new, unified theory, giving rise to more powerful theories, methodologies and reference models than available today.

For the study of Collaborative Networks, previous work has developed a roadmap to facilitate the invocation and integration of previous results into a theoretical foundation, including terminology, axioms, models, and methodologies [2,3,4,5,6,7,8,9].

The critical question in the present paper is*: is it possible to develop a theory of how the CN Body of Knowledge is developing as a discipline?*

Kandjani and Bernus [1] argue that Cybernetics [10,11], Management Cybernetics [12,13] and General Systems Theory (GST) [14,15] have previously tackled these types of problems at the same, or similar, level of abstraction and generality, therefore, to describe discipline evolution we use a similar approach to the cybernetics-inspired discussion of how CNs develop.

2 Viability of the CN Discipline and Effective CN Practice

In this section we propose a viable model of the CN body of knowledge, as an interdisciplinary discipline of designing, creating and maintaining CNs.

2.1 Beer's Viable System Model

Beer [16] describes every system as consisting of three main interacting components: Management, Operation and Environment. Every system of interest has a meta-system as its management and operates in an environment, where each component could be further decomposed into more detailed elements. There are communication channels to keep the Operation in homeostasis, these channels are called variety attenuators and -amplifiers [16,17,13], to ensure that the variety what the Operations can provide meets the variety of the demands of the environment.

According to Beer [16] the 'variety' of the operations is always less than that of the Environment, and the 'variety of Management' is always less than the variety of Operations. In contrast, based on Ashby's law of requisite variety (1956), in order to achieve dynamic stability under change, the variety of Operations should be equal to that of its relevant environment, and the variety of Management should be at least equal to that of Operations. In fact variety attenuation and amplification mechanisms need to be designed in order to keep the system of interest viable ('evolvable') in its environment.

2.2 The CN Discipline as a Viable System

One can map the three components of Beer's VSM to the CN Discipline itself, and to its surrounding Environment (Fig. 1). We consider CN-related disciplines as 'Operations' shown as a circle, and the CN discipline as its integrating and interdisciplinary meta-system ('Management') shown as a square, with CN's task being to observe and cross-fertilise problem domains, and observe the 'Environment'.

The CN discipline acts as a meta-system, investigates the CN problem domains and using attenuation mechanism, invokes the relevant terminology, models and theories from CN-related disciplines (e.g. industrial engineering, management science, control engineering, information and communication technology,…) to respond to new issues arising in these domains.

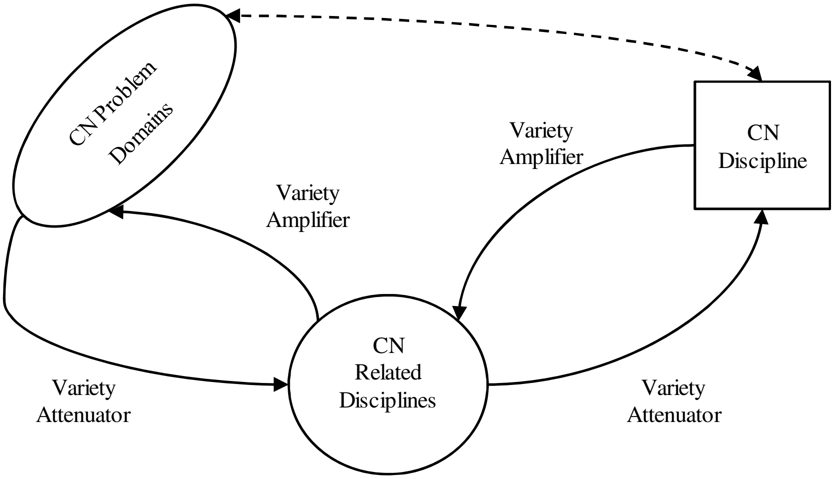

Fig. 1. Three components of a Viable CN Discipline

Changes in the problem domains mandate the evolution of individual CN related disciplines, so as to respond to the new requirements of the evolving environment.

In order to harmonise this co-evolution, we need to understand what the relevant mechanisms to guarantee an effective evolution of the CN discipline itself are.

If we consider the CN discipline as 'problem solving', then the step-by-step stages of co-evolution would be: 1) diagnose a significant problem in the CN problem domain, 2) invoke one or more relevant disciplines studying the CN problem domain and decide if such multi-disciplinary combined action is adequate, and if not, then 3) provide solutions for CN problems by harmonising and integrating multiple theories, models, techniques and methods from relevant disciplines in a synthesis (new or extended theory), and 4) adopt any 'new' case records of relevant disciplines and integrate them into the CN Body of Knowledge.

The need for a unifying theory clarifies the role of the CN discipline as a meta-system (as in Beer's VSM) answering a) what CN problem domains would be addressed in specific CN practices?, b) what would be the invoked disciplines targeting the problem domains in combined use?, c) how to formalise and harmonise other disciplines' contributions and apply them in a CN practice?

As the invoked disciples are continuously progressing and evolving in their specific domain and field of application, a more effective CN practice could be guaranteed if the evolution of these disciplines were influenced or monitored by the CN discipline and the findings reflected in CN theory and practice when necessary.

3 Co-evolution Mechanisms for an Evolving CN Discipline

We discussed three components of a viable CN discipline in Section 2, now the question arises: *what are the mechanisms to keep the requisite variety of the CN discipline as a viable system?*

3.1 Co-evolution Path Model, Dynamic Homeostasis vs. Dynamic Hetereostasis

Beer [12] argues that a key property of a viable system and a "measure of its submission to the control mechanism" is its ability to maintain its equilibrium or homeostasis, which he defines as "constancy of some critical variables (outputs)". In our model of co-evolution, we define the dynamic sustenance of requisite variety based on Ashby's law: "only variety can destroy variety" [11], paraphrased by Beer [16] as "variety absorbs variety". Here, 'variety' is the number of possible states of a system [17], or as recently re-interpreted and refined by Kandjani and Bernus [18], the number of relevant states of a system.

Considering the system and its environment as two coupled entities, if one component is perturbed, the effect of that perturbation on the other component is either amplified through positive feedback, or may be reversed (attenuated) through negative feedback. These channels serve as self-perpetuating mechanisms of the system. (Note that what we call here a 'system' includes the system's controller.)

The role of the negative feedback loop is to reverse the effect of the initial perturbation and restore the system's homeostasis (in which critical variables are stable), while positive feedback can create unstable states [19].

As both the system and its environment (including systems in that environment) evolve, change can create imbalance between the requisite variety of our system of interest and the variety that would be required for it to maintain homeostasis. In other words, *systems that want to live long must co-evolve with their environmen*t.

More formally: we consider the environment an entity with a possible set of observable states and if two such states require different response from the system then the system must be able to differentiate between them (thus they are two different relevant states). Consequently in Fig. 2, for this purpose, the complexity of a system (CS) is defined to be the complexity of the model that the controller of the system maintains (appears to be maintaining) in order to manage the system's operations, so as to maintain adequate interaction with the environment.

The complexity of the system's environment (CE) is a relative notion and is defined to be the complexity of the model of the environment that the controller of the system *would need to maintain* the in system's homeostasis. Specifically, such an 'environment model' must have predictive capability, so that the system, while interoperating with the environment, could maintain a homeostatic trajectory.

These models are needed to be able to represent and predict the states of signals and resources among the system, the external systems and the rest of the environment. This because based on the theorem of the 'Good Regulator' [20], a good controller of a system must have a model of that system with an equal complexity at its disposal as the system to be controlled has.

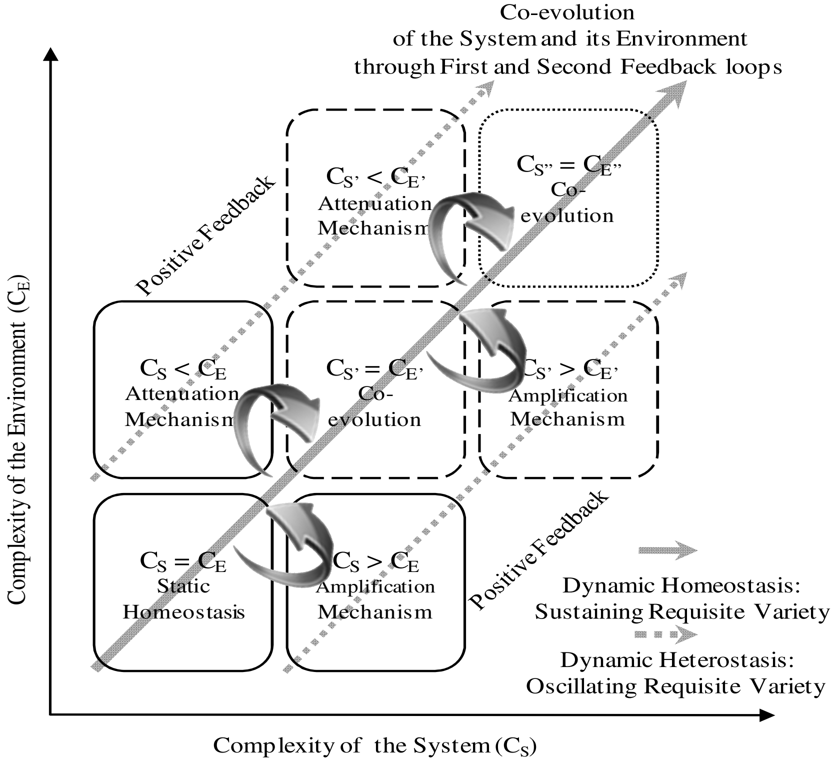

Fig. 2. Co-evolution Path Model

1) If the complexity of the system (CS) equals to that of its environment (CE), then the system has the requisite variety and is in static equilibrium. However, any change in the complexity of the environment should be sensed by the system's self-perpetuating mechanism to restore the system to its initial state or to create a new equilibrium state.

2) If the complexity of the environment is greater than that of the system, then the system should attenuate the effects of this complexity, i.e., change and co-evolve with its environment (in other words, the environment produced, or is recognised to have the potential to produce, some states in which the system cannot function adequately).

3) If the complexity of the system is greater than that of its environment, then the system can potentially create a set of different states and perform behaviours, which are not differentiated by its environment. The system can identify this extra complexity as undesired, or use an amplification mechanism to create new differentiations in the environment.

Any system has a number of variables characterizing its essential survival properties. Ashby refers to these as 'essential variables', and defines survival as: "a line of behaviour [that] takes no essential variable outside given limits" [21,22] . Therefore, by definition, any line of behaviour outside limits of essential variables is on the non-viable system path and is fatal to the system.

For a system to be regarded as adaptive, and therefore viable, Ashby introduces two necessary feedback loops [21,22,23]. The first loop makes small modifications and corrections to the system. As opposed to this, the second loop changes the structure or architecture of the system and operates if essential variables are predicted to fall outside the limits of survival. If the system's second feedback loop does not respond to the changes in complexity of the environment, then the system will be on a non-viable path.

Based on Ashby's theory of adaptation [21], according to Umpleby [23], the first feedback loop is necessary for a system to learn a pattern of behaviour necessary for a specific environment, while the second feedback loop is required for a system to identify the changes in the environment and design/create new patterns of behaviour. If there is a dramatic increase in environment complexity and the system is not prepared to act, then the lack of functioning of the second feedback loop makes the system non-viable and the system is doomed to fail.

3.2 Co-evolution Path Model of the CN Discipline

Looking at the CN discipline as a system ('discipline-as-a-system') the co-evolution model of Section 3.1 applies to that system too (see Fig. 3), therefore the question is: *what are the co-evolution mechanisms through which the CN discipline can maintain requisite variety and remain relevant in light of changes to problem domain changes?*

The CN discipline as an integrating discipline invokes models, theories, and methods of related disciplines, and effective co-evolution is only guaranteed by: a) invoking the right theories, models, and methods from CN-related Disciplines (CNRD) to address new and emerging CN Problem Domains (CNPD) in a combined use (attenuation mechanism), and b) promoting new synthesised CN terminologies, reference models, and methods to provide solutions in CN problem domains using a holistic approach (amplification mechanism).

Thus, if at any one time the variety of the unified theory of CN discipline is less than the variety of the CN problem domains, then the CN discipline cannot respond to the needs of the environment problem domain) and must increase its variety by attenuating the relevant variety (e.g. adopt new elements from relevant CN related disciplines).On the other hand, a CN researcher or practitioner should also formulate and execute a 'promotion' mechanism if the variety of CN models, methods and frameworks is more than the variety of the CN problem domains. In this case, system managers, users, and stakeholders would not be able to comprehend these complex CN models, methods and etc. and would probably avoid using them, therefore one should decrease the variety of these models, or promote the use of more complex models by inventing new applications in the problem domain.

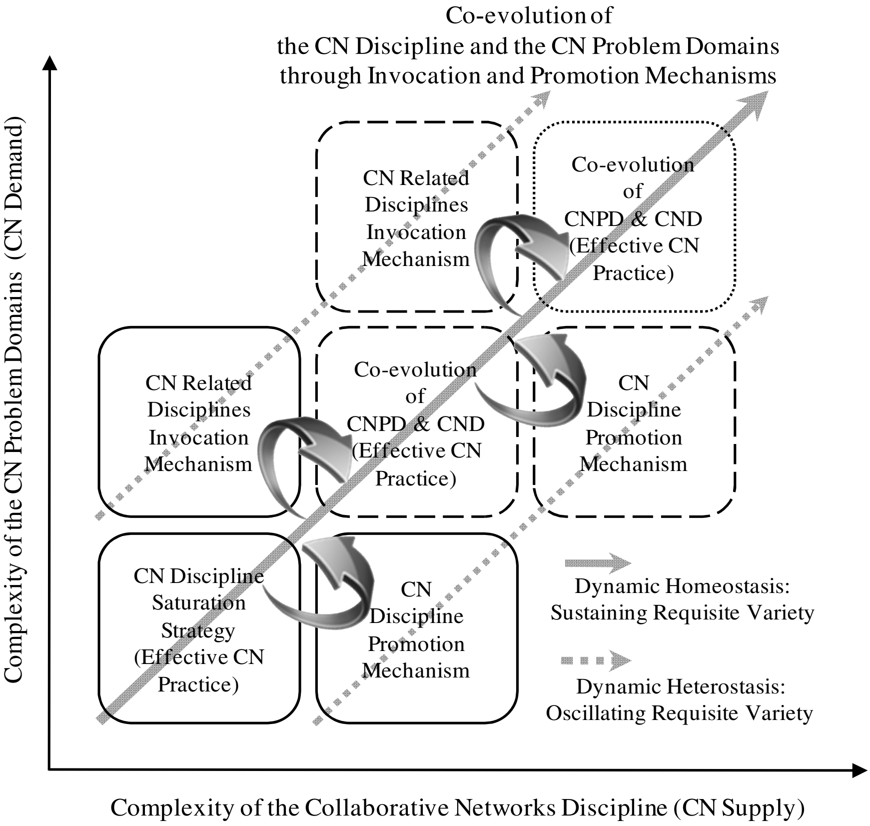

Fig. 3. Co-evolution Path Model of the Collaborative Networks Discipline

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The evolution of problem domains must therefore be closely monitored (including strategic forecasts) so as to be able to perform the mentioned ‘invocation’ and ‘promotion’ to provide the CN problem domains with relevant combined discipline-contributions in practice.

4 Conclusions

To develop a theory of evolution of the CN Body of Knowledge, we focused on the viability of the CN discipline as a system, discussed it using Beer’s Viable System Model (VSM), and introduced its three components using VSM. We also proposed the concept co-evolution mechanisms concept for the evolving CN discipline based on VSM and a companion theory, Ashby’s law of requisite variety, but used a new complexity measure, that takes the relativity of this term into account.

Our cybernetic model of the evolution of the CN discipline enriches Anderton and Checkland’s model of developing disciplines, who previously demonstrated the cyclic interaction between theory development and formulation for a problem, and theory testing [24,25], warning about the need for theories to remain ‘relevant’ (viable). Our model which is based on the Co-evolution Path Model [26,27] now illustrates the mechanisms of theory development from this point of view.

A relevant field of study called ‘Enterprise Architecture Cybernetics (EAC)’ [28,29,30] has a similar purpose and level of abstraction to this intended theory, however EAC has a different scope and genericity (namely its scope encompasses all socio-technical systems of systems in the broadest sense, including social, economic and ecological systems, and aggregates thereof).

Future work will concentrate on applying this model, whereupon testing and validation of this theoretical model of discipline development is to be performed by illustrating the above effects through concrete cases from the development of the CN body of knowledge–hopefully also discovering new, open problems in this domain.

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Ontology Supported Recombination of Multi-Models

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Abstract. Current practice in the construction industry is that participants apply their own method to develop their information model, apply software of their preference and hence choose data formats that suit them better. Hence, diversity appears. The concept of multi-models is introduced to handle this diversity. By employing multi-models, each participant will be able to collaborate despite having different resources. Information exchange can be accomplished by using multi-model containers as transport medium. An ontology model is used as a resource to gather, store and manage the meta-information about the multi-models. As a part of Semantic Web technology, the ontology is able to describe the meaning of each multi-model. Furthermore, it creates the possibility of inferring information to a logical pattern. With this ability, the ontology can support participants to retrieve information they need much more properly and precisely than object or relational data structures would allow.

Keywords: Ontology, Multi-Model.

1 Introduction

In construction projects, different information models are used which are strongly interrelated. Each of the models has its own domain, purpose and information. Each stakeholder creates his own model, at least for company internal use. The ideal vision, that there is only one common model, was never touching reality. This is because the construction industry is too granular and each project is a one-of-a-kind project with always a one-of-a-kind-consortium. Hence, the virtual enterprise established for construction projects has to find new ways of ICT and cannot be based on one common virtual enterprise modeling method. This is common for most other industry sectors. Former attempts are based on the approach of structuring the common model in several dimensions, see e.g. [1, 2]. This helps to manage complexity, but does not meet stakeholders' needs sufficiently. Therefore the multi-model method was introduced by [3] and continuously developed during the last years. Multi-models are the assembly of several information models or information model views, which are completed with one or more link models. They can contain information models based on different data models, as long as the data models follow the basic paradigm that each data entity has a unique ID or at least is uniquely defined such that a unique ID can be generated [4].

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 257–264, 2013.

2 Models and Ontologies in Construction

For several decades, the vision was followed to establish one common data model which can be served by all participants in a construction project. This was the vision of many large software companies, which resulted in software company specific models not interoperable with other companies´ models. However, the vision of construction industry companies resulted in an attempt to establish a standardized publicly available model. The first attempt was done in the 80s resulting in several parts of ISO 10303 (STEP) and later on in the construction specific ISO 16739 (IFC). The latter is meanwhile implemented by all leading CAD software companies in construction.

2.1 Building Information Modeling (BIM)

The most recent technology in Architecture, Engineering and Construction (AEC) is Building Information Modeling (BIM). BIM is a building design and documentation methodology based on coordinated, reliable, high quality information [5]. It enables design and construction teams to create and manage information about building projects consistently and reliably across different scopes of projects. BIM consists of many different models, like the raw building model, HVAC model, furniture model or structural system model. BIM plays an important role in the construction process and the vision is that the information is stored in one single building model. This ensures that the information is coordinated, consistent and complete. By adopting BIM, project participants (e.g. architects, engineers, contractors and the owner) can easily create coordinated digital design information and documentation. BIM can be represented using the IFC (Industry Foundation Classes) data model, which is standardized as ISO 16739. IFC is expressed in EXPRESS (ISO 10303) and can be exchanged in STEP physical file format (SPF) for 3D modeling. This format can be read by most BIM software, as well as IFC viewers and browsers. It is worth to mention that BIM models can but must not necessarily be expressed in IFC.

2.2 Cost Estimation Modeling

Beside BIM, which represents the building itself, there are also models which deal with the estimation of costs. They are known as Bill of Quantity (BoQ) or Quantity Takeoff (QTO) models. These models generally integrate mathematical algorithms used to estimate the cost of a project. The models typically function through the input of the parameters that describe the attributes of the project. This involves counting the number of items associated with the construction project, determining the associated materials and labor costs, as well as formulating or estimating as part of the bidding process. The participants who create such a model are often called cost estimators or cost engineers and are also known as quantity surveyors.

2.3 Schedule Model

The schedule model is helpful in creating the overall schedule for a project. By knowing the timing of activities and tasks, the management will be able to make more efficient use of their resources. The schedule model proves to be the most effective when used with software programs designed to analyze the schedule network. The software used to create the finalized schedule applies this analysis. At present there exists no ISO standardized model in the construction industry. In practice, the most commonly used model is the Microsoft Project exchange data format.

2.4 Multi-Model Approach

With the variety of models in construction, a multi-model approach is a good solution to combine all the difference models. The idea is to go through the borders of disciplines / trades in a construction project and reach a horizontal integration based on different information and data models. To be able to exchange multi-model information, the so called Container Method was introduced [6] which defines a superstructure to encapsulate different kinds of models. As a result, the multi-model can be exchanged, filtered and applied in any discipline. A framework bases on an ontology was suggested in [7] and was developed and implemented in a stepwise manner in the multi-model approach [8]. The purpose behind this was to handle efficiently the needed metadata and to describe and classify the Multi-Model Containers (MMC) and all models within them.

3 Recombination of Multi-Models

3.1 Multi-Model Container, Multi-Model Template and Elementary Model

Multi-models consist of multiple related models, which can be compiled and evaluated with a certain software application, and exchanged by using multi-model containers. A multi-model template is a container which contains the requirement of the requested or desired elementary models. The idea of a multi-model is to combine both engineering and management models in a single information resource. The elementary models in the container are bound together with the help of a Link Model. Through the introduction of a link model, a consistent multi-model that represents a certain status of a project as well as the general information of the project can be achieved [9]. Participants can use software applications, such as e.g. iTWO (RIB Software AG), GRANID (gibGreiner GmbH) and SolidWorks (SolidWorks GmbH) to create their own multi-model container. An elementary model can be any kind of either engineering model or management model, such as IFC. It is used for the exchange of building information models (BIM) or GAEBXML[1] (German Joint Committee for Electronic Data in Construction), as a standard for construction information exchanged during construction bidding, contracting and invoicing as well as during construction execution. Therefore, a multi-model container can consist of a 3D building model and calculated quantities deduced from its elements. These can be interlinked with the items in a BoQ and a corresponding cost calculation as well as with the activities of a time schedule. With multi-models, different aspects of the different relevant tasks and respective auxiliary measures can be transparently presented.

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[1] `http://www.gaeb.de/produkte505.php`

3.1.1 Multi-Model Containers

Communication between participants in a multi-model platform shall use multi-model containers as an exchange format. The container defines a structure to bundle different kinds of elementary models. Elementary models are treated as independent information resources with their application domain, data schema and data formalization. In this way multi-models can be applied in any domain [9]. Each multi-model container is realized by an compressed exchange file. The container contains an XML-based description of its contents [6]. It provides metadata on the particular subject and information about the data formats of the different elementary models as well as the creators or contributors for each elementary model.

Metadata consist of information about the elementary models inside the container. Besides, metadata can also build a multi-model template that prescribe the requirements regarding which content and formalization of elementary models are needed for a certain task [9]. In principal, multi-model containers consist of elementary models from different domains and project participants can independently process each model. They have the opportunity to create or develop their own elementary models and link them with existing models. This opportunity creates a possibility for all participants to recombine the multi-models based on (1) what they specifically need, and (2) the general requirements of the project and individual domain tasks.

3.1.2 Multi-Model Templates

Although project participants are allowed to construct their own model, they should use multi-model templates (MMT) to get the elementary models from the model storage. End users should not create MMT; they should use one of the MMT that have been provided by their company. MMT is a reference model, which may consist of partially filled MMC with metadata about the required elementary models [3]. Participants might have different skills and have to carry out different tasks. It is not necessary for them to know all models in all their technical aspects. Therefore a MMT and MMC management supporting tool is to be asked for. As described in the developed Project Collaboration Ontology [10], template retrieval starts by selecting suitable registered content fitting the described situation. Based on the detected content, templates can be chosen whose characteristics allow processing information for this context. Thereby templates can already contain preset models as basis for subsequent processing.

When a participant accepts a suggested template, the corresponding container with possible preset models is generated. Otherwise, on the basis of existing templates and in conjunction with the ontology, it is also possible to establish and add new templates. As said before, that should only be done by an authorized person of the company because templates are Quality Management items of the company. As a result, we can ensure that the involved end user retrieves task and situation-specific MMTs matching the current state of all project entities, and hence fulfilling good collaboration requirements. The basic idea is to describe the product model instances and templates for better assignments of participants and process [10].

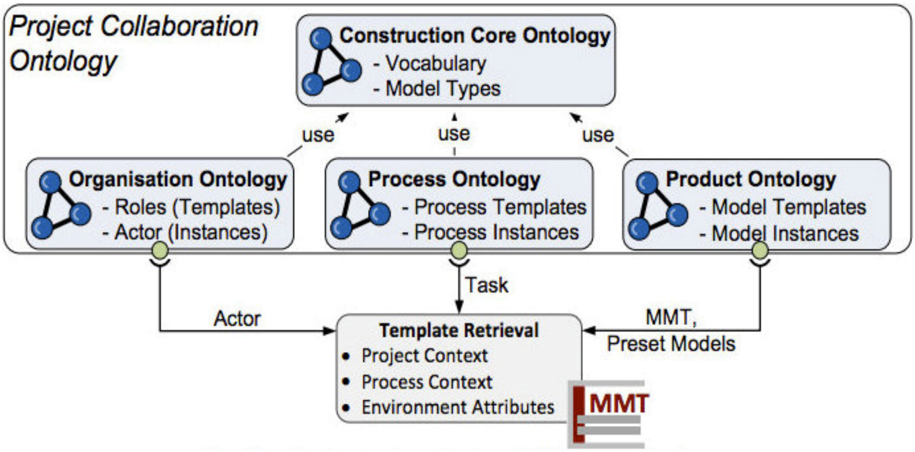

Fig. 1. MMT Retrieval in Project Collaboration Ontology

3.2 Multi-Model Recombination Scenario

Two scenarios will be introduced in this section. The first scenario is to register a new elementary model inside a MMC into the Multi-Model Ontology (MMO). The second scenario is to get the information from MMO about the existence of required elementary models as shown in Figure 2. It is assumed that each participant has the same role to create and request meta-information about an elementary model.

Beside creating and requesting, project participants also have to store their created elementary models in a particular storage, which can be accessed by other participants. They should provide the information about the storage URL when registering the new elementary model. It is important to keep in mind that all elementary models are bundled in a multi-model container. An MMC consists of one or more elementary models, such as BIM, Cost-Pricing, Scheduling. Each Elementary Model can be in different file formats such as ifc, cpixml, gaebxml, or plain xml. All participants have approved these different kinds of file formats as a readable format in their systems. Along with the agreement of the format, it is also important to have an agreement regarding the vocabulary, which includes languages, abbreviations, etc.

3.2.1 Creator Role Scenario

As already mentioned, project participants have the opportunity to construct their own elementary models. There can be many kinds of elementary models, depending on the roles and needs of each participant. In the previous section, it was explained that all elementary models belong to one context, e.g. one or several related tasks are bundled in a MMC. As can be seen in Figure 3, after creating the MMC, participants have to register their new container, which includes their new elementary models. Registration does not mean to insert the multi-model in certain storage, but only to add information about new multi-models which contain particular elementary models.

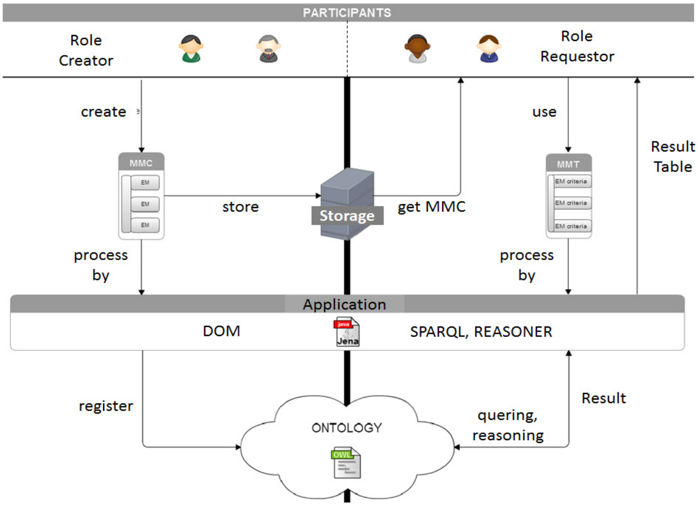

Fig. 2. General Scenario for ontology supported Collaboration using Multi-models

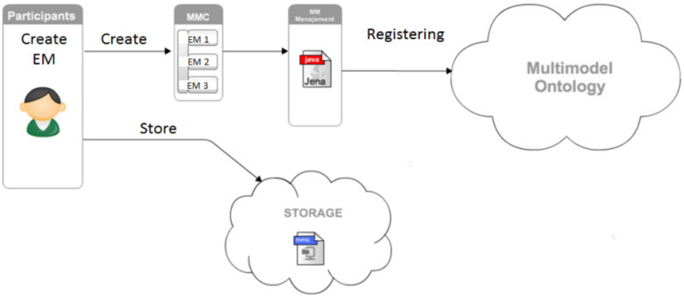

Fig. 3. Creator Role Scenario

3.2.2 Requestor Role Scenario

Project participants might need some elementary models, which are established by other participants. The role Requestor does not mean that one participant sends a request to other participants, but a participant sends a request to the MMO to get the information whether their required elementary models are already created or not. To create a MMC, participants need to use a MMT. They can create the template themselves or they can get it from a MMT provider. With this MMT, participants can send a request to the MMO. After sending a request, they will get the list of appropriate elementary models available. The result might comprise one or more elementary models, and the participants have to choose which elementary model fits their request. The requestor can get the requested MMC from the URL address provided by the creator. The mechanism of how to get the MMC from the storage will not be discussed in detail here. Important is to note that the requestor can always get the multi-model by having access to the storage, given by the creator.

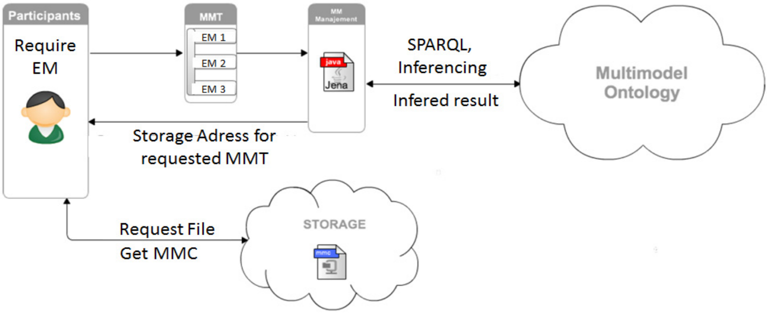

Fig. 4. Requestor Role

3.2.3 Combination of a New Multi-Model

As the result of both shown roles, the combination of new multi-models can be made. It is called New Combination because it consists of elementary models, which were inside the previous multi-model created by another participant, plus the new elementary model(s). The new multi-model should have a unique name or ID, otherwise it cannot be registered in the MMO. It will reject any kind of the same instance names as this can cause inconsistency in the ontology. The elementary models inside the new multi-model might have exactly the same properties with one of the registered elementary models. These elementary models will be registered to the ontology as a different instance with a different ID because they are bundled in a different multi-model container, and the naming of a new elementary model will follow the name of the multi-model container's ID. Thus it is possible that there is an elementary model with two different IDs due to their role concerning the MMC they belong to.

4 Conclusion

The technologies of information systems have been progressing in a rapid pace. Information systems are now being called upon to support knowledge management, not just to process data or information. The key to provide a useful support for knowledge management lies in how meaning is embedded in information models, which can be done explicitly through ontologies. The special feature in our approach is not only the ability to compose new models from existing multi-models, but also to include existing workflows and to calculate with them an expected virtual information space. The use of the developed ontology can be especially effective and useful for the support of project collaboration management through knowledge management.

Acknowledgments. The research in this paper was enabled by the financial support (Euro 9.4 million) of the German Federal Ministry of Education and Research (BMBF), Department of ICT under contract n° 01IA09001A, which is herewith gratefully acknowledged. The results have been developed in the frames of the project Mefisto (Mefisto-bau.de; 2009-2012). The prototype implementation was carried out in the frame of a Master Thesis work of the first author. The authors want to thank particularly Dr. Jansen and Mr. Beichert for their dedicated support.

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Collaboration Platforms

Enterprise Collaboration Network for Transport and Logistics Services

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Abstract. The development of the Single Window concept (unique access/contact point for composite services) for the multimodal door-to-door freight transport management is a complex endeavour that is being addressed by the European MIELE project. Led by port authorities, the project identified the need for a novel strategy to foster collaboration among stakeholders with a diversity of processes and technology. The multimodal perspective requires a convergence and thus collaboration of maritime, railway, road, and air transport facilities as it is the case for the need of traffic information for a real-time (re)planning if some accident is hindering the current route. This requires that traffic information from different operators is integrated into the freight transport routing planner. Furthermore, a unified coordination and operations management of the existing business processes is lacking. To integrate such contexts, an open enterprise collaboration network (ECoNet) infrastructure is presented and discussed.

Keywords: Collaborative Networks, Logistics Single Window, Service Oriented Architectures.

1 Introduction

The Logistics Single Window (LSW) [2] and Port Community System (PCS) [9] concepts have been developed by the European MIELE project on proposing an IT infrastructure and systems to offer transport and logistics services for a door-to-door freight management. Led by port authorities, the project identified the need for a novel strategy to promote collaboration among stakeholders with a diversity of sizes, processes and technology. This need naturally emerges from the recognized complexity of managing the huge number of business messages, adopting diverse formats (GS1, EDIFACT, DATEX), exchanged by such heterogeneous group of logistics and transport stakeholders. Furthermore, customs and other government agencies are required to be efficient on the enforcement and authorization processes

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 267–278, 2013.

in other to make the overall multimodal and cross borders transport process as efficient as possible. The existing single window system for the Portuguese ports (the JUP[1] system) is mainly for the customs and other administration services. The Portuguese participating ports (Lisbon and Leixões) in the MIELE project adopted the development of a PCS as an extended single window accommodating business-to-business messages exchange. These two layered single windows (JUP and PCS) aim to contribute for an efficient movement of cross international borders cargo identified as a bottleneck for international trade and transport [9]. According the EPCSA[2] the PCS is "*pivotal in the Single Window concept and will reduce duplication of data input through efficient electronic exchange of information*" and "*a strategy to aggregates, optimizes, orchestrates, secures supply chain business processes for stakeholders enabling customs to focus on high risk cargo*". The multimodal perspective requires a convergence and collaboration of maritime, railways, road and air transport facilities and stakeholders with their own standards and normalization initiatives. The Intelligent Transport Systems (ITS) area, initially focused on the application of Information and Communication Technologies to the road infrastructures, is moving towards a multimodal approach and specialized areas as freight-ITS and Passenger ITS are being integrated to offer advanced goods transport and mobility services [6].

This trend is contributing for a growing involvement of organizations (from SME to large enterprises) as nodes of collaborative networks (CN) in this sector [1], [2]. As an example, a logistics service provider needs to collaborate with a logistics platform differently from the collaboration with the customs on exchanging legal documents. These distributed collaboration processes [15] are nowadays based on specific software and technological platforms. As suggested in [1], there is a need for a long-term cooperation agreement and adoption of common principles and infrastructure as a preparedness basis for different dynamic collaboration models. One important contribution to a high level abstraction is the ARCON, a reference model for collaborative networks, based on three main dimensions: i) life cycle management, ii) environmental perspectives both endogenous and exogenous, and iii) the intent as different modelling abstractions, as developed by the European project ECOLEAD [4], [5]. The proposed ECoNet and related concepts will be later framed on the ARCON reference model in an attempt to contribute to the consolidation of collaborative networks as a growing multidisciplinary scientific area. The ECoNet framework and infrastructure is an open bridge between the endogenous elements and the exogenous interactions.

The design of the ECoNet framework and infrastructure is motivated by the need to establish a simple and generic strategy to logically connect individual organizations. The collaboration context concept is discussed in [14] as a strategy to capture business collaboration development and management under the three dimensional views: behaviour, level and facet. For partners to integrate such networks they have to adapt their internal systems to access the offered services (proprietary APIs). Disparate internal organization's IT systems, as shown in the Fig.1, need to be connected (usually) through specialized electronic data interchange software

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[1] JUP – *Janela Única Portuária*; or Port Single Window (PSW) in English.

[2] EPCSA European Port Community System Association - `http://www.epcsa.eu/`

managing specific collaboration contexts like UN/EDIFACT for order and invoicing electronic messages, DATEX traffic information messages [8], SWIFT banking messages, etc.

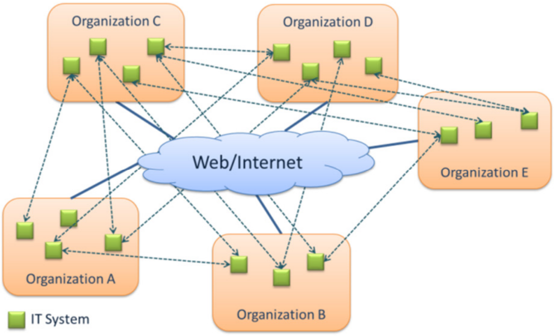


Fig. 1. Organizations manage uncoordinated point-to-point collaborations

Motivated by this difficulty and based on the concept of collaboration layer (CL) proposed and discussed in [16], this paper contributes with one step further by proposing an open generic framework and infrastructure based on the enterprise collaboration manager (ECoM) concept. The ECoM is an implementation of the proposed CL, based on an adaptive suite of services each one tailored to manage a specific collaboration context (CoC). By a collaboration context we mean an application domain where two or more organizations need to exchange electronic messages and coordination on pursuing some business objective. A CoC can embed (abstract) the integration to existing business platforms promoting in this way more peer-to-peer or flat collaborative relations (reduce business dependencies by adopting an open technology strategy). Such open framework establishes the ECoM nodes and makes the enterprise collaboration network (ECoNet) infrastructure.

2 The MIELE Transport and Logistics Single Window Challenge

The MIELE project on a Logistics Single Window (LSW) system, established the following main requirements:

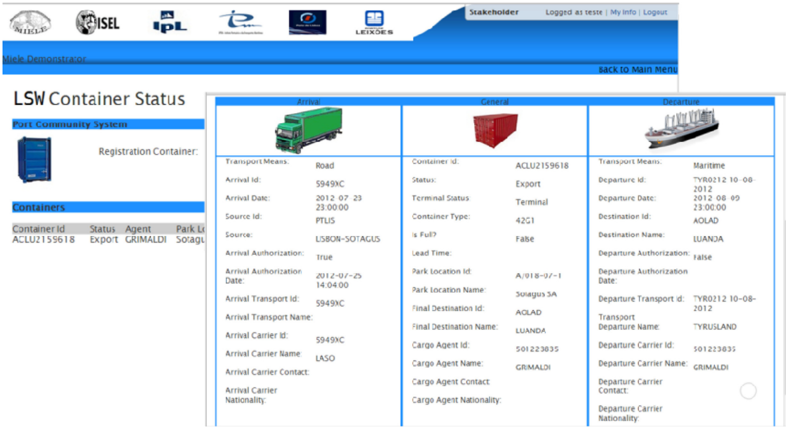
- Shippers are able to source and book door-to-door (D2D) services with operations management and control along the supply chain;
- Definition and operations management of one-stop-shop Business-to-Business (collaborative) processes for logistics services;
- Integration of existing messaging and courier/transport services connecting Clients and Providers based on public and private services;
- Interconnect systems of different actors (carriers, logistics integrators, PCS and other logistics platforms) with the proposed LSW platform;

- Construction of optimized multimodal transport chains based on composition of available services from competing providers;
- There might be Logistic Integrators offering door-to-door transport solutions to customers, based on a pool (registered/trusted) of qualified service providers;
- Specific search and multi-criteria selection for transport and logistics providers (cost, delivery time, environmental impact, and evaluation of suppliers).

The LSW system establishes itself a complex ecosystem of B2B platforms, transport providers, and freight forwarders, needing to ensure interoperability and integration among existing and new technology systems. This raises the need for a minimal set of to guarantee interoperability. Such minimal commitment from a potential participating stakeholder might suggest the creation of a catalogue able to bind the selected services to the provider's technology supporting IT infrastructures.

The registered service providers should be able to publish their services in the LSW and this way be connected to other logistics integrators (composite service providers).

Such Logistic Integrators are able to build their own private networks while they establish compositions of services and related service providers eventually based on geographical or transport means that best fit the customers' needs. As many (competing) LSW platforms may exist, Logistics Integrators and Logistics Service (providers and clients) may be able to rank (qualify) the used services in order to establish a competitive federation of interoperable Logistics Single Window platforms. The Fig.2 shows the result of a call to the track-and-trace service.



LSW Container Status

Port Community System

Registration Container:

Containers

Container Id	Status	Agent	Park Lo
ACLU2159618	Export	GRIMALDI	Sotagu

Arrival

Transport Means: Road
Arrival Id: 5949XC
Arrival Date: 2012-07-23 23:00:00
Source Id: PTLIS
Source: LISBON-SOTAGUS
Arrival Authorization: True
Arrival Authorization Date: 2012-07-25 14:04:00
Arrival Transport Id: 5949XC
Arrival Transport Name:
Arrival Carrier Id: 5949XC
Arrival Carrier Name: LASO
Arrival Carrier Contact:
Arrival Carrier Nationality:

General

Container Id: ACLU2159618
Status: Export
Terminal Status: Terminal
Container Type: 42G1
Is Full? False
Lead Time:
Park Location Id: A/018-07-1
Park Location Name: Sotagus SA
Final Destination Id: AOLAD
Final Destination Name: LUANDA
Cargo Agent Id: 501223835
Cargo Agent Name: GRIMALDI
Cargo Agent Contact:
Cargo Agent Nationality:

Departure

Transport Means: Maritime
Departure Id: TYR0212 10-08-2012
Departure Date: 2012-08-09 23:00:00
Destination Id: AOLAD
Destination Name: LUANDA
Departure Authorization: False
Departure Authorization Date:
Departure Transport Id: TYR0212 10-08-2012
Transport Departure Name: TYRUSLAND
Departure Carrier Id: 501223835
Departure Carrier Name: GRIMALDI
Departure Carrier Contact:
Departure Carrier Nationality:

Fig. 2. An example of a container status from the LSW track and trace service

The logistics service users or customers search for simple or composite services according to some selection criteria (capacity, delivery time, cost and service level). The LSW is responsible to manage customer requirements and process them based on routing, ecological footprint, and other criteria considering the registered network of

Logistics Integrators. In a simple scenario and for a better understanding of the LSW capabilities, the first three business cases to be considered are:

1. Business case one:
    - i. Apply for the role of Logistics Service Provider (LSP) and Logistics Integrator (LI);
    - ii. Qualify as Service Provider and/or Logistic Integrator.
2. Business case two:
    - i. Publish services.
3. Business case three:
    - i. Apply for a specific logistic integrator network (membership);
    - ii. Follow/execute integration procedures.

Dependencies from processes, information models and specific technologies – dependent from system vendors (vendor lock-in) makes the construction of the LSW platform a complex endeavour. In the following sections, a strategy based on the adoption of Collaborative Networks is proposed and discussed.

3 The Enterprise Collaboration Network (ECoNet)

One main objective for ECoNet is to establish a unified and trusted endpoint connecting any organization to a generic collaboration space. Such spaces supports a virtual organizations breeding environment (VBE) based on a minimal preparedness level. It is of the responsibility of the ECoM component to coordinate such participations by playing the role of adaptation/mediation between the companies' internal IT systems and the different collaboration contexts the organization participates in. A simplified SOA modelling language (SoaML) [13] model of ECoM is shown in Fig.3.

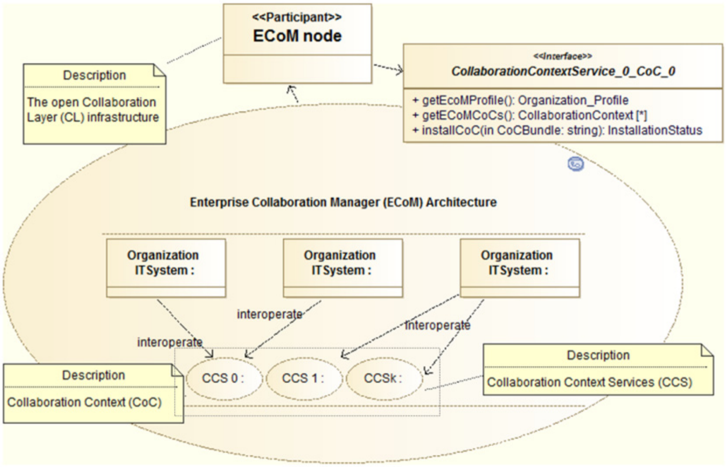


Fig. 3. A simplified SoaML model of an ECoM node

One of the main problems organizations face is the dependency from specific integration products and the lack of a unified management for such electronic business relations. The fast adoption of cloud computing services is deepening dependencies and raising the need for new interoperable frameworks able to support moving between alternative providers. In spite of the new possibilities brought by cloud computing, namely a growing trend for business process outsourcing and proposals to structure service delivery frameworks for communities, ecosystems and business networks [3], interoperability among approaches remains a main issue. Even if each individual subsystem is compliant with well-established operational service level agreement (SLA), the control of the commitments depends on more than one internal IT system, what makes its satisfaction difficult to manage and maintain. Furthermore, different internal IT systems are tightly linked through software adapters managing differently message commitments with different public authorities, implementing different versions of the DATEX message format standard [8].

The fast growing logistics single window (LSW) concept [2] is an application domain where collaboration infrastructures are centred on proprietary business platforms (INTTRA, DHL, GT Nexus). Participating organizations such as logistic providers or customers have to integrate their internal systems (ERP, SCM) following proprietary technology connector/adapters. This emerging complex web of collaboration contexts has been contributing for increasing technology dependencies and a number of other problems such as:

- Computational responsibilities (as IT applications/systems) answering business process requirements tend to establish integrated systems, as complex monolithic and vendor lock-in IT solutions.
- Difficult to join new strategic collaboration contexts as the costs and risks of adaptation discourage new technology developments. This results in a lack of dynamic adaptability to new business opportunities.
- Costs of the required complex IT systems are not compatible with the business risks SMEs are able to take.
- Different, while complementary, collaboration contexts are managed as “IT islands” as key internal IT systems follow proprietary integration strategies to adapt to peer organizations.
- Existing computer engineering abstractions are not powerful enough to develop a business-guided modularization process (processes modelling). Model driven architecture (MDA) [7] approaches are mainly for documenting rather than to be automatically interpreted by execution environments.

The proposed ECoNet abstraction establishes a minimal, context free infrastructure to connect trusted organizations. The network nodes identity management and access to implemented services adopt the results of the European eProcurement PEPPOL project [12]. While this project has been focused on specific collaboration contexts, one important contribution is related to the establishment of a trusted information transport infrastructure recently adopted by OASIS[3] as a new open specification. The specification moved meanwhile to the new BusDox Technical Committee, created to

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[3] Advancing Open Standards for the Information Society (`www.oasis-open.org`).

establish a federated network of organizations able to safely and securely exchange documents. Other application specific domain contributions from PEPPOL were considered in specific ECoNet's collaboration contexts as discussed later in the paper.

The BusDox specifications include six main parts: i) the BDEA (Business Document Exchange Architecture), a specification based on the 4-corner model associated to the exchange of business documents; ii) the SMLP (Service Metadata Location and Publishing), a federated, secure, reliable and lightweight organization's addressing mechanism; iii) the START (Secure Trusted Asynchronous Reliable Transport), a reliable, secure and trusted asynchronous messaging system; iv) the LIME (Lightweight Message Exchange), a lightweight secure and reliable messaging protocol; v) a secure, trusted, asynchronous and reliable messaging based on ebMS (ebXML Message Service Specification); and conforming with interoperability tests to enforce specifications adoption. While other parts of the specification might be adopted in forthcoming evolution phases, the ECoNet initial version is based on the Service Metadata Location and Publishing (SMLP) [11]. Any ECoNet enabled organization is registered with a Service Metadata Publisher (SMP). A SMP is itself an ECoNet node and only the root needs to be created manually.

The signed and trusted metadata publisher is based on a minimal CN profile, making possible for peers to establish trusted electronic "conversations" through an existing collaboration context (CoC). Nevertheless, an effort will be developed to match as much as possible the concepts that are being developed by OASIS and, if possible, to contribute for a consensus on structural and modelling decisions.

The ECoNet infrastructure is therefore organized around three main components, as shown in Fig.4:

- Enterprise Collaboration Manager (ECoM) – abstracts a composition of one or more collaboration contexts, where ECoM = $\{CoC_0, CoC_1 \ldots CoC_n\}$, for n > 0. Any ECoM must have a system collaboration context that we identify as the Collaboration Context zero (CoC_0);
- Collaboration Context (CoC) – abstracts a specific collaboration and is made of one or more collaboration context services (CCS), where CoC = $\{CCS_0, CCS_1 \ldots CCS_k\}$, for k> 0. The collaboration context service zero (CCS_0) is a mandatory (system) service and establishes the CoC entry point;
- Collaboration Context Service (CCS) – abstracts an atomic computational responsibility that can be implemented based on the Cooperation Enabled System (CES) [17] framework. In a first phase the collaboration context services are being implemented on a free technology strategy approach. The access to a CoC is done through its entry point (mentioned above).

To demonstrate the main features of the proposed ECoNet infrastructure, an enterprise chat (ECoChat) is being developed as a specific collaboration context. It aims to put at conversation authorized users from the participating organizations.

The reutilization of common functionalities (CCS services) can be shared if using the cooperation enabled system (CES) framework, making it available as a system service. Nevertheless, a main concern on designing the ECoNet was the simplicity and, as much as possible, maintaining isolation (independency) among collaboration contexts.

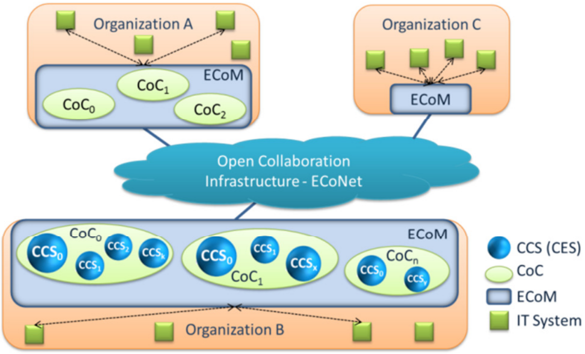

Fig. 4. The main components of the ECoNet infrastructure

4 The Enterprise Collaboration Manager

A Collaboration Context is defined as a set of services under a coordinated choreography on contributing for some valuable (business) objective. Its structure depends on the required services to answer context requirements. The proposed ECoChat demo collaboration context, initially supporting instant messaging, might evolve for an enhanced application if extended to provide audio and video and advanced management features. A collaboration context can be seen also as a collaboration application in the sense it incorporates mechanisms making possible for people or systems to work together for some common objective. It is important to note that openness is limited to the ECoNet infrastructure. Depending on the adopted strategy, a specific collaboration context can be developed and in this case all the network members need to adopt the same IT solution.

In the MIELE project, an open specification for a logistics single window (LSW) collaboration context will be designed and demonstrated. In this case a collaboration context will manage a number of collaboration processes (or services) on cooperating to door-to-door multimodal freight transports.

The Enterprise Collaboration Manager (ECoM) is a composition of one or more collaboration contexts where CoC_0 is the collaboration context zero (or system context), responsible for the establishment of an ECoNet node. In the next abstraction layer the collaboration coordination/context service zero (CCS_0), as mandatory member of CoC_0, has the responsibility to establish the ECoM trusted network (the ECoNet VBE). An organization that wants to adhere to ECoNet should proceed in the following way in order to be part of the ECoNet VBE:

- Access an ECoNet registry directory provider:
    - Register as a new ECoNet node by filling a registration form and by exchanging trusted information (eventually with the need of some legal document from some governmental authority).
    - The new registered node has the possibility to make its profile private or public (modes: secret, private, public). Where secret mean no other organization has access to the profile; private means restricted access ECoNET VBE members; and public means access without any restriction.

- Download the ECoM basic infrastructure or configure the access through a ECoNet service provider based on a cloud computing infrastructure [10]:
  - The basic infrastructure includes the CoC$_0$ and the respective CCS$_0$ responsible for the basic services and more precisely for the establishment of the ECoNet VBE;
  - Includes also the ECoChat collaboration context as a reference implementation for a specific collaboration context.

As proposed in [17] the objective of the utilization of CCS services implemented as CES entities is to establish a dynamic adaptable IT infrastructure independent of specific technology frameworks (.NET, JEE, etc.). Nevertheless, considering the underlying complexity associated to the specificities of each collaboration context, the ECoNet framework does not restrict the implementation strategy. However, in a potential later normalization process to promote an open specification for a collaboration context, an adaptive modularity approach needs to be adopted. The main objectives of the adopted ECoNet infrastructure are:

- Provide an integrated management and coordination of collaboration relation;
- A unified representation of specific collaboration contexts based on collaboration context services (CCS);
- An open marketplace for innovative collaboration contexts, e.g. www.econet-cno.org/CoC-marketplace/.

The ECoNet infrastructure is itself organized as a collaboration context where the CCS$_0$ is responsible to manage a root registry, Fig.5. This registry stores the profiles of registered organizations, those that are members of the ECoNet VBE. The ECoNet specification is what we can mention as the ECoNet collaboration context (CoC$_0$) normalization process.

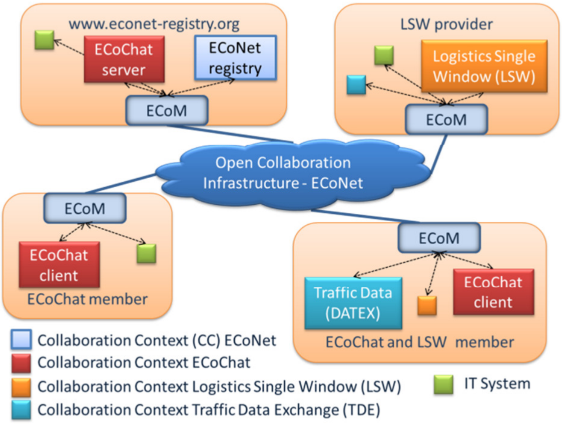

Fig. 5. The Collaboration Contexts ECoNet, ECoChat and LSW

The ECoNet framework is being validated in four main collaboration contexts, as shown in Fig.5:

- The ECoNet collaboration context responsible to establish the ECoNet breeding environment as a trusted collaborative network (CoC_0);
- An organizational network making possible for organization users to exchange messages, develop conversations and meetings and other specialized functionalities;
- Exchange of traffic messages using the DATEX standard and based on the management of contractual commitments (agreed SLAs);
- The collaborative network established by an implementation of the Logistics Single Window (LSW) concept for transportation services considering an integrated management of door-to-door freights.

A first version of an ECoNet organization's profile (ECoM node) is shown in Fig.6.

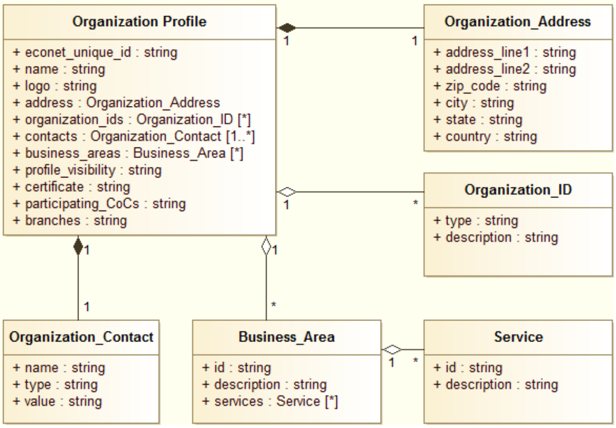

Fig. 6. A first version for the ECoM node profile

Nevertheless, the success of the proposed framework depends on proving key aspects such as:

- Being able to demonstrate a robust dependability strategy considering aspects like security, reliability, scalability, and completeness against the specificities of business requirements depending on specific business domains;
- A development and execution model coping with existing processes and technology dynamics (achievements and innovations) from communication, computer engineering, to business modelling expectations and strategies;
- Adaptive framework accommodating novel process and technology patterns namely to be able to cope with complexity growing holistic (systemic) approaches from sensors/actuators to business intelligence services;

The demonstrators under development (ECoNet system collaboration context, ECoChat, LSW and TDE) will help to validate the initial design and to tune further developments towards an open collaboration (technology agnostic) framework.

5 Conclusions

The growing adoption of process automation, accelerated by the emergence of computing as a utility, is focusing the research challenges into multidisciplinary systemic approaches. In this sense, the Logistics Single Window (LSW) offers a single point of contact for a diversity of stakeholders with their own IT systems. The stakeholders involve port authorities, transport and logistics services providers, customs, shipping agents, freight forwards, road concessionaries, logistics platforms, traffic management centres, to mention only a few. The number and diversity of normalization organizations, business and technology cultures, knowledge bodies, regulation cultures, and other aspects establish a complex ecosystem. Furthermore, it represents a complex endeavour for the computer science and engineering on a balanced and multidisciplinary approach to help to structure such web of heterogeneous stakeholders.

The proposed ECoNet framework and infrastructure, with its Collaboration Contexts (CoC) and Collaboration Context Services (CCS), establishes a trusted Virtual organizations Breeding Environment (VBE) able to manage and coordinate a diversity of collaboration contexts. A reference implementation is being developed for the Logistics Single Window (LSW) and Port Community System (PCS) sample services (MIELE project). To demonstrate the generality of the proposed models two other collaboration contexts are being developed, namely a demo chat application (ECoChat) and a Traffic Data Exchange for the Brisa highway concessionaire. The strategy is to validate the integration of services from a road operator and maritime/ports and logistics related service providers (MIELE stakeholders).

Acknowledgements. This work was partially supported by Brisa Innovation and Technology, and Administration of the Port of Lisbon and Porto, Leixões (APL/APDL) through research and development grants with participation in the European **MIELE** (Multimodal Interoperability E-services for Logistic and Environment sustainability) project. The MIELE project has the participation of INESC-TEC and Porto Business School (PBS), beyond other partners. Reference implementation of ECoNet framework concepts and demo examples has been developed by Paula Graça, Ana Mourato and Tiago Dias. Concepts from the European project **GloNet** were also adopted.

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An Agile Approach to Glocal Enterprise Collaboration

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Abstract. Effective industry and public project planning, design and execution are increasingly dependent on instant collaboration to deal with unexpected situations and events, caused by nature, technology or people. Agile approaches to enterprise design, responding to growing variety, emergence and complexity of sectors are being researched. This paper presents an agile approach, and illustrates its potential through reporting from pilots and case studies. Agile model-based and architecture-driven solutions have been prototyped. These have a potential for removing interoperability barriers, managing dependencies and complexity, enabling iterative design and smart adaptive operations of products and services. Instant collaboration is triggered by parameters and rules linking affected workspaces, and enabled by architecture-driven knowledge spaces integrated in a visual role-oriented and adaptive work environment. Local practices and work-centric context as well as global context are captured.

Keywords: Instant Collaboration, Active Knowledge Architecture, Holistic Design, Architecture-driven Solutions and Knowledge Modeling Methods.

1 Introduction

Business, project and solution developers, managers, architects and users are faced with domain-specific layered approaches, where each layer is divided in stages dominated by single disciplines linked by gateways, and supported by chained application software systems. Gateways are used to control progress and manage the handover of information to other teams by delivering a standardized set of documents. When collaboration is not within the organization, but integrates resources across organizations in supply networks, extended enterprises [13] and digital ecosystems [5], the limitations of this approach become obvious. What is missing in current ICT landscapes is an integrated, holistic view on data, their dependencies and derived rules across the full process and product lifecycles. Design and engineering of products and processes are decoupled from the actual execution and product use. A tight integration of all traditional tools used throughout a product lifetime is not feasible. Collaboration, property management, knowledge sharing, dynamic viewing, solution reuse, and competence transfer among stakeholders are severely limited.

Instant collaboration to support project and product design and enable iterative work execution will simplify project and work management, and enable traceability

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and predictability, and decision support. Instant collaboration means that users taking on roles and performing assigned tasks can decide when to involve other roles and users in executing work, managing performance parameters and sharing knowledge.

Agile, role-oriented approaches supporting holistic design, responding to growing variety, emergence and complexity of markets, regions, and companies are being researched. In section 2 we provide more on the needs of future organizations. In section 3 our agile approach, based on architecture-driven solutions, is presented. Five prototypes are available for demonstrations and we present one of these in section 4, before pointing to further implications in section 5. Section 6 holds the conclusions.

2 Background and Identified Needs

Present collaborations are to a large extent pre-planned among roles and partners, and supported by static software tools. This is dependent on collaboration taking place in known environments with predefined contexts, such as synchronized timing of exchanges and contributions. In e.g. the EU project LinkedDesign [14] the support of more dynamic situations of collaborative engineering in a Virtual Obeya [6], a collaborative work environment [12], is experimented with. But this work is still in an early stage. Instant collaboration, enhancing and exploiting human mental models [2], is an agile approach to enterprise knowledge architecture and holistic design of enterprises, balancing parameters and dependencies. Knowledge modelling and management must be performed by role-oriented teams involving practitioners, applying conceptual, fine-grained graphic languages to capture emerging knowledge.

Fine-grained graphic languages were conceived as the solution to agile modelling and executable models as early as 1994 [7]. Enterprise methodologies will become knowledge models and active elements in emergent Enterprise Architecture (eEA), enabled by agile workplaces for enterprise design. An agile workplace is influenced by tasks performed and data created by users at any other workplace. To enterprise managers, the CTO and CIO in particular, this means that a deeper understanding of role-oriented workspaces, visual knowledge models, model-based workplaces and visual modelling methods are needed. Smart networked enterprises cannot be built by acquiring or developing application software systems alone, and adaptive services cannot be delivered by current methods. Future development, use and value of ICT will be managed by sharing situated enterprise knowledge and reusing role-oriented workspaces and architecture-driven workplaces as illustrated in Fig 1.

The nature of enterprise knowledge spaces and workspaces must be conceived by users applying graphical modeling to capture work-centric context in an active knowledge architecture. The resulting enterprise platform will support customer-driven solutions and situation-driven operations. Knowledge and experience sharing will be facilitated and knowledge assets will be decisive for future competitiveness and progress. Collaboration has traditionally been supported by process modelling [3] and the setting up of synchronized events [8]. With new demands for customer, partner and supplier involvement and support of holistic design [9] we must support the execution of instant collaborative design, team-building and project planning and execution. New competences are needed as illustrated in Fig.1 and Fig.2.

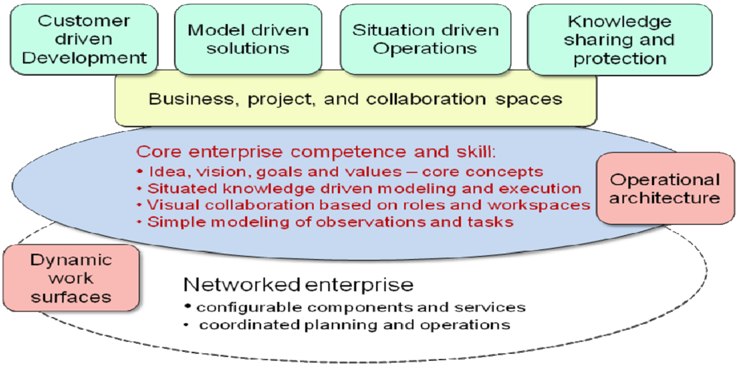


Fig. 1. New ICT enabled enterprise concepts, approaches, methods and solutions

Conceptual design of projects and products are currently poorly supported by static ICT solutions. Graphic language constructs allowing users to define tasks, data and emerging values are missing. This gap in the design life-cycle must be filled. Present life-cycles are linear and rarely support collaboration and iterations as they are dealing with physical artifacts, and material or document flows.

To support future networked enterprises we must meet the following needs:

1. ***Collaborative Enterprise Networking*** for participation in multiple networks.
2. ***Self-developing organizations*** for role-based learning and competence transfer.
3. ***Agile autonomous methods*** for communication, collaboration, visualization, knowledge sharing and enterprise readiness.
4. ***Emergent Enterprise Architecture*** for handling dependencies, traceability, predictability, adaptation, alignment and change.
5. ***Powerful data capture*** for analyses, and domain modelling and aggregation for developing new knowledge.
6. ***Federated product models*** for transparent co-design, flexible manufacture and in-use modifications.
7. ***Communities of Practice and Learning*** [15] for transferring competence.
8. ***Front-end loading*** of project knowledge architecture (base), for effective reuse of knowledge and adaptive solutions.
9. ***Value-chains*** with holistic organizations, enabling bottom-up collaborative patterns and knowledge sharing.
10. ***Designing for emergence***, enabling continuous innovation and learning and practical training spaces (the digital apprentice).

In networked enterprise design, product and services delivery, we see the need for agile workplaces driven by Active Knowledge Architecture (AKA) to support instant collaboration and emerging knowledge sharing among teams, as illustrated in Fig. 2:

- **Conceptual Design Team**; developing new enterprise designs, business models, solution concepts, performing conceptual and holistic project design.
- **Architecting Team**; building and adapting the active architectures and the common emergent EA, creating and adapting graphic languages and application templates, and accessing reference models (repository of classes).

- **Organization Team;** defining and aligning new roles, their model-based workplaces, their access rights and security, and the services and views they require as local and joint contexts evolve.
- **Methodology Team;** developing methodology for networked enterprise design and development, and organization and life-cycle management.
- **Applications Team;** developing and validating new services, methods and models, experimenting with alternative approaches, methods and solutions, and supporting continuous learning and innovation.
- **Management Team;** planning, performing and following up on work /tasks, situations and actions, managing alternatives and supporting decision-making, and recruiting and training personnel to take on roles.
- **Knowledge Management Team;** developing, maintaining and managing enterprise knowledge and providing services to build the architectures required.

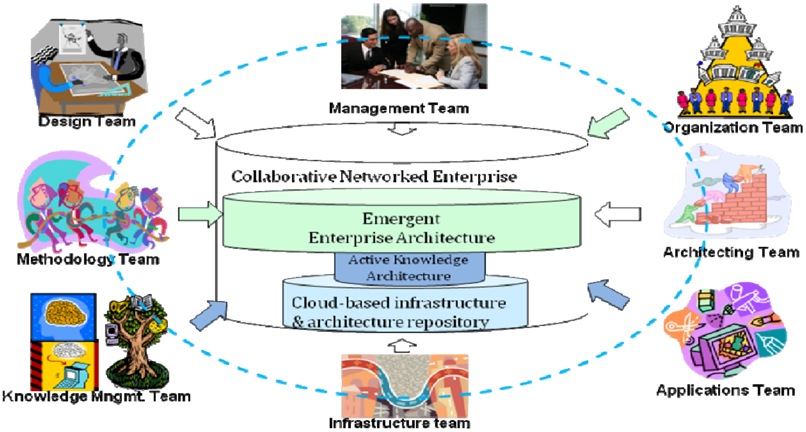
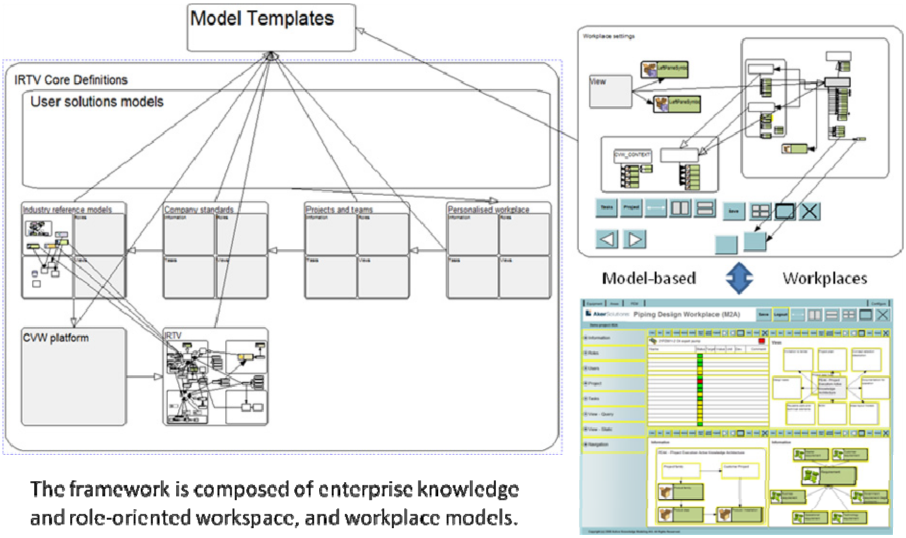


Fig. 2. Core collaborating teams of networked enterprises

3 Model-Based, Architecture-Driven Solutions

An agile holistic design approach, based on Active Knowledge Modeling (AKM) [4, 8], provides creative workers and practitioners with model-based workplaces and adaptive visual working environments. Methods and capabilities needed for instant collaboration, knowledge sharing and holistic design can be modelled. The approach will enable agile knowledge architecting, and collaborative learning and innovation, embracing new design and working concepts and methodologies. Challenges faced by industry and public domains to master participation in multiple global projects require *an agile holistic design approach and an active knowledge environment* enabling role-oriented learning and reuse [4]. Based on the agile approach to building and managing enterprise workspaces, Collaborative Enterprise Architecture (CEA) is envisioned as the core of the next generation enterprise ICT solutions [7], irrespective of public or industrial sector. The agile approach enabled by model-based workplaces and architecture-driven solutions, piloted since 2007 [8], is illustrated in Fig. 3. Workplace layout and behaviour is one model (top right) allowing each workplace to be tailored to roles and users. The agile model-based, architecture-driven approach removes existing interoperability barriers, and supports iterative design and emerging operations. Simple fine-grained graphic modelling by users supports data capture and powerful visualization of local work-centric context as well as global dependencies. Agile workspaces and model-based workplaces allow radical cuts in lead-times and expenses, and support the realization of customized smart products and adaptive manufacturing plants, and establish a practical knowledge-base for new projects. Change management will be replaced by traceable iterations and choice among parallel alternative solutions. This will facilitate global project design, knowledge sharing, competence transfer, and new approaches to work management [11].



The framework is composed of enterprise knowledge and role-oriented workspace, and workplace models.

Fig. 3. Knowledge modelling of model-based and architecture-driven workplaces

Agility and emergence is achieved by model-based, architecture-driven workplaces, providing capabilities for extending and modifying the Active Knowledge Architecture (AKA), and to reflect operations across workspaces. A key characteristic of our approach is best summarized as “use visual modelling rather than coding to capture global as well as local context”. A second key characteristic is supporting categories of users (e.g. designers and engineers) in capturing events, situations, dependencies, changes, data and local knowledge contexts by building role-oriented workspaces, adaptive models and agile workplaces.

The agile approach will have revolutionary impacts on business approaches, on methodologies, knowledge management and reuse across sectors. ICT development will be performed by distributed teams collaborating to develop knowledge models, composing user services, building federated architectures, and managing future classes, categories and families of enterprise knowledge assets across sectors.

4 Industrial Pilots

We have since 2007 performed five industrial pilots. These pilots demonstrate the feasibility, opportunities, and potential benefits of model-based, architecture-driven solutions and workplaces. One of the pilots focused on new approaches and methods for oil field Engineering, Procurement and Completion – EPC projects [10]. Model-based architecture-driven holistic design and generation of collaborative workplaces were successfully developed to support the piping manager, piping engineer and the methodology responsible. The early joint architecting workplace is shown in Fig. 3.

A pilot from the MAPPER project [16] highlights the potential of collaborative seat-heating design using shared views of design parameters. The needs of Kongsberg Automotive (KA), the seat-heating producer, are very similar to the needs expressed by companies in other industrial and public sectors, such as aerospace, construction, transport and energy supply. In short, the needs and goals were to:

- Capture and correctly interpret customer requirements and preferences,
- Create role-specific, simple to use and re-configurable workplaces,
- Create effective shared workplace views and services for parameter balancing,
- Improve the quality of specifications and design for customers and suppliers,
- Improve communications, collaboration and coordination among stakeholders,
- Find a good methodology for product design, using task-patterns for automating most of the customized product design and engineering.

To fulfil these goals, KA decided on investigating the AKM approach, adapting several methodologies and building model-based workplaces. Material specifications are the core knowledge of collaboration between the seat manufacturer, the seat-heating producer represented by KA, and the supplier represented by Elektrisola (E). The material specification is today managed as a document, typically created in Microsoft Word. The content in a specific version of the material specification is put together by one person at KA and approved by E and both companies are filing one copy of the approved material specification. Over time, additional customer requirements and changes need to be communicated, resulting in new parameter values in new versions of the document. The most serious disadvantages are:

- The content in the material specifications is not easily accessed and cannot contribute to the two companies' operations directly.
- The process and work logic to achieve a consistent specification is not captured, making integration with other processes impossible.
- The involvement and commitment from the supplier is not encouraged, there is no support for mutual adjustments in supply and demand. Keeping the material specifications updated in both companies can be quite time consuming.

The proposed approach was to replace the document with an operational visual knowledge environment supporting dynamic viewing and knowledge sharing. The environment developed was enabled by an active knowledge architecture built by using the Configurable Visual Workplace module developed with AKM-technology [8]. The main advantages with the model-based knowledge architected solutions are:

- The content in the material specifications will be easy to access by both companies and can be part of the each company´s complete knowledge architecture, provided that the model-based solution is replacing the document based solution for other applications within the companies.

- The involvement from supplier E and other suppliers will be encouraged and the supplier commitments will be more obvious and traceable.
- The time for agreeing on the best seat-heating design alternative, considering also the material specification and the seat manufacturing process, is reduced to days. There is no real need of filed paper copies anymore.

5 Contributions to Sustainable Reindustrialization

The model-based, architecture-driven solutions design and delivery is ideal for what is described as the reindustrialization of western industries. Instant collaboration, open innovation [1], workplace training and learning and rapid competence transfer and adaptation to new environments and situations are just a few of the demands mentioned in section 2. As illustrated in Fig. 4, the common approach, methods, infrastructures and solutions to all industrial and public enterprises can be composed by the Architecting team applying fine-grained modelling methods.

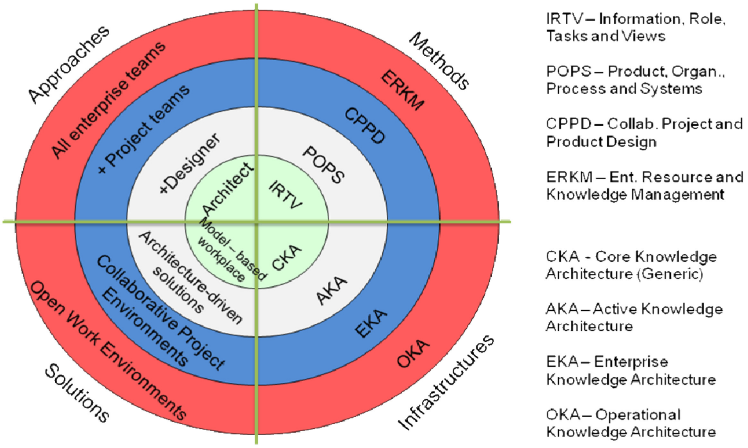


Fig. 4. Spaces of emergent approaches, methods, infrastructures and solutions

The Core Knowledge Architecture (CKA) meta-meta model, the generic IRTV language constructs, the Architect workplace and core services, and the agile approach are common to all sectors and solutions. Adding designer and user teams, extending modelling language and methods to capture aspects of Product, Organization, Process and System (POPS), enabling the design of sector specific methods, architectures and solutions. Architecture-driven solutions will enhance present PLM solutions with capacities similar to the seat-heating case. In the third space, adding more project teams, adapting components of the CPPD methodology [8], the teams are able to start focusing sector specific solutions, and adding classes and categories of enterprise knowledge assets to support sustainable life-cycles.

6 Conclusions

To meet the rapidly growing challenges and opportunities, industry and public sectors are in urgent demand for new ways of providing and applying computing power. We believe the AKM technology has the concepts, capacities and properties required to provide this new way of computing. Future work will focus on developing and providing sector and life-cycle specific agile approaches, holistic design and analysis methods, knowledge architectures and open AKM-platforms. These will be enhanced and extended through applications in both the private and public sectors.

We will build partner networks for AKM Platform component development and platform composition, operation and support, and for methodology modeling and integration. Partner networks for Collaborative Learning and Training, and for Open Innovation and Experimentation will be established to promote the approach and help SMEs and private people in joining business, training and other networks.

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Collaborative Platform for Virtual Practice Enterprise Learning

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Abstract. Virtualizing structures, functions and operations of real companies, simulated enterprises provide a learning environment where learners acquire professional knowledge and practical skills. Collaborative networks for simulated enterprises allow participants performing management functions, virtual transaction or production simulations and developing entrepreneurial behaviors in a collaborative professional environment. This paper aims to present a functional collaborative environment for practice in virtual enterprises in which actors are students, universities and real companies.

Keywords: simulated enterprises, collaborative platforms, virtual practice and learning.

1 Introduction

Nowadays, collaboration takes more sophisticated meaning if one refers to web collaboration technologies. Collaboration is now developing on integrated business platforms that must provide the seamless flows of information across organizational and departmental domains, regardless of which technologies or standards are in place [1].

As businesses become more transparent thanks to the increasing volume of information available online, enterprises began to use IT and web technologies in their business strategies. This lead to the development of a new concept: collaborative business platforms. Therefore, organizations can improve their efficiency and productivity, harness knowledge through collaboration, make contacts and networking and use collective intelligence to evolve.

Bordering the business platforms, a virtual educational environment developed: the simulated enterprise. This is a virtual company that simulates the organization and the activity of a real company for educational aims. Simulated enterprises provide a learning environment where learners acquire professional knowledge and practical skills. By simulated enterprises, students gain work experience, developing their entrepreneurial spirit and creativity in enterprises that mirror real companies. Further, students will enjoy the benefits of the teamwork and could compete with real leadership situations, regardless of the area [2]. Collaborative networks for simulated enterprises allow participants to

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 287–294, 2013.

perform management functions, virtual transaction or production simulations and to develop entrepreneurial behaviors in a collaborative professional environment.

The present paper describes a collaborative platform dedicated to business learning and practice in a virtual environment that simulates the functionality of several real enterprises.

2 Simulated Enterprise as a Practice Environment

A Simulated Enterprise (SE) is a virtual company that simulates the structure, the functions and the operations of a real company, but without real money exchanging. A SE is in the same time a training ground for entrepreneurial thinking and action. This results in an efficient learning environment where learners acquire theoretical and practical skills.

Practice enterprise learning method is based on applied problem-based learning and learning-by-doing approaches. Students groups are given tasks with initial information and sources for additional data. Learning in the practice enterprise context requires students to take responsibility and initiative in their tasks accomplishment.

The practice enterprise is a simulated enterprise run by students. Groups of students manage various simulated companies supported by real enterprises, called mentor companies, operating in the background to support business and production planning and to provide real-life information [3], [4]. Each simulated enterprise provides a business set-up, allowing students to participate in order to gain business experience in an authentic learning environment. The company operates in a simulated business environment like a real company though the products are not real and bank transactions are only virtual. In a practice enterprise students divide the roles between themselves to manage the organization according to the company's needs. The lifetime of the practice enterprise is divided into five phases: orientation, planning and founding, start-up, business operations and evaluation [5].

Therefore, the objectives of simulated enterprises are to familiarize students with the specific activities of a real company, to simulate real processes from real business life, to develop competences, skills and attitudes needed by dynamic entrepreneurs, to increase the graduated students' integration in the work market and to reduce the accommodation period in a company [6].

3 Collaborative Platform for Romanian SE

3.1 Problem Statement

A platform for collaborative work is a virtual workspace. It is a site that provides to participants or actors all the necessary tools related to a project management. It integrates software applications, data bases and their management system, group decision aid tools and communication facilities using Internet protocols. The role of the platform is to facilitate communication between actors within the work, while measuring their impact on the behavior of the group.

In Romania, the simulated enterprise is a rather new concept that has been implemented on a larger scale after the year 2006. Existing simulated enterprises are integrated in a national system coordinated by ROCT – The Romanian Coordination Centre of Training Firms. This system aims to interconnect the existing simulated enterprises in a national network, so as to facilitate their contacts and business relationships. In this context, there was a need to integrate the simulated enterprises in a unique collaborative framework where students can acquire entrepreneurship skills by virtual management practicing.

The project for building a SE collaborative platform started at the end of 2010 and was developed by four Romanian universities in partnership with an Austrian consulting company. The main objectives of this project are to facilitate integration of Romanian young people in real enterprises work environment, to develop an innovative study tool for students from Romanian universities and to facilitate the experience exchange between two European states.

As a result of the project implementation, Romanian students have worked in several simulated enterprises developing their management skills and increasing their adaptability to the requirements of a real job. Through simulated enterprises, students gained a lot of experience working in a "replica" of a real company. They have the opportunity to develop their entrepreneurial spirit and creativity and to be confronted with real decisions and situations that usually occur in real enterprises.

3.2 Methodology and Implementation

The role of the platform is to integrate in the same framework activities performed by three types of actors: students, universities and real enterprises. In this way, the virtual work environment is closer to the real one in respect of features, demands and activities. Thus, the platform has a dedicated section for each of the actors, also allowing their interaction.

The platform architecture is a service orientated one [7]. It includes an ERP solution to interconnect the simulated enterprise departments, a collaborative customer relationship management module (CRM), an open source web-based learning management system (ILIAS), a database management system, a group decision aid tool, and a GPS map of all national existing simulated enterprises [8] (Fig. 1). Data bases include information about all participants of the collaborative environment and their relationships: students, teachers, faculties, universities, managers and experts from real companies, simulated enterprises managers etc. (Figure 2).

The economic areas in which the simulated enterprises activate are various: web design, GPS navigation systems, electronic service, IT, advertising, human resources, hospitality, consultancy and equipment for agriculture, leasing cars, import eco-roofing systems, sanitation, production and distribution of mineral water. The activity of their entrepreneurship is evaluated on the base of some quantitative and qualitative indicators as: the number of products sold or acquired from the intern and international market, number of employers, number of paid taxes, employments and clients satisfaction degree, the existing operational and strategically management plan, the degree of investments and innovations, etc.

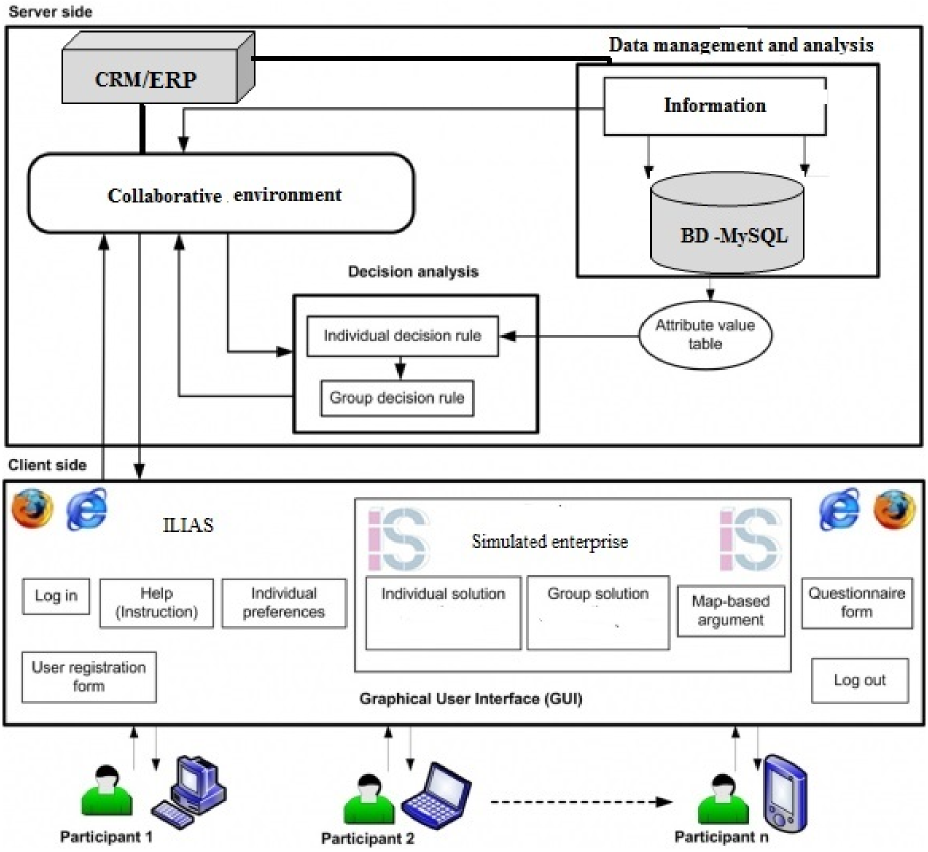

Fig. 1. Collaborative platform's architecture

SE Positions	Real firm	SE	Position within the SE
Name	Internal code (FR11, FR12...)	Internal code (SE11, SE12...)	Student
SE	Name	Name	SE
	CUI - Fiscal Identification Code	CUI - Fiscal Identification Code	Position
	CAEN - National Economy Activities Cla	CAEN - National Economy Activities Clasification	Current position start
	Contact	Tutor	Remarks
	Tutor	ELIS (from the users list)	Objectives
	Remarks	Remarks	Meeting targets percentage
	Web page	Contact	Position entry questionaire (9 criteria)
		Web page	Students' strong points at current position start
		Business plan (yes, no)	Skills to be improved and entry remarks
		Business plan file	Position exit questionaire (9 criteria)
		Organization chart (yes, no)	Students' strong points at position exit
		Organization chart file	Skills to be improved and exit remarks
		Internal procedures (yes, no)	

Fig. 2. Part of the data base structure

The platform also has a section dedicated to e-learning that has all specific features for distance education. It allows uploading course materials, text and media files assignment, coordination and tutorial of study schedules and grades assessment. The platform has also a socialization role. It provides communication facilities as e-mail boxes, blogs, chat, videoconferences, real time whiteboard actualization, discussion lists. Figure 3 represents a window over the participants' accounts.

In addition to the practice developed in a simulated environment, participants have other facilities: group decision aid tools [9], mass-media communication, on line information, newsletter messages, virtual networking, news tracking etc.

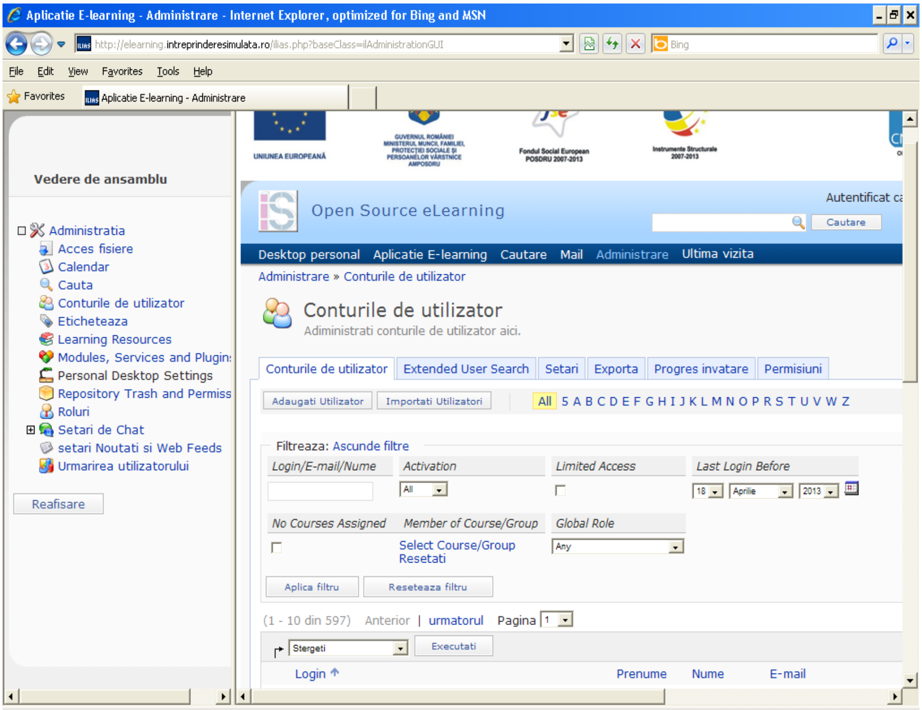

Fig. 3. Participants' roles and accounts

4 Experiences and Results

The created collaborative platform is now used by a number of 16 simulated enterprises and four Romanian universities [8]. Real enterprises are associated with the created SE having various activities from production and services to sales and marketing (Figure 4). Sixteen local real companies that signed cooperation agreements with universities in order to support the simulated business activities were attracted in the project. Since they were created, SEs closed on average a total of 10 commercial transactions with other national SE through the ROCT Center.

Students promoted their imagination and examined their reliability in completing transactions. Each group of students has a tutor, whose role is to act as a consultant for the group and to evaluate the students' performance. More than 320 students used the experience of working in a virtual SE to enrich their knowledge and to increase the chances for a suitable job.

Project "From theory to practice through simulated enterprise" is implemented by the Ministry of Education, Research, Youth and Sports, in partnership with Polytechnic University of Bucharest, Valahia University of Targoviste, Technical University "Gheorghe Asachi" Iasi, University of Oil and Gas Ploiesti and OSB Consulting GmbH, and is financed by Social European Fund through Operational Programme for Human Resources Development 2007-2013.

There are involved 320 students,
From 4 universities in Romania,
Which have initiated 16 simulated enterprises.
We are 20 of this big team, representing the
Simulated Enterprise ENVIRO Ltd

Fig. 4. One of the simulated enterprises on the collaborative platform

All 16 Simulated Enterprises had the opportunity to participate in the first Romanian SE-fair. The first fair was held in Bucharest where more than 100 students and 17 teachers participated, and ended with over 600 commercial transactions. The fair had a huge success stimulating students' ingenuity and reliability in closing a business deal. The fair also provided a tangible environment for preparing students to participate in a real fair. Some of the Romanian students participated at the SE fair that took place in Liezen, Austria in January 2013 where they were they were reworded for their work.

An important feedback of the project implementation is that graduates have been easier integrated in the economic environment and they were rapidly absorbed by the work market.

The second SE Romanian fair takes place in June 2013 at Mamaia, Romania. Over 200 students and 21 simulated enterprises are expected to participate at this fair. In this edition, students will compete in inventiveness, imagination, entrepreneurial skills and the essential marketing techniques in promoting a real company. Simulated enterprises will compete in six sections rewarded with prizes: the best exhibition, the best advertising, the best negotiator, the best website, the best catalog and the best PPT presentation. Areas in which these SEs activate are: construction and installations, industrial and agricultural equipment, electrical, software, hardware, food, consumer goods trade, transport, medical service, tourism service, electrical and electronic equipment, production and advertising.

5 Conclusions

Simulated Enterprise is an educational concept and a learning tool recently implemented in Romanian universities. By learning and practicing in a company that simulates a real business, students increase their chances to get a real job understanding better the operating principles of a real company.

This paper presents a part of the work developed within the national project called "From theory to practice through simulated enterprises”. The main objective of the project is to develop practical business skills of young people in transition from school to work, using the innovative method of learning through virtual practice enterprise. The presented methodology can be generalized to assist students in building and running simulated virtual enterprises. The following of the project implies that more than 320 students will go through the experience of engaging in simulated enterprise, thus enriching their knowledge base and increasing their chances of accessing a job according to their qualification.

In addition, the national system coordinated by ROCT [10] connects the Romanian simulated enterprises with the European network EUROPEN [11], thus providing a European learning and practice environment, where students can improve their foreign languages, as well as their communication and negotiation skills.

Entrepreneurship courses preceded the actual start-up businesses activities from simulated enterprises created by students from the four Romanian universities involved in the project and were supported by teacher trainers and web platforms [12]. With this aim, local experts specially trained in Austria (OSB Consulting GmbH) have previously held a series of seminars in Romanian universities.

Acknowledgements. This work was developed within the national project POSDRU/90/2.1/S/58123 [13]. The project is financed by the National Ministry of Education and Learning over the Sectorial Operational Programme for Human Resources Development 2007-2013. The project started in November 2010 and it is now in the last stage of implementation.

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A Collaborative Planning, Information and Decision Support System

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Abstract. In this paper, we discuss the importance of collaborative planning for manufacturing enterprises. We have analysed user stories provided by industry to understand the collaborative processes in their workplaces and their needs for Information Systems (IS) support. Based on the analysis of the user stories, we have proposed a framework for collaborative planning and ideas for the design of IS supporting this activity. These will be used to conduct focussed interviews with the users to refine our design before implementing the system.

Keywords: Collaborative planning, Collaborative Processes, Global Manufacturing, Knowledge Management Systems, Decision Support, User Stories.

1 Introduction

Globalization has made manufacturers face increased challenges for better product quality and shorter delivery time [1]. To remain competitive in the market, organisations have to cope with pressure on prices, smaller orders, more suppliers, more governmental regulation and increasing material and energy costs. These new business drivers have made it necessary for manufacturing enterprises to collaborate with each other, their customers and suppliers to leverage each other's competences to remain competitive. This has increased the need for Information Systems (IS) support for collaborative planning across organizational borders. The behaviour, activities and all the dynamic aspects of the manufacturing enterprises highly depend on information systems and the processes, services, and data they manage [2].

Today's market is dynamic and uncertain. The products are highly customized and diverse in nature. The environment consists of repetitive (standard) and non-repetitive (customized) components and tasks. There is a high complexity in the nature of products, with short lead time, increased outsourcing and distributed teams who are trying to rapidly fulfill the needs of the customers. To effectively tackle these challenges and to obtain competitive advantage in today's internet economy, an efficient collaborative planning, information and decision support system is required. Collaborative

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 295–302, 2013.

practices and methodologies have been developed for coordination between long term partners. Examples include Vendor Inventory Management and Collaborative Planning, Forecasting and Replenishment [3]. More recently, a collaborative model, Coagmento, for collaborative information seeking has been developed [4].

There is a growing interest in understanding relationships and interactions both within and between organisations, how they collaborate and how IS can support this. The benefits of collaboration to alleviate, or ideally to eliminate, various problems and allowing the partners to pool resources and exploit complementarities are still far from being fully realised. Over the past few years, the researchers and practitioners have recognised the value derived via collaborative processes. However, frameworks, architectures and application that coherently integrate all the information and planning systems are scarce [5]. The analysis of user stories and the design of a framework for collaborative planning discussed in this paper aims to address this gap and provide a fresh perspective in this multi-disciplinary area of research. This is done in three stages: (i) obtaining user stories and analysing them to find the shortcomings of collaborative planning within and across organisations; (ii) exploring the literature and industrial applications of IS; and (iii) proposing the design of a system for collaborative planning, information and decision support. The data used for our study are from samples of user stories or statements obtained through interviews. In this paper, we propose design ideas for a framework for supporting collaborative planning. The design ideas and the proposed framework have been presented to the industrial companies that have provided the user stories to validate the ideas and to refine the system design by conducting additional focussed interviews.

This work has been conducted within the context of the EU FP7 project LinkedDesign. The rest of the paper is structured as follows: Section 2 provides an overview of Collaborative Planning and identifies the current challenges; Section 3 presents the LinkedDesign project; Section 4 describes the approach that we have taken for our work; Section 5 describes examples of user stories and identifies high-level generic requirements for manufacturing collaboration and IS support; Section 6 presents a framework for collaborative planning, information and decision support system and Section 7 concludes the work and provide future perspectives.

2 Collaborative Planning

Collaborative planning is a concept that has been studied by various authors and there is a general notion that collaboration planning has a positive impact on joint decision making in relation to suppliers [6], [7], and new product development [8], forecasting and replenishment [9] and collaborative process planning in product lifecycle management [10]. The suggested benefits of inter and intra-organisational collaborative planning include decreased inventory levels, more predictable order cycle times, elimination of redundant activities, increased product availability and increased sales [11] and [12]. Moreover, effective collaborative planning can be expected to require that the information shared will be of high quality [7].

Many companies rely on technology in the form of collaborative information systems to supplement the traditional modes of communication and information sharing between the customers, suppliers, manufacturers and partners. The main goals of these systems are to provide and facilitate the flow of information across and within the organization boundaries while also improving the quality of the shared information. But there is still a lack of visibility and communication within and across the companies. This causes difficulty for the design of interaction mechanisms [13].

Challenges still remain; e.g. existing collaborative planning practices and methodologies have a single organisation's perspective and are restricted to centralised planning and control. There is a lack of flexibility and real time information sharing. The tools do not address the levels of collaboration and compatibility, error handling, engineering changes, data conversion, management of applications, uncertainty and risk adequately. The support available lacks the capability to store and manage the knowledge, experiences and skills; ineffective support for human interaction in distributed teams for efficient decision making and there is a lack of collaborative virtual space for better information sharing and communication.

These challenges pose requirements on the design of IS that support collaborative planning and decision making, e.g.: support for collaboration and coordination, support information dependencies within and between manufacturing enterprises, storage and management of knowledge and skills, support for interoperability to allow free interaction between different entities, support real-time decision making, address errors, operational issues, uncertainties, engineering changes, variations, and risks to cope with the dynamicity and complexity of manufacturing systems, support to improve sourcing; reduce development and operational costs, increase product innovation, and results in a strategic impact on revenue and support for applications management and process alignment.

3 LinkedDesign Project

LinkedDesign is a European research project (http://www.linkeddesign.eu/) which addresses Linked Knowledge in Manufacturing, Engineering and Design for Next-Generation Production. The central goal of the project is to develop a Linked Engineering and Manufacturing Platform that enables the context-driven and collaborative access to data, information and knowledge from both the engineering and the manufacturing world. The relevant information is scattered in different formats and locations. By using such a platform, engineers will be able to access and integrate (currently disconnected) information sources in a convenient way. To achieve this goal, the project has conducted interviews and workshops with three manufacturing enterprises, the use case providers in the project consortium, to identify their needs.

4 Approach

The starting point for this work was the user stories or statements that have been provided by the three industrial partners in the project. The approach that we have taken is illustrated in Fig. 1. In addition to the user stories, we have reviewed relevant literature to identify challenges in collaborative processes. We have described scenarios ("stories about people and their activities" [14]) to obtain a deeper insight into the users' needs and to identify the requirements for design and the collaborative processes that involve their work and who they collaborate with. These were used to design a solution.

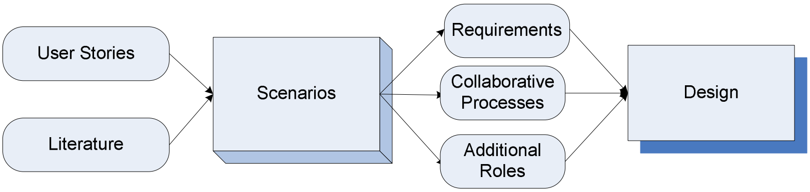

Fig. 1. Design Approach and Process

The design presented in this paper is a refined version of our initial design. The revisions are based on feedback from two industrial partners. Since then, an improved design, presented in this paper, has been presented to the third industrial partner who provided positive feedback

5 User Stories and Requirements

In this section, we analyse the user stories provided by the industrial partners to obtain high-level requirements to design a collaborative planning, information and decision support system. User stories have been collected from people who fill different roles in manufacturing enterprises, e.g. Design Engineer, IT Specialist, Knowledge Engineer, Project Manager, Supplier, Manufacturer and Customer. These are mostly in the form of statements from specific people expressing a desire or a need for technical support for a specific activity. Examples of user stories or statements from the different roles are provided below.

The Manufacturer, on error handling:

- "I want to be able to retrieve a list of errors that occurred during my shift so that I can evaluate my own performance."
- "I want to see every production error as it occurs so that I may react appropriately."
- "I want to see previous lists of errors so that I can compare parameter settings from production history."
- "I want to see a description of the error type so that I can determine the type of action."
- "I want to be able to access the parameters of the process step immediately before the error occurred."

The Knowledge Engineer on error handling:

- "I want to receive error summaries so that I can analyze possible machine defects."
- "I want to see a detailed history of changes to the system so that I can reevaluate my rule set."

- "I want be able to formulate rules for error detection so that the system will automatically send error messages."

The Project Manager on error handling:

- "I want to receive a report that contains produced parts and number of error parts, monetary equivalent of error parts of the last shift so that I can get an overview of the last shift."

It is important to note that in order to provide access to all relevant information for any user, it requires information that is created by another user or as a result of another user's actions; e.g., the error reports that are desired by the Project Manager may be created during the previous shift by the Manufacturer. Similarly, the error summaries and the detailed history of changes to the system desired by the Knowledge Engineer may be created at another time. Although the user stories are statements from specific people expressing a desire or a need for technical support for a specific activity, it implies collaboration, sometimes implicitly, among several roles; e.g. the Manufacturer and the Knowledge Engineer. It also implies that collaborative planning is central to the activities of the users across the enterprise. The statements also imply that collaboration often occurs through information, e.g. error reports, or perhaps other artifacts or knowledge, e.g. rules.

Timely detection and handling of errors can save time and resources and prevent other problems down the road. The decisions concerning how to deal with errors in collaborative planning, i.e. which strategy to implement, depend on the final goal of the production management and involve many economic and production variables. Also, they depend on the manufacturing type of environment (collaborative, dedicated, flexible, etc.), and the advantages arising from using a certain error handling policy vary from one organisation to another. When an error occurs, the whole or a part of the collaborative plan is concerned. Thus, the development of a preventive off-line planning or that of implementing a real-time decision support system to react to errors is strictly required [15].

An overview of the high-level generic capabilities that were desired by all the users can be summarized as below (this is not an exhaustive list):

- Personalized and role-based support and capabilities.
- Easy access to all relevant information to perform their tasks.
- Access to historical information.
- Real time access to domain knowledge and expertise.
- An overview of all tasks.
- Support for internal knowledge and experience transfer.
- Life cycle assessment.

6 Collaborative Planning, Information, and Decision Support

The purpose of this section is to propose a concept of collaborative planning, information and decision support system to carry out collaboration between partners within and across organisations and thereby meet the main requirements for IS support identified through the user stories. We have designed some mockups, using the Pencil application, to illustrate some ideas for a collaborative platform to address the needs of the users; see Fig. 2. The main motivation for our design is to bring forth a holistic view and design a collaborative platform to provide support for the different roles in the various processes. One of the main aims of the proposed design is also to support specific processes within an engineering enterprise such as error handling, order management or knowledge management and to provide the various roles involved in these processes personalized, role and task specific support to do their work effectively.

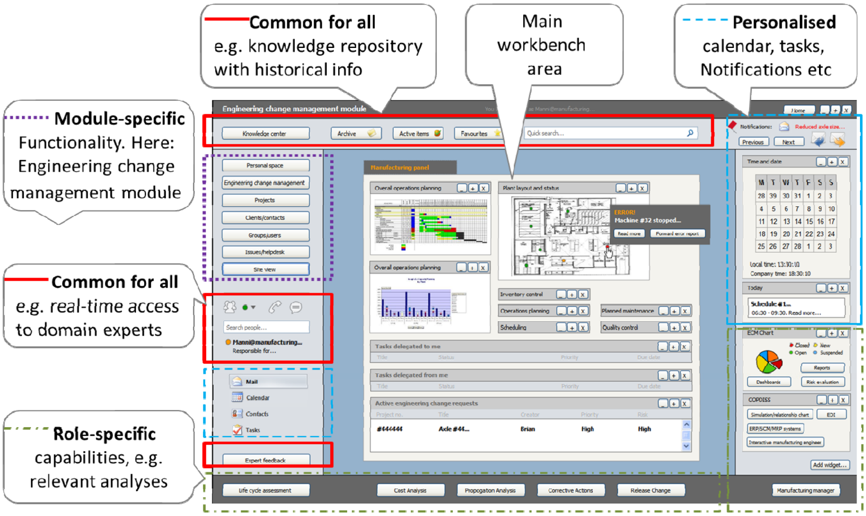

Fig. 2. Design of the functionalities in the Collaborative Platform

To provide personalized or role-based support, it is beneficial for each user to have their own profiles on the platform and some support for their specific as well as general activities. To address the common needs such as the need to access correct and timely information, to have an overview of relevant information and knowledge, both in terms of historical information as well as human expertise, overview of their tasks, we have designed the collaborative platform with some generic functionality that will be accessible for everyone, while executing all processes. The screen layout presented in Fig. 2 is designed to categorize the different types of functionalities that are incorporated into a common workspace for any user. The following categories of functionalities have been considered:

- **Common for all**: functionality that is available for all roles and individuals. These functionalities are available on the top of the screen, which are dedicated to accessing information sources and searching for information. Another block of common functionalities are placed to the left of the page which provide real time access to other people and can provide an overview of people who are online and available at any time. A similar capability is available to the bottom left of the page where expert feedback is available.

- **Personalized**: these functionalities are personalized to the users. Such functionalities include the calendar and task list, available from the top right hand side of the screen and bottom.
- **Role-specific**: these functionalities are tailored to the role of the person and are framed; e.g. a Design Engineer will see a different set of functionalities compared to a Knowledge Engineer. These are available from the bottom left and the very bottom of the screen.
- **Module-specific**: these functionalities are tailored to the module or the relevant process, such as error handling or change management, and are placed at the top right and the bottom left of the screen. These functionalities are aimed to support specific processes within enterprises such as handling errors and managing changes during a manufacturing process.

The area in the middle of the screen is dedicated to the role and module specific content. For example, a design engineer will have content that is specific to his/her role and tasks, which is shown on the top right of the area.

7 Summary and Future Work

In this paper, we have discussed the importance of collaborative planning for manufacturing enterprises. We have analysed user stories and statements provided by industrial partners to understand the collaborative processes in their workplaces and their needs for IS support. Based on the analysis, we have proposed a framework for collaborative planning and ideas for the design of IS support. The design that is presented in this paper is the result of the interviews and feedback on earlier version from the users.

Validation of the mock-up of a collaborative planning, information and decision support system presented in this paper has been conducted with one of the industrial partners. The feedback received was positive and confirmed the need for the types of functionalities proposed in this design. We plan to revisit the other industrial partners in the near future for further validation of the approach and the user interface. Focussed interviews will be conducted to verify the collaborative processes that we have identified through our analyses.

Acknowledgement. This research was done in the LinkedDesign project that has received funding from the European Union's Seventh Framework Programme ([FP7/2007-2013]) under grant agreement no. 284613. We wish to thank the partners for providing the user stories.

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Services I

Enhancing Services Selection by Using Non-Functional Properties within BPMN in SOA Context

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Abstract. In the Future Internet vision, multiple services coming from heterogeneous organizations have to collaborate together in order to achieve the customers' demands from both functional and non-functional point of view. Hence, it is necessary, within an organization, to put in place an interoperable approach that ensures the best functioning control and selection of services. This paper presents a comprehensive framework for representing the customer Non-Functional Properties (NFP) within a collaborative Business Process Management (BPM) and the contribution of the Service Oriented Architecture Governance (SOA Governance) to give customers a better selection of services that best suits their business NFPs requirements among all Web Services candidates provided by functional matching.

Keywords: Collaborative Process, Interoperability, Non Functional Properties, Service Selection, SOA Governance, BPMN, SLA.

1 Introduction

In an era marked by a deep and growing technological progress, the environment in which firms are located has become more complex and characterized by increasing competition. Companies have realized that they can ensure their future development using new technologies such as Service-Oriented Architecture (SOA) and by migrating their Information System to this paradigm. SOA is a computer system architectural style based on distributed and loosely coupled applications in which functions are separated into distinct web services. A Web Service (WS) can be defined as an autonomous and distributed entity, independent of any platform and that responds to a particular need. However, to achieve the user's requirements, several heterogeneous WS can be assembled to interact and collaborate within a business process[1]. Selecting the right WS in each task of this business process has become a major challenge in a collaborative context. On one hand, this is due, to the inexorable rise of services existing in the web. On the other hand, it is also due to the fact that the number of services offering the similar functional properties is relatively huge. That is why the NFPs play a crucial role to sort them.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 305–313, 2013.

Our Contribution. To address the aforementioned challenge, this paper takes into account these properties with a particular focus on Non-Functional ones. It presents a complete framework for modeling NFPs annotations within a Business Process Management Notation (BPMN) 2.0, discovering WS, selecting and ranking them. The contribution of this paper is threefold. First, we propose a solid way to annotate NFPs in BPMN. Since interoperability is an important factor in SOA, it is essential to ease it by adopting standards. Thus, we are principally interested in the use of common agreed standards for the NFPs annotations in BPMN. We also incorporate a graphical representation of these NFPs annotations to enable the user to annotate his NFPs requirements in each task of the BPMN2.0 process. Second, an essential component in our approach is the SOA Governance Registry. It provides an uniform way of governing WS. We use the SOA Governance Framework to facilitate and standardize the discovery of WS and their NFPs. Our third contribution binds the two previously ones. We propose algorithms that match BPMN business tasks with the set of WS candidates published in SOA Governance registry and provided by semantic matching according to the NFPs requirements of the user.

Related Work. BPMN, non-functional properties and WS selection are very active research topics. Guangjun and al., in [1], present a method for WS selection based on ontology to select the best WS from a functional and QoS (Quality of Services) points of view. However, their NFPs selection approach never takes into account the user's NFPs preferences values. Their QoS filter consists on ranking services candidates between them according only to the user's NFPs weights. Youakim and al. propose, in [2] a framework for selecting WS based on the user's NFPs. Even if they take into account the user's preferences, they do not use a common well-known model for representing NFPs. Besides, they don't detail the registry where WS are published. In [3], John and al. also present a framework that details how to represent and use NFPs within a process. In contrast, their work enumerates only some NFPs and they mostly focus on representing them in the development phase and not in the entire life-cycle. The key difference between previous approaches and our solution is that we take into account all the user's preferences in the selection and ranking of the set of WS provided by the semantic functional matching. Thus, the result is very close and fits the user's expectations. What's more, none of those previous approaches does address the issue of a robust registry where the discovery of WS is done. The rest of the paper is structured as follows. First, in Section 2 we present an overview of the important techniques related to our approach. Then, the architecture of our approach is detailed in the Section 3. Finally, a conclusion and future works are presented in Section 4.

2 Preliminaries

This section briefly outlines the major concepts and techniques used in our approach.

BPMN is a standard supported by the Object Management Group (OMG). It allows the design of a wide variety of business processes, the design of diagrams, which are easily understandable and potentially executable. The graphical modeling using BPMN is done using a quite intuitive set of elements allowing a quick understanding for any user if the diagram is not too big or too complicated.

Web Service-Policy (WS-Policy) was developed by the W3C in 2006. The basic construct around WS-Policy is the assertion, which is a bit of metadata. Assertions are not defined, but rather left to developers of individual standards. That's why to define NFPs assertions, we propose to combine WS-Policy with the use of the Web Service Quality Factors (WSQF) model that clearly depicts a model for NFPs.

WSQF was published in 2011 by the WS Quality Model TC as an OASIS Committee specification. According to the specification [4], WSQF refer to a set of several properties which are classified into six groups: 1-Business Value Quality (refers to the business perspective to evaluate the business value of WS), 2-Service Level Measurement (characterize the quality that a user perceives when actually using WS), 3-Interoperability (represents the ability to evaluate whether a WS system conforms to standards), 4-Business Processing (indicates the capability of a WS platform for assuring correctness in business processing), 5-Manageability (delineates the capability of a WS platform for assuring correctness in business processing), and 6-Security (identifies the degree of ability that can protect WS from various threats).

Based on this, WSQF model comprises the majority of NFPs that can concern a WS during its entire life-cycle. Which resonates perfectly with our needs.

SOA Governance, according to definitions presented in [6], can be defined as a set of processes, rules, mechanisms of control, enforcement policies and best practices put in place to ensure the successful achievement of the SOA. Its central component is the registry that promotes the discovery and reusability of WS. As detailed in [6] and [6], SOA Governance registries serve not only to catalog and inventory data, but also as places to store metadata about services as the descriptions of their functionalities, service contracts, capabilities and NFPs.

Service Level Agreement (SLA) is a commonly used way to indicate non-functional objectives to be reached by the business service once deployed. They are also needed to define the responsible entities to be alerted if a constraint is violated. SLA template is a model used for the representation of its various clauses and the main NFPs that can be measured at the runtime phase.

3 General Architecture

In the remainder of this section, we focus on the description of our approach. Formally, the proposed framework, as defined in Figure 1, consists of two major parts. The first one concerns the graphic representation of BPMN with NFPs Annotations. The second one defines an algorithm witch matches the user's NFPs requirements with WS that are provided from the functional matching.

Modeling NFPs Annotations in BPMN. WS is characterized by two sorts of properties: functional properties (what does the WS do?) and NFPs (how does the WS do its functionalities?). The final selection of WS depends on matching according to both of them. The functional matching, as detailed in [7], provides a set of WS that match functionally (syntactic and semantic) with the target business task request. Then, using this provided set of WS, we match them, this time, according to their NFPs which is our main interests in this section. As explained previously, we use the WSQF model that extends WS-Policy as support to such annotations. The Figure 2 shows a screenshot of our graphical framework that supports NFPs annotations at the design phase of the business process.

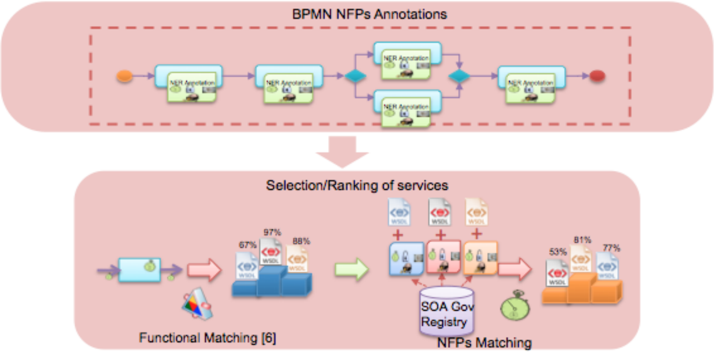
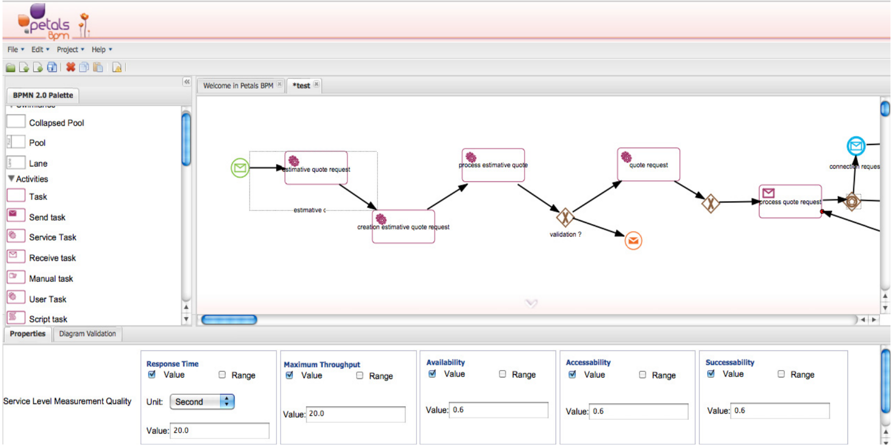


Fig. 1. General architecture of enhancing WS selection according to NFPs BPMN annotations



Service Level Measurement Quality

Response Time ☑ Value ☐ Range
Unit: Second
Value: 20.0

Maximum Throughput ☑ Value ☐ Range
Value: 20.0

Availability ☑ Value ☐ Range
Value: 0.6

Accessability ☑ Value ☐ Range
Value: 0.6

Successability ☑ Value ☐ Range
Value: 0.6

Fig. 2. Screenshot from our BPMN design framework supporting NFPs annotations

SOA Governance Registry. According to the BPMN annotated file and the algorithm of functional matching, as explained in [6], a first set of services candidates is given. For each service of this set and among to our SOA Governance Registry framework, we can extract all NFPs that correspond to it. For example the response time property can be found it in the SLA template published by the service provider. Finally, among all this information, we can apply the non-functional algorithm presented in the following.

NFP Services Selection and Ranking Algorithm. Since the non-functional features play different roles, we can identify two sorts of NFPs: those where it is better to maximize the value, such as the availability, the service recognition, the service provider reputation, etc.; and those where it is better to minimize their values like the price, the response time. We call the first set of properties "NFPs to maximize" and the second set "NFPs to minimize". Besides, NFPs are also subdivided into further levels according to the type of the property. We identify three levels of types: Numerical values, Boolean values, and Ranges. Our NFPs matching algorithm take into account this levels and is presented below.

Step1: Elimination of Services Candidates outliers: our approach aims to be very close to the user's preference, so all services provided by the functional matching do not necessarily have to be kept in the case where they unduly deviate from the user's NFPs requirements. Hence, we set a threshold tolerance parameter (we consider the default 30%) and we eliminate any service, from the services candidates, that at least has one NFP value that exceeds this threshold.

Step2: Normalization and Centering of Services Candidates: Since the values and dimensions of NFPs properties are different, they cannot be compared directly between them. It is necessary to normalize the NFPs values to bring all the features into proportion with one another. Once the normalization of the set of Services candidates is done, the centering part aims to represent them around the target business task. In the following, we explain clearly this steps using the adequate formula in each case.

$$\begin{array}{c c} & \begin{array}{cccc} \mathbf{P1} & \mathbf{P2} & \ldots & \mathbf{Pm} \end{array} \\ \text{Business Task} = & \left(\begin{array}{cccc} \alpha 1 & \alpha 2 & \cdots & \alpha m \end{array} \right) \end{array}$$

$$\begin{array}{c c} & \begin{array}{cccc} \mathbf{W1} & \mathbf{W2} & \ldots & \mathbf{Wm} \end{array} \\ \text{Weight} = & \left(\begin{array}{cccc} w_1 & w_2 & \cdots & w_m \end{array} \right) \end{array}$$

$$\sum \mathrm{Wi} = 1 \ \forall\ i \in [1,m]$$

$$\text{Services Candidates} = \left(\begin{array}{c|cccc} & \mathbf{P1} & \mathbf{P2} & \ldots & \mathbf{Pm} \\ \mathbf{S1} & p_{11} & p_{12} & \cdots & p_{1m} \\ \mathbf{S2} & p_{21} & p_{22} & \cdots & p_{2m} \\ \mathbf{S3} & p_{31} & p_{32} & \cdots & p_{3m} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathbf{Sn} & p_{n1} & p_{n2} & \cdots & p_{nm} \end{array} \right)$$

For the business task: As our main interest is to be close to the user's requirements, we normalize the values NFPs values of services candidates according to the user's preferences. Each value of the business task will be equal to 1 in the normalization part and 0 after the centering step.

$$\text{Normalized and Centered Business Task [m]} = 0\,. \tag{1}$$

For Services Candidates: the coefficients of NFPs for each service candidate reflect meaning between the NFPs of the service and the NFP of the user requirement. We distinguish three different ways to normalize according to each type of NFPs.

A) Case of Boolean values: there is not any change because the NFPs can have only two values: 1 or 0. Then there is not any obligation to normalize them.

B) Case of Numerical values: the normalization and centering of the value of each NFP of Service Candidates is depending on the NFPs Properties when it is a property to maximize, we use the formula (2) and the formula (2') when it is a to minimize.

$$\text{Normalized and Centered Service Candidate [nm]} = \frac{\text{Service Candidate[nm]}}{\text{Business Task [m]}} - 1\,. \tag{2}$$

$$\text{Normalized and Centered Service Candidate [nm]} = 1 - \frac{\text{Service Candidate[nm]}}{\text{Business Task [m]}}\,. \tag{2'}$$

However, there is a particular case when the value of NFP in Business Task is equal to zero. So in this case, for each non-zero NFP of services candidates, we apply the formula (3) if it NFP to maximize and (3') in the other way.

$$\text{Normalized and Centered Service Candidate [nm]} = \frac{\text{Service Candidate[nm]}}{\text{Max (Service Candidate [m])}}\,. \tag{3}$$

$$\text{Normalized and Centered Service Candidate [nm]} = -\frac{\text{Service Candidate[nm]}}{\text{Max (Service Candidate [m])}}\,. \tag{3'}$$

C) Case of Ranges in the Business Task: for each NFP value in the services candidates that is includes in the range of corresponding NFP in business task, satisfy the requirement of the user on this NFP. The value of NFP for each service candidate after the normalization and centering is calculated according to (4) if it is NFP to maximize and (4') else.

$$\text{Normalized and Centered Service Candidate[nm]} = \frac{\text{Service Candidate[nm]} - \text{Business Task [m] Lower bound}}{\text{Business Task[m]Upper Bound} - \text{Business Task[m]Lower Bound}}\,. \tag{4}$$

$$\text{Normalized and Centered Service Candidate[nm]} = \frac{\text{Business Task [m] Upper bound} - \text{Service Candidate[nm]}}{\text{Business Task[m] Upper Bound} - \text{Business Task[m]Lower Bound}}\,. \tag{4'}$$

Else, when the NFP value is out of the range, it is normalize with the upper bound when it is superior -formula (5)- and, else, with the lower one- formula (5').

$$\text{Normalized Service Candidate [nm]} = \frac{\text{Service Candidate[nm]}}{\text{Business Task[m]Upper Bound}}\,. \tag{5}$$

$$\text{Normalized Service Candidate [nm]} = -\frac{\text{Service Candidate[nm]}}{\text{Business Task[m]Lower Bound}}\,. \tag{5'}$$

As previously the centering of NFPs values depends on where it is a property to maximize, then we use the formula (6) or to minimize, then we use the formula (6').

$$\text{Normalized and Centered Service Candidate [nm]} = \text{Normalized Service Candidate [nm]} - 1\,. \tag{6}$$

$$\text{Normalized and Centered Service Candidate [nm]} = 1 - \text{Normalized Service Candidate [nm]}\,. \tag{6'}$$

Step3: Selection and Ranking Services Candidates basing on to the NFPs values

At this step, we have a matrix of services candidates with normalized and centered NFPs values. We distinguish three types of NFPs values: positive ones (that means that the NFP value acts positively towards the corresponding user's NFP requirement), null ones (that means that the NFP value is exactly the same as the user one), and finally negative ones (in this case, NFP value acts negatively towards the corresponding user's NFP requirement). Indeed, each NFP value of this matrix reflects the degree to which it influences the user's requirements.

To tackle with that, we propose to divide the matrix into two sub-matrixes. The first one includes services candidates that have all NFPs values equal to or greater than zero. The second sub-matrix contains the rest of services candidates. For those services in the first sub-matrix 1, we are sure that all of them match the user's NFPs requirements. Thus, for sorting them we need to calculate the weighted distance (according to the weights of NFPs defined by the user and that express his preferences) of each service candidate and then to rank them starting with the one who rolls the highest value. Once we classify the entire services candidates of the first sub-matrix, we address the second one. In the first step, for each positive NFP value, we replace it by zero, we calculate the weighted distance for each WS, and the rank them starting with the lowest value. In case of ex-aequo, we addition to the founded distance the weighted distance of NFPs positives values and finally we rank them starting with the higher global distance.

Illustrative Example: In the following example, we try to match a Business Task (BT) from our BPMN process once the user annotated it with his NFPs constraints. As shown in the vector « Business Task », we consider that the user annotated this BT with four NFPs: response time (in milliseconds), availability (a float value expressed by a percentage), price (in milliseconds) and encryption (is a boolean value). Response Time and Price are properties to minimize. Availability and Encryption are properties to maximize. WS Candidates corresponds to the six services provided by the functional matching. The NFPs values of these WS are expressed in the matrice « Services Candidates ».

$$\text{Business Task} = \begin{array}{cccc} \text{Response Time} & \text{Availability} & \text{Price} & \text{Encryption} \\ \left(4 \right. & 0,9 & 4 & \left. 1 \right) \end{array}$$

$$\text{Weight} = \begin{pmatrix} 0.25 & 0.5 & 0.15 & 0.1 \end{pmatrix}$$

$$\text{Services Candidates} = \begin{array}{c|cccc} & \text{Response Time} & \text{Availability} & \text{Price} & \text{Encryption} \\ \hline \mathbf{S1} & 50 & 0.9 & 3 & 0 \\ \mathbf{S2} & 35 & 0.95 & 0 & 1 \\ \mathbf{S3} & 40 & 0.3 & 1 & 1 \\ \mathbf{S4} & 45 & 0.91 & 4 & 0 \\ \mathbf{S5} & 40 & 0.9 & 4 & 1 \\ \mathbf{S6} & 45 & 0.95 & 4 & 0 \end{array}$$

According to the step 1 of the algorithm, we deduce that the service candidate "S3" is an outlier because its availability value is out the threshold tolerance. Thus, it is necessary to eliminate it. The second step of the algorithm is normalization and centering. Thus, for the target business task, we apply the formula (1) and we obtain the vector "Normalized and Centered Business Task" below. Then, for Services Candidates, we apply the formula (2') for Response time and Price, the formula (2) for Availability and finally for Encryption we keep the same values as it is a Boolean NFP as shown below.

$$\text{Normalized and Centered Services Candidates} = \begin{array}{c|cccc} & \text{Response Time} & \text{Availability} & \text{Price} & \text{Encryption} \\ \hline \mathbf{S1} & -0.25 & 0 & 0,25 & -1 \\ \mathbf{S2} & 0,125 & 0.055 & 1 & 0 \\ \mathbf{S4} & -0.125 & 0.011 & 0 & -1 \\ \mathbf{S5} & 0 & 0 & 0 & 0 \\ \mathbf{S6} & -0.125 & 0.055 & 0 & -1 \end{array}$$

$$\text{Normalized and Centered Business Task} = \begin{array}{cccc} \text{Response Time} & \text{Availability} & \text{Price} & \text{Encryption} \\ \left(0 \right. & 0 & 0 & \left. 0 \right) \end{array}$$

Once the business task and the services candidates are normalized and centered, the third step of our algorithm is to select and rank these services according to their degree of NFPs matching with the target business task. As we detailed previously, we divide services candidates into two sub-matrixes: the first one includes services candidates that have all NFPs values equal to or greater than zero, so in our example S2 and S5 and S1, S4 and S6 belong to the second one. Then, for the first sub-matrix (S2 and S5), to rank services we need to take into account the weights defined by the user to calculate the weighted distance as depicted in the sub-matrix below:

$$\begin{array}{l}\text{Weighted Distance}\\ \text{for Services Candidates}\\ \text{belonging to the first}\\ \text{sub-matrix} =\end{array} \begin{array}{c} \mathbf{S2} \\ \\ \mathbf{S5} \end{array} \left(\begin{array}{l} \sqrt{(0.125)^\wedge 2\times 0.25+(0,055)^\wedge 2\times 0.5+1^\wedge 2\times 0.15+0^\wedge 2\times 0.1} = 0.39 \\ \\ 0 \end{array} \right) \begin{array}{l} \text{① } \textbf{Score = 100\%} \\ \\ \text{② } \textbf{Score = 100\%} \end{array}$$

Likewise, for those that belong to the second sub-matrix (S1, S4 and S6), we obtain the following matrix:

$$\begin{array}{l}\text{Weighted Distance}\\ \text{for Services Candidates}\\ \text{belonging to the second}\\ \text{sub-matrix} =\end{array} \begin{array}{c} \mathbf{S1} \\ \mathbf{S4} \\ \mathbf{S6} \end{array} \left(\begin{array}{c} 0.125 \\ 0.2539 \\ 0.2539 \end{array} \right) \begin{array}{l} \text{③} \\ \text{④ Weighted distance for positive NFPs= 0.0077} \\ \text{④ Weighted distance for positive NFPs= 0.0388} \end{array}$$

Finally, the final selecting and ranking of services candidates that best match with NFPs user requirements defined in the business task is: S2, S5, S1, S6, S4.

4 Conclusion

In this paper, we present a complete solution for enhancing WS selection with a particular focus on NFPs according to the NFPs BPMN business tasks requirements. Indeed, we try to match each business task annotated NFPs by the user with NFPs of the set of WS provided by the semantic matching. Thus, we consider that for one business task, there is a set of services that each meets fully the functional requirement of the user (1-1 approach). However, in many cases services need to collaborate together to achieve the requirements of the Business Task. Thus, for one business task, a collaboration of several services is required (1-n approach). We have started working on the extension of our solution by adding the 1-n matching.

Acknowledgement. This paper is based on an ongoing work supported by the Agence Nationale pour la Recherche (ANR) through the Project SocEDA: SOCial Event Driven Architecture.

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Analyzing Mobile Services in Alternative Agrifood Networks

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Abstract. Recently, Alternative Agrifood Networks (AAFNs) represent a form of collaborative agrifood networks characterized by a re-connection and close communication among producers and consumers in order to overcome the limits of dominant capital-intensive agribusiness system. In this paper, we propose a framework to analyze and explore the value of the use of mobile information services in an AAFN. The applicability of the framework is shown by presenting some results obtained from an analysis of different types of case studies referring to the use of mobile services in real-world AAFNs.

Keywords: agribusiness, Alternative Agrifood Networks, mobile services, mobile applications.

1 Introduction

Over recent years, the industrialization of mainstream food systems has resulted into a concentrated control of product markets, with a small number of dominant organizations. Big organizations monitor every transaction among millions of disconnected producers and consumers, leading both to the loss of decisional power for farmers and producers and to the crisis of confidence in mass-produced, ‘placeless and faceless’ food products, as well as the ‘crisis of trust’ among consumers [1], [2]. In addition to that, rural SMEs are subjected to a continuous imbalance of their bargaining power; they suffer cost-price squeeze, unfair contractual agreement, rising production costs and declining commodity prices that reduce their profitability [1], [2] [3], [4].

All the above mentioned factors have induced farmers, and other people or organizations dealing with agricultural and rural issues, to organize themselves spontaneously in order to solve their problems and those of rural communities. This has led to new and alternative business models to guarantee competitive advantages, to improve farm revenue streams, to return in taking an active role in the agrifood[1] system, and to develop new consumer market niches, [3], [4], [5], [6], [7], [8].

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[1] Agrifood is a generalized term for mostly farm-originated products that are intended for human consumption. Of course, this definition is a fuzzy definition, since it depends on how much a product is farm-originated. A deep discussion on farm-originated food is beyond the scope of this paper. However, it is useful to distinguish:

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 314–323, 2013.

With this aim, different forms of collaborative networks have been introduced in the agrifood sector as characterized by a re-connection or close communication among producers and consumers, allowing the development of new forms of relationship and governance of the actors' network and also enhancing a re-distribution of value for primary producers [1], [2], [9], [10].

According to Goodman [5], *alternative agrifood networks* (AAFNs) is an umbrella term that is used to indicate all these new forms of collaborative development. AAFNs are alternative to the logic and organizational arrangements of the dominant agrifood system which is based on long and multinational supply chains in the direction of shortening the distance (physical, social, cultural, and economic) between world production and world consumption [11], [2].

AAFNs can be shaped into different organizational forms (Direct on Farm Sales, Farmers Markets, Box Schema, CSA, Collective Kitchens) in relation to the socio-economic context of the reference territories and to the peculiarities of the many grassroots initiatives promoted both by producers and consumers, see [12] for a descriptions of these forms.

However, no matter of organizational issues, in any AAFN the agrifood is regarded as 'embedded' with value-laden information, concerning the mode of production, provenance and distinctive quality assets of the product, when it reaches the consumer. An AAFN provides a sort of liminal space that subverts the normal experience of food shopping [13] and where a variety of information and knowledge related to agriculture, rural economy, the environment, food production, healthy eating and consumer values, may be exchanged [14].

Nowadays, such information/knowledge exchange may be supported by new types of services based on recent technology developments. In particular, mobile services can provide information offerings regardless of temporal and spatial constraints, in an AAFN, they make easy to share detailed agrifood and agrifood source information, bringing AAFN people closer to each other. On one hand, agrifood producers can give consumers insight into sourcing and production methods, monitor their customer base, and make transparency a competitive advantage; on the other hand, consumers may be empowered with more timely and accurate information to make better buying decisions based on their personal values. In essence, the use of mobile services may contribute to the growth of AAFNs through supporting grass-roots and up approaches aimed to connect local citizens, restaurants, and produce distributors directly to the local farmers in their communities.

In this paper, we propose an AAFN mobile service analysis framework for eliciting key components that concur to generate value for AAFN people. In our opinion, such a framework constitutes a valid basis to develop an evaluation model of AAFN mobile information services under a user-centric perspective. Its applicability is

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primary processed products that are consumed in the original state, as they are produced with no value additions being made, or are processed and refined as little as possible, before being consumed;

secondary processed products that require basic level of processing (grading, sorting, cleaning, cutting, etc.) before they are consumed;

tertiary processed products that result in the output being in a different form, shape and with a higher value as compared to the original production.

showed by presenting some results obtained from an analysis of different types of case studies referring to the use of mobile services in real-world AAFNs.

2 AAFN Mobile Information Services

The term mobile service is used to describe all services that can be used independently of temporal and spatial restraints, and that are accessed through a mobile handset (mobile phone, PDA, PC tablets , smartphone, etc.). They differ "from traditional interpersonal services that are delivered face-to-face, or from other types of e-services, such as wireless online services, where the service delivery is linked to a specific fixed local area network or specific location", [15]. In general, benefits of mobile services are mainly due to four factors: ubiquity, convenience, localization and personalization that differentiate mobile services from online services [16].

In an AAFN, mobile services can provide new opportunities for serving awareness and transparency needs of consumers as well as request of information of producers on their business processes. For example, they may provide farm site or agrifood product information (processing methods, provenance of the produce, agrifood physiological and health aspects, etc.) in digital format (labels, pictures, videos, geo position, and graphics) on a user's individual display or through headphones for audio content. Moreover, the integration of new technologies, such as object recognition, feature tracking, RFIDs, Near Field Communication (NFC), geotagging, and web services, in mobile devices has enabled to conceive new mobile services that enrich the relations between AAFN actors and better support their activities.

AAFN mobile services can be grouped in five major classes [17]:

Virtual Visits Services: most of them provide an interactive virtual farm tour. They aim to create an opportunity for consumers to know the countryside and to facilitate a wider understanding of the environmental, economic and social issues linked to an AAFN. Moreover, they improve consumers' confidence in offered products allowing consumers to find out how agrifood is grown and produced and discover what happens on a farm. For instance, in a virtual egg farm tour consumers can get information about where eggs come from and how hens are raised (in cages or in barns with or without access to outdoors run).

Traceability and Product Related Information Services: they deliver tailor made information (including physiological and health aspects, origin, recipes, conserving methods, etc.) according to individually determined criteria selected by a consumer [18]. Traceability data can be provided by a code. Product information can be got through scanning the related code by using a smartphone camera. For instance, these services enable consumers to read product descriptions, view photos and availability, compare prices, read recipes and access to information such as origin of the product, presence or absence of GMO, absence of pesticides, fat content, food miles, etc..

Location-Based Services and Geospatial Services: based on geotagging technology, they make searching for in season agrifood products and places where AAFN activities may occur. For instance, through GPS routing and getting turn-by-turn directions, they may enable a consumer to easily find farmers markets near his/her current location or within a state/city, and to get market information (hours/dates of operation, parking places, prices of products for sale, etc.).

Dietary and Health Services: exploiting location-based services or object recognition applications, they essentially provide a consumer with agrifood nutritional information (e.g. what vitamins a fruit or a vegetable have, and what diseases they are good at protecting against) and dietary advices (e.g. daily healthy-eating tips and how many calories, vitamins, and minerals are in a certain meal). Some of them are customized services that provide personal dietary and health advices (e.g. explanations and warnings about agrifood's nutrients and ingredients) on the base of the consumer's profile (body mass index, intolerances, special diets, alimentary restrictions, etc.).

Social Networking Services: they allow interactive learning experiences through uploading of photos, tagging of photos and presenting of feedback or recommendations. They represent a mean for consumers to get information about their past behavior, or actions of other consumers in similar positions [19]. For instance, consumers, farmers, distributors, and food producers can submit pictures of their products and add information about which farmers' market, restaurant, or grocer the agrifood is bound for; this helps people to know where agrifood comes from, who produces it, and who handles it as it travels from its source to plate.

The overall value of these mobile services is influenced by four main factors:

1. *Consumption motivation*: this factor refers to the relative importance of the learning, social and utilitarian value generated for service users. Learning value refers to intrinsic motivation that is associated with needs of experiential learning about AAFN agrifood products, people, organization, and environment [12] [20]. Social value is also referred to intrinsic motivation, but the associated needs are more communicative and relational (e.g. sharing downloaded digital content and received messages for AAFN social belongingness). The utilitarian value refers to extrinsic motivation that exists in goal directed service use and is associated with effectiveness/efficiency information needs (e.g. saving time and easily finding vendor or producer location, time table of operations, etc.) in performing a task [15].
2. *Use context criticality*: the time when and place where the service is used affect the value generated for service users. Temporal criticality points out how urgently the user needs the service. Spatial criticality indicates if the service can be used anywhere, i.e. non-location-based service, or if the service should be used at a specific AAFN place (e.g. a farm site), i.e. location based service.
3. *User's role*: this factor refers to the relative importance of the role played in the AAFN by a service user. The service can be oriented to specific AAFN roles (e.g. consumer, producer, organization operator, etc.) in order to increase the value gained by its users.
4. *Information source*: any mobile service utilizes a variety of knowledge and information sources that can be valuable in terms of their extension (or coverage), their intension (or density), and their trustworthiness. Such source qualities naturally affect the value generated by the service for its users.

The above-described factors are further expanded in the next section and have been used as the base in developing our framework for analysing mobile information services in an AAFN.

3 A Mobile Service Analysis Framework

In this section, we propose an AAFN service analysis framework for eliciting key components that concur to generate value for AAFN people. The value segmentation, introduced in the previous section and such a framework constitute a useful basis to develop an evaluation model of AAFN mobile information services under a user-centric perspective. In order to analyze the overall value generated by an AAFN mobile service, three main components are considered:

a. the human-service system interaction (HSSI);
b. the knowledge and information source (KIS);
c. the information content domain (ICD).

Such components are interrelated, as depicted in Figure 1, in the following sense:

HSSI-ICD: the information exchanged in the interaction regards some ICD elements. For instance, a mobile service may provide information about agrifood products (e.g. seasonality or shelf life) or AAFN organization culture (e.g. norms or values).

HSSI-KIS: in the interaction, some KISs are made accessible by the service system. For instance, a mobile application can make it possible to access an organizational database containing data about the sale, movement, and distribution of produce along the AAFN.

KIS-ICD: any KIS of the service system is related to a subset of ICD that constitutes its information content domain. For instance, a research center, as an AAFN external source, may be involved in service management by providing scientific knowledge that can be lately exploited by farmers to learn how to grow better quality, higher-yielding crops.

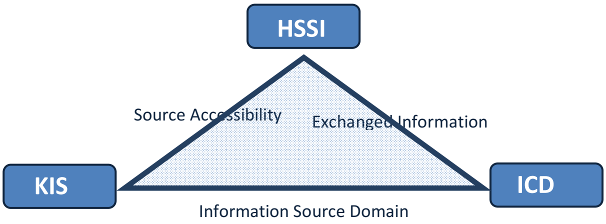

Fig. 1.

Let us discuss now the structure of each single component.

3.1 Human-Service System Interaction (HSSI)

By taking into account a user-centric perspective, we group interaction characteristics into dimensions as follows:

a.1 User's role: it specifies the role of the user in the AAFN, when acting in the interaction with the service system. Such role is typed as consumer, producer, or organization operator.

a.2 Scope: it specifies the type of motivation for the participation to AAFN activities. Participation is seen in terms of expressing and discussing ideas, developing plans, evaluating actions, and decision-making. Motivation types are social (e.g. tighter relationship with others, social belonging), ecological (e.g. lower environmental impact), economical (e.g. available income/budget impact), and personal wellbeing (e.g. physical and mental health, pleasant time).

a.3 Timing**:** it specifies the moment in the agrifood chain of the AAFN when the interaction occurs: "production", "distribution", "consumption", and "waste management" turn out to be the values along this dimension. Synchronicity and asynchronicity can be also considered in this group interaction characteristics, especially when the use situation is time critical.

a.4 Place**:** it specifies the place where the interaction occurs; this place is typed as "farm site", where the agrifood product is coming from, "agrifood terroir", i.e. the land bestowed upon the agrifood, "proximate area", i.e. an area (e.g. urban area) that is close to the agrifood terroir. Such a dimension is particular important in location-based services in which a mobile application uses the user's location interaction place.

a.5 Flow type: it specifies both the type and the direction of the information flow in the interaction; it is typed as "informational", i.e. information is only pushed from a mobile application to the user, "reporting", i.e. information is only pulled by the mobile application from the user, and "interactional", i.e. a bidirectional flow between the user and the mobile application occurs.

3.2 Knowledge and Information Source (KIS)

A service system makes use of many KISs that can be grouped in the following categories:

b.1 Participants: AAFN people (e.g. consumers, producers, FM operators, regarded as individuals) constitute KISs, since they possess interesting information and individual knowledge, independent of an organizational entity's existence, which can be exchanged in a user interaction with the service system. For instance, producers could provide information and knowledge about the farm origin of agrifood, including the environmental and social conditions of its production, as well as the cultural significance behind agrifood tied to a specific method or place of production; consumers could provide information and knowledge about taste, culinary uses and sales responsiveness of agrifood products.

b.2 Organization: any organizational entity (e.g. a consumers group, a group leader, a farmer-driven board of directors, a vendor-consumer advisory committee, a FM operator) in an AAFN is a source of organizational information and knowledge that is embedded within the behaviours that manifests in the overall AAFN organization through its culture (values, principles, norms, traditions, unwritten rules, and informal procedures), its structure (roles, relationships, and regulations that govern their use), and its business function (activities or tasks, such as planning, production, sales, performed together to obtain a defined set of results). For instance, a FM operator could provide information and knowledge about market prices and even latest agricultural practices that are essential in creating opportunities for small producers to know their economic performance.

b.3 Environment: external entities (e.g. input providers, certifying and extension agencies, NGOs, governments, financial service providers, research centers and other agrifood organizations) operating in an AAFN surrounding (socio-political, economical, bio-ecological) environments constitute a KIS. For instance, input retailers often serve as a de-facto source of expert information for small farmers who can learn about the application and use of nutrients and pesticides.

3.3 Information Content Domain (ICD)

In analyzing the component ICD, we distinguish two main dimensions:

c.1 Content exposure: it refers to what extent the ICD (or a part of it) is accessible to service users. In *public* exposure the domain is publicly accessible by anyone at any time. In *private* exposure the domain can only be accessed by a pre-selected (by a third party) group of users.

c.2 Content orientation: it refers to semantic aspects of the ICD. An ICD of an AAFN service may be related with the following categories:

c.2.1 agrifood product, i.e. content items regarding attributes (e.g. price, seasonality, varieties, taste shapes, textures and aromas of agrifood) of products exchanged in an AAFN;

c.2.2 people: content items that are useful to know a person (e.g. trustworthiness, loyalty, integrity, wishes and needs) involved in AAFN activities;

c.2.3 organization functions: content issues about activities (e.g., agricultural practices, processing methods, food preparation) at any stage (production, distribution, consumption, and waste management) of the agrifood chain in an AAFN;

c.2.4 organization structure: content items that are useful to know roles, relationships, and regulations that govern their use in an AAFN;

c.2.5 organization culture: content items that are useful to know norms, values, experiences, and history of an AAFN;

c.2.6 environment: content items regarding social, economic and natural aspects of the environment surrounding an AAFN.

4 Selected Case Studies

In order to demonstrate the applicability of our service analysis framework, we have selected and analysed 10 real world cases of AAFN services that have been considered relevant in the mobile service classes described in section 2.

For each of them, the analysis has been carried out by examining relative web sites, combining qualitative information from relative professional literature, and, when possible, downloading and using relative supporting mobile applications.

Analysis results are synthetized in Table 1, where rows correspond to mobile service classes and columns correspond to analysis dimensions (including organizational forms of an AAFN as a further dimension). Mobile service examples mentioned in the table may be placed in several classes depending on the use situation and the individual user's preferences.

Table l.

	ICD		KIS	Users Interactions					Org. Form
	Private CO	Public CO		ur	s	t	p	ft	
Virtual visits[1]	Consumers shopping list	**Agrifood products:** prices, descriptions, photos and availability; **Organizational functions:** Producers practices, hours, dates of operation **Organizational Structure:** FM map: producers at the market; Market Information: what's new at the market, hours, and parking info	Producers, FM steering committee; Other Organization	**Producers:** managing information on own profile and products **Consumers:** search information about market and products, sourced by producers	**Producers:** grow their customer base by providing detailed information to consumers. **Consumers:** shop with confidence, save time and discover new products with information sourced directly from the producers themselves	Asynchronous Distrib.	Non location based	**Informational**: from producers to consumers	FM
traceability and product related informations[2] **,**[3,4]		**Agrifood products:** descriptions, information about food provenance, source and traceability **Organizational functions:** agricultural practices; Productions methods **Organizational structure:** Producers relationships **Organization culture:** Farmers history[3]	Producers input providers Other Organization	**Producers:** managing information on own profile and expose QR-codes **Consumers:** Scan QR-codes to get information about food source;	**Producers:** grow their customer base by making traceability a competitive advantage. **Consumers:** searching for food provenance and food source	Asynchronous Prod./ distrib.	location based FM or farm site/	**Informational**: from producers to consumers	FM DoFS
location-based services [5,6,7]	GPS coupons for those in the area[6]	**Agrifood products:** fruit and vegetables in season, nearest to consumers.[5] **Organizational functions:** production methods; **Organizational structure:** FM or vendors location on map (and GPS routing)' hours/dates of operation **Organization culture:** Farmers history [6]	Government Consumers[7] Other Organization[4] Producers[6], FM steering committee[6]	**Producers:** managing information on own profile[5] **Consumers:** search information on market location and product availability; reporting information about listed AAFNs or add new one. [7]	**Producers:** providing information about places where AAFN activities may occur. **Consumers:** searching for in-season, local food by pinpointing nearest DoFSs, FMs, and CSAs	Asynchronous Distrib	location based farm site/proximate area	**interactional** from producers, or Other Organization to consumers and vice versa	CSA; BS, FM DoFS
dietary and health services [8, 9]	nutrition calculator for consumers[8]	**Agrifood products:** nutritional information, preparation guide, recipes, storing advices and pesticide information **Organizational structure:** FM where to buy organic or healthy products	Government, Research centers Other Organization	**Consumers:** search nutritional and health information food products	**Consumers:** Wellbeing: searching for health aspects related to fruits and veggies	Asynchronous Distrib/ Consump.	non location based	**Informational**: From Other Organization to consumers	FM
Social Networking services[5, 10]	:	**Agrifood products:** descriptions, photos and availability **Organizational functions:** sourcing and production methods; **organization structure:** distribution practice and places **Organizational culture:** Farmers history	Producers; AAFN operators; Consumers;	**Producers:** add pictures of their products and information about which farmers' market, restaurant, or grocer the food is bound for. **Consumers:** share details on food, pictures, and food source information with friends	**Producers:** grow their customer base, and make transparency a competitive advantage. **Consumers:** connecting directly to farms and identify where food is from and where to buy it	Synchronous/ Asynchronous Production/distribution	location based FM or farm site/proximate area	**Interactional:** in both directions from prod. to cons. and vice versa	FM, DoF

Information Content domain (ICD): Private Content Orientation (Private CO); Public Content Orientation (Public CO);
Users Interactions: users role (ur); scope (s); timing (t); place (p); flow type (ft)
Organizational Forms: Farmers' Market (FM); Direct on Farm Sale (DoFS); Community Supported Agricolture (CSA); Box Schema (BS)

Table 1. Reference urls of mobile services

1. Edibly Pike Place Market (itunes.apple.com/us/app/edibly/id553296441?mt=8)
2. shopSavvy (shopsavvy.mobi/2011/03/08/food-traceability-on-shopsavvy; top10produce.com)
3. localsqr (localsqr.com)
4. HarvestMark Food Traceability (harvestmark.com)
5. locavore (getlocavore.com)
6. Atlantic Highlands Farmer's Ma (itunes.apple.com/us/app/atlantic-highlands-farmers/id521136603?mt=8)
7. NRDC Eat Local (simplesteps.org/eat-local)
8. Smart Foods-Organic Diet Buddy (saagara.com/apps/organic-diet-buddy-app)
9. Seasonal and simple (seasonalandsimple.info)
10. foodtree (foodtree.com/you);

5 Conclusions

AAFNs can benefit of the use of mobile information services in several different ways. Under a user perspective, the overall value of a service is based on consumption motivations, use context criticalities, user's role in the AAFN, and information sources of the service. According to this value segmentation, we have proposed an analysis framework that represents a meaningful tool for both AAFN managers and service providers. Specifically, the first ones can benefit of using the framework to evaluate AAFN people reactions to specific mobile services and to understand which types of mobile service are likely to be tried and used in an AAFN. The second ones can benefit of using the framework to segment their customers, to assess critical success factors of their services from a customer-centric viewpoint, and to develop strategies to create value for AAFNs.

Real world cases of AAFN mobile services have been taken into account as exemplifications of our analysis scheme. However, because the focus is on general characteristics of mobile services, the framework can be used to explore or create new types of services for AAFNs.

Acknowledgement. This research work was supported by AGROMATER LAB, and DIRECT-FOOD, two projects funded by the EU and the Italian Government, both aimed to support marketing of typical agrifood products in Calabria (Italy).

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Interactions Patterns in NFC Interfaces for Applications and Services

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Abstract. Near Field Communication (NFC) technologies are normally used to establish radio communication between two NFC compatible devices by touching them together or bringing them together less than four centimeters. Nowadays, the interface of a large range of business and consumer applications are based on such technologies. In this paper, we propose a model to identify human-system interaction patterns that occur when NFC enabled devices are employed. Moreover, we show the applicability of such a model through an analysis of a relevant number of real world cases of applications and services which have currently arisen in many business streams. The study is aimed to categorize current NFC interfaces and to explore their underneath value.

Keywords: NFC, interaction pattern, mobile service, human-system interaction.

1 Introduction

The term "Near Field Communication" (shortly, NFC) is used to refer to a short range wireless communication technology that is derived from Radio Frequency Identification (RFID) and enables communication between two NFC enabled devices within few centimeters. It is based on an integrated circuit chip in a card, or any other form factor device. More precisely, NFC devices (e.g. a contactless card and a mobile phone) can communicate with each other when they are less than four centimeters nearby. NFC technology is usually employed to provide applications with NFC interfaces (shortly, NFC apps) that are:

- RFID compatible. They ensure interaction with existing RFID infrastructures;
- Usable. They can be easily used to make an application run, without requiring any particular technical knowledge of NFC devices (a communication starts by bringing two devices together, and it is cut by separating two devices), [1];
- Secure. Security measures can be built into NFC technology in order to establish a NFC secure channel for confidentiality, integrity and authenticity of the data transferred between devices. This would protect against eavesdropping, data corruption, data modification, and man-in-middle attacks, [2];
- Convenient. They can advantageously assist people to perform every day actions, especially in searching for information . Many useful information (e.g. location-relevant map, transport timetables, special discounted product/service offers, etc.) can be more easily accessed through an NFC interface rather than using conventional human computer interface.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 324–334, 2013.

Nowadays, NFC interfaces have been developed for a large range of business/consumer applications and services in various industry sectors. Nevertheless, many researchers continue to propose application scenarios or use cases in order to explore new opportunities of NFC apps that can generate significant business value through the provision of more accurate and timely information, [2]. However, a characterization of NFC interfaces is still needed in order to provide both a common understanding of capabilities and features of NFC apps and a support to the design, development and deployment of novel services.

In this paper, we propose a general model to identify human-system interaction patterns that occur when NFC enabled devices are employed in services and applications. The resulting classification provides definitions and distinctions that constitute a primary benefit at a general level of communication among all NFC ecosystem stakeholders. Many services that are currently available in different business sectors, exhibit the same interaction patterns and make use of NFC apps with considerably overlapping interface requirements. Another motivation of our work is to provide an aide for the interface design of NFC apps with a generic applicability.

Moreover, in order to show the applicability of our model, we present results obtained by an analysis of a relevant number of real world cases of applications and services in many target service industries (e.g. marketing, transportation, education, etc.).

2 Backgrounds

NFC is a subclass of RFID technology which uses similar working principles. NFC-enabled devices can both extract information from an RFID transponders and imitate them. NFC technology supports two main communication modes:

- the communication between two active devices, powered and equipped with data processing capability;
- the communication between active devices and passive NFC tags.

In general, when two devices interacts thru NFC, we can have three different communication configurations [2] as in Table 1.

Table 1. Communication Configurations

Device 1	Device 2	Explanation
Active	Active	The RF field is alternately generated by Device 1 and 2
Active	Passive	The RF field is generated by Device 1 only
Passive	Active	The RF field is generated by Device 2 only

In addition to the active/passive mode definition, two different roles can be played by a device in NFC interactions [2]. The role of the device which triggers the data exchange is called initiator, the role of the other device is called target. So, an active NFC device can be both initiator or target; a passive device can only work as a target.

NFC is becoming a significant rival of Bluetooth for proximity communication where a Wi-Fi connection is unavailable or not trusted. For example when two active NFC devices interact we have some advantages over Bluetooth:

- Simpler and easier gestures for communication start (touch or tap);
- Lower-latency for effective data transfer start (hundredths vs. seconds);

- NFC power consumption in active devices is significant less than Bluetooth (passive NFC tags are powerless);
- NFC technology is cheaper and less complex;
- Shorter field range ensures more security against man-in-middle attacks.

In last years, many scientific work has been devoted to study the NFC world. Scientific papers have essentially regarded four major NFC topics: theory and development, applications and services, infrastructure, ecosystem. In particular, many surveys have been proposed in order to cover a large number of implemented and prototype applications in many economic fields such as transportation, retailing, banking, security, social networking, entertainment. Most of these surveys have tried to put in strict relation NFC operation modes with benefits and future scenarios in the NFC ecosystem [3]. These typical modes are mainly identified as:

- “Reader/Writer Mode Applications”: let NFC devices to read and write content data stored in NFC passive (i.e. without battery powering) tag;
- “Card Emulation Mode Applications”: let NFC devices to act like a standard smartcard (ex: for payment and ticketing);
- “Peer-To-Peer Mode Applications”: allows two NFC devices to create a device to device connection to exchange any kind of data (ex: pictures, contacts) .

Such NFC modes are considered as “essential characteristics for examining NFC applications”, since they can provide different benefits to users and can suggest different future usage scenarios [4].

Other surveys are focused on a single business stream, like mobile contactless payments, examining advantages and obstacles of NFC technology adoption. However, all these investigations essentially adopt a designer perspective by taking into account technical features of NFC interfaces, e.g. NFC operation modes. A user-centric perspective would be more effective both in identifying common solution for common problems in human-system interactions and in explaining usability aspects of NFC apps supporting a service.

3 Interaction Patterns in NFC Interfaces

In software engineering, a pattern is generally defined as “a common solution that can be applied to a common problem in a given context” [5]. In particular, much research work has been devoted to interaction patterns in user interfaces, i.e. patterns that are focused on solutions to problems that end-users have when interacting with systems. Such studies essentially take into account a designer perspective and are aimed to improve both communication within and across software development teams (programmers, managers and end-users of a software system) and productivity of software engineers, [6]. Restricting our attention to NFC interfaces, we take into account a user perspective by focusing on those patterns that really benefit the user, and explain usability aspects of NFC apps. Of course, patterns that are identified under a user perspective are also usable for designers, but not vice versa.

In this section, we categorize NFC interface patterns according to the kind of usage problems they address in different application domains. Our categorization is based on a survey of real-world NFC applications that are described in professional and academic literature or commercial web sites.

The rationale is to specify attributes and properties of the different pattern types to facilitate their understanding and reuse. In this sense, it should be noted that the link between patterns is as important as the pattern itself: in most real world NFC applications, an interface pattern are applied in conjunction with other patterns that might be used alternatively or as complementary ones.

In [7], it is stated that "Each pattern is a three-part rule, which expresses a relation between a certain context, a problem, and a solution". Applying this concept to an NFC interface pattern, we may say that pattern attributes are:

1. the **pattern name**, or a pattern identifier, which is used to capture the meaning and intent of the pattern in a way that facilitates communication and describes the offered service.
2. the **problem**, which explains the user need to be satisfied when the user interacts with the system;
3. the **context**, which describes the situation where the pattern is relevant and when to apply the pattern;
4. the **solution**, which describes how to solve, as far as possible, the problem. The description deals with the adopted user and system NFC devices, their communication configuration and NFC operation mode;

Since an NFC basic pattern essentially concerns with the transmission of a unit of information in a human-system interaction trough an NFC protocol, we may analyze it with respect to three fundamental dimensions:

- **content entirety**: the information content may be either self-contained (SC) , i.e. it can be useful and understood if viewed alone with no other supporting data, or containing external references (ER), e.g. a link, an identification key;
- **content domain orientation**: the information content may regard either the human (H), i.e. personal data, or the system (S), i.e. system data. Personal data include data about the person interacting with the system, data about his/her interaction NFC device, or data collected for personal use. System data include data for its functioning, management, or comprehension;
- **content use side**: the unit of information generated in the NFC interaction may be either used (scanned/read/viewed/processed) at the system's side (SS), i.e. the system is the end-user, or at the human's side (HS), i.e. the human (or client) is the end-user.

According to these dimensions, we may group NFC basic interface patterns in eight classes that are described as follows:

1. Pattern **P(SC,H,SS)**

Problem: a person is required to provide his/her own personal data in a way understandable to a system's component (personnel or device) that has to make a decision or take an action depending on such information; the person should be relieved of searching for data and performing data entry;
Context: any human-system interaction where a person needs to give his/her personal data to the system through a quick one-step interaction; the person may be not familiar with the data, he/she may not know the exact required syntax, he/she is temporary unable to provide such data.

Solution: provide the person with a passive NFC tag that contains his/her own personal data readable by the system NFC active device, eventually used by the system personnel.
Example Scenarios: A user can bring a passive NFC tag (i.e. embedded in a lace or wrist band) containing basic medical information to be read in case of first medical aid when unable to communicate with medical operators (user can be unconscious or affected by a social disorder disease). Another scenario can be simply related to the need of printing a photo contained on user device directly on an NFC-enabled printer like FujiiFilm SmartPix Kiosks in UK [u20].

2. Pattern **<u>P(ER,H,SS)</u>**

Problem: a person is required to provide his/her own personal data in a way understandable to a system's component (personnel or device) that has to make a decision or take an action depending on such information; the person should be assisted in searching for data and performing data entry;
Context: any human-system interaction where a system's component (personnel or device) is required to perform an action depending on the person's data that are stored at an external source (another component at system side or third-party archive);
Solution: provide the person with an NFC tag that contains a reference to his/her own personal data stored at an external source (another component at system side or third-party archive); the reference is in a format readable by the system NFC active device that can perform a query to obtain the complete information.
Example scenarios: digital personal ID (smart ID)
Future Personal ID or passport can be issued with NFC technology, embedding an encrypted NFC tag, with owner personal information, into physical card (rubber or plastic) or directly into SIM phone card (for example [u21])

3. Pattern **<u>P(ER,S,SS)</u>**

Problem: a person should be relieved of providing the system with a complete and truthful information (license, certificate, token, permit, etc.) that is needed to be validated by the system before taking an action;
Context: any human-system interaction where the person needs to access and/or redeem a service and he/she could be provided with a reference to secure and acceptable data stored at an external source (another module at system side or third-party archive), no matter of the location of the system device charged to check it out;
Solution: provide the person with an NFC device that contain a reference to truthful information (license, certificate, token, permit, etc.) necessary to access the service; the system is in charge to get the reference and validate the license/token/certificate to let the person access to the service.
Example Scenarios: smart boarding pass: an airline company can allow members of its frequent flyer programme to use their mobile phone as their smart boarding pass. These members attach an NFC sticker to their mobile phone and this will then act as a wireless transmitter across the airport at self-service kiosks, security, fast track lanes, lounges, and gate facilities. In this way, the tags not only replace their boarding passes, but also allow them to access the priority security check, and even enter the VIP-style lounge. (see [u14]) SAS Airlines introduced a "Smart Pass" pilot program; others can be found in [u15][u19].

4. Pattern **P(SC,S,SS)**

Problem: a person should provide the system with some parameter values through a quick one-step interaction; such values are needed by the system in order to perform an action;
Context: any human-system interaction where the person needs to provide the system with setting configuration values based on situation profiles;
Solution: provide the person with an NFC tag that has been programmed to efficiently adjust a series of system settings based on situation profiles , e.g. settings based on the arrival or departure of commonly visited locations.
Example Scenarios: Auto-start timers: an NFC tag is put on a home appliance (e.g. washing machine, oven, or vacuum cleaner) so that, when tapped, it fires up a timer.

5. Pattern **P(ER,S,HS)**

Problem: a person needs to quickly get enriched information about a system entity (product, person, digital object, space area) located in a physical/virtual space; the person wants to enhance his/her comprehension of such an entity and should be assisted in searching for appropriate information;
Context: Any circumstance where enriched information of system entities are available to be accessed by a person, through using external reference to information contained in an external source (another component at system side or third-party archive); the person is not required to strive for data entry necessary to retrieve system entities information on the external source.
Solution: provide any physical entity (a system component) with a passive NFC tag that contains external references; the person is provided with an active NFC device (e.g. a mobile phone with an appropriate app) able to get the referenced content on this device.
Example Scenario: smart poster. A poster promoting some kind of new product or service, or an event, could be provided with an NFC tag; a person could touch his/ her device against the tag embedded in the poster, and he/she will receive the URL for a web site containing further information [p1].

6. Pattern **P(SC,S,HS)**

Problem: a person needs to quickly get enriched information about a system entity (product, person, digital object, space area) located in a physical/virtual space; the person wants to enhance his/her comprehension of such an entity and should be relieved of searching for information;
Context: Any circumstance where several physical entities are presented and arranged spatially on a limited area. A non-expert person needs to perform an infrequent task consisting of getting entity few basic information about a physical entity (or physical objects grouped conceptually), by a simple action (touch/tap);
Solution: provide any physical entity (a system component) with a passive NFC tag and the person with an active NFC device (e.g. a mobile phone with an appropriate app) able to read and display the tag information on it (such device can be owned by the user or system can make it available to the user); the tag information may regard location or content information about the physical entity;

Example Scenario: In a store, merchant can embed an NFC passive tag on products, containing valuable ready-to-use information; any user can read the content of the product tag by using a NFC-enabled phone.
Another scenario can be outfitted for visual impaired people, sticking an NFC tag on "everyday " objects, including food products, to aid them to get memo- text ready to be synthetized by specific TTS-enabled app. The user can even record him/herself the memo-text using speech-recognition app (ASR) to transform speech to text before writing it in NFC tag [p5].

7. Pattern **P(SC,H, HS)**

Problem: a person should provide its own device with some parameter values in a quick one-step interaction in order to let it perform a frequent preferred task in a certain location;
Context: Any circumstance where the person needs to provide its own device with preferred settings configuration values depending on the location where he/she is;
Solution: provide a physical entity in the person's environment with a passive NFC tag and the person with an active NFC device (e.g. a mobile phone with an appropriate app) able to interact with system components; the tag information may regard location or content information about the physical entity;
Example Scenario: At home, an NFC tag can be put near the door and can be settled to do things like: enable Wi-Fi, decrease brightness, disable Bluetooth, and auto-sync. The tag has been previously programmed (e.g. by using NFC Task Launcher [u24]) to "switch," so that when the person exits his/her house and taps the tag for the second time, it changes those settings (ex: enabling Bluetooth for in-car use)

8. Pattern **P(ER,H, HS)**

Problem: a person needs to quickly get personal information (text, audio, images, video) stored on his/her own device; the person should be assisted or relieved of searching such information;
Context: any situation where a person in a certain place frequently needs to know the location of a file on his/her own device;
Solution: provide user with a set of NFC passive tag (i.e. stickers) to be formatted and written by the user him/herself with reference to personal information on his/her device; the user can later read the NFC tag to retrieve referred content.; user can use his/her personal device (smartphone) for both write and read the NFC tag via a specific app.
Example Scenario: Getting shortcuts to specific personal notes: an NFC tag can be programmed to link directly to specific notes on an NFC mobile phone. For instance, a tag can be put on a desk so that when tapped, it opens a to-do list (or a checked-in contacts view) on the mobile phone, or it can be placed near a tech product so that when tapped, it links to a note with personal remarks on how to use it [u22].

4 Selected Case Studies

Since June 2006, when the NFC standardized technology architecture has been introduced, higher-volume NFC deployments have become common in many devices (mobile handsets, PCs, set-top boxes, cameras, printers, cash machines, posters, street signs, bus stops, parking meters, door openers, and product packaging). This has pushed software developers to conceive and implement a lot of NFC-enabled applications that, currently support several hundreds of NFC services in different business areas. In order to demonstrate the applicability of our classification model, we have selected and analyzed 26 real world cases of services and projects that have been considered relevant in main target industries (transport, hospitality, banking, retail, medical, logistic, educational, office automation, government, and amusement). For each of them, we have identified the underneath NFC-enabled application and patterns that occur in a human-system interaction mediated by NFC devices to execute a service function. Results obtained from the analysis of these case studies are reported in Table 2, where we have deliberately omit technical features (NFC embedded modules, external peripheral devices, etc.) not useful to our purpose.

Table 2. Case-studies results

Service provider/ref	**Target Industry**	**Business Stream**	**Solution Description/status**	**Pattern identifier/Service Function**	
VingCard [u1]	Hospitality	Reception Mgmt	Hotel guests use NFC-enabled phones as guestroom keys. CA	P(ER,S,SS)	Door Unlocking
KIX– Cityzi [u2]	Banking	Mobile Payments	Suite of mobile banking and payments service with NFC-enables mobile phones. CA	P(ER,S,SS)	Payment Credentials Sending
				P(SC,S,HS)	Transaction Result Response
Hointer Store [u3]	Retail	Customer Mgmt	Customers can shop (try on and pick a size) using the app on their smartphone. Their selection automatically drop the item in the changing room from a robot-operated stockroom. CA	P(ER,S,HS)	Product Info Collecting
Take-a-Bag [u4]	Logistics Sys.	Lost Baggage Finding	Solution for tracking of lost baggage with NFC-enabled devices. CA	P(ER,H,HS)	Baggage Code Collecting
6Starz [u5]	Retail	Coupon System	Users check-in at a location, make friends online, collect&redeem coupons received from venue owners. CA	P(ER,H,SS)	User Info Sending
				P(ER,S,HS)	Coupon Codes Collecting
				P(ER,S,SS)	Coupon Codes Sending (redeem)
Fitbit Flex [u6]	Medical	Health Record Mgmt Sys	User can access his/her fitness stats using a wristband and NFC-enabled phone. CA	P(SC,H,HS)	Read Personal Fitness Data

Table 2. (*continued*)

ICA to Go [u7]	Retail	Coupon Sys.	Users can get coupons for every lunch purchased and then redeem free lunches in their loyalty "card" program. CA	P(ER,S,HS)	Coupon Codes Collecting
				P(ER,S,SS)	Coupon Codes Sending (redeem)
Poken [u8]	Office Solutions	CRM Sys.	People collect digital content from smart tags, and exchange each other's contact information with special NFC-tokens. CA	P(ER,H,HS)	Collect Poken user ID
X-Rays [u9]	Medical	Health Record Mgmt Sys	Medical practitioners can acquire images access rights from a digital X-ray camera and can relate them to patient records. EP	P(SC,H, HS)	Get access params to sync with x-ray cam
PaybyPhone [u10]	Logistics Sys.	Parking	Users can buy parking time. NFC can get parking zone ID. CA	P(SC,S,HS)	Get parking zone ID
AIT Lab [p2]	Medical	Glucose Meter	Operator/user can transfer results from blood-glucose meter to a smartphone or NFC-enabled device. EP	P(SC,S,HS)	Get medical parameters
Ticket Rest. [u11]	Medical	Mobile Payments	User can redeem coupons for food vouchers using NFC-enabled mobile phones. EP	P(ER,S,SS)	Coupon Codes Sending (redeem)
FIAT E- Key [u12]	Logistics Systems	e-Key	Users can unlock drive hi/hers car by tapping with NFC-Device mobile phones on the windshield. EP	P(ER,H,SS)	Car Door Unlocking and Engine Start
Smart Posters [p1]	Education	Access digital content	Users can get info about staff and resources at University from smart posters located in a building. EP	P(ER,S,HS)	Collect references to enhanced content
idOnDemand [u13]	Office Solutions	Access Control Sys	User can authenticate him/herself to access to organisation's private information and services from mobile devices. CA	P(ER,H,SS)	Send reference to personal user data
SAS Smart Pass [u14]	Logistics Systems	Access Control Sys	Members of frequent flyer program can use their NFC-enabled mobile phone as their SAS Smart Pass. EP	P(ER,S,SS)	Send token/id to be verified by the sys.

Table 2. (*continued*)

ATM [u15]	Logistics Systems	Ticketing	Users can obliterate their tickets by tapping with NFC-phones on a system NFC-device placed at the station or train. EP	P(ER,S,SS)	Send token verified by the system
				P(SC,S,HS)	Transaction Result Response
NFC Lab [p3]	Government	Mobile Voting	User can select candidate to be voted, touching NFC tag with their NFC-enabled mobile phones. EP	P(ER,S,HS)	Get Candidate Reference ID
Bike Id [u16]	Logistics Systems	Tracking Lost Bike	Users can get a certificate of ownership of the bicycle and set an alarm notification against the bike theft. CA	P(ER,H,SS)	Get Bike Code
D-MTEC [p4]	Office Solutions	Product Mgmt Sys.	Shop assistants can check availability and stock information of products from the Point of Sale (PoS). EP	P(ER,S,SS)	Get Product Code
RMV HandyTicket [u17]	Logistics Systems	Ticketing	User can buy train ticket using a NFC-enabled device phone. CA	P(ER,S,SS)	Payment Credentials Sending
				P(ER,S,HS)	Transaction Result Response
Turin Visual Impaired [p5]	Medical	NFC for visually impaired	Visually impaired people can get contextual/direction info from NFC-tags in a multi-path environment. EP	P(SC,S,HS)	Get Contextual Info
Grab & Go [u18]	Office Solutions	Product Mgmt Sys.	Users can view and select products from a screen and transfer items to their mobile device for later review or purchase. EP	P(ER,S,HS)	Collect Products Code
NFC Toys [u19]	Amusement	NFC-embedded Game	Toys are equipped with NFC in order to interact with WII U console gaming. CA	P(ER,S,SS)	Send character id to gaming console
FujiFilm kiosks [u20]	Office	Printer Output NFC R/W	Consumers can NFC transfer pics, from phone to the kiosk, in order to print them. CA	P(SC,H,SS)	Send picture to the sys.
UAE/Etisalat [u21]	Government	Access Control System	Citizens are provided with a national ID card embedded into NFC-enabled phones. CA	P(ER,H,SS)	Send reference to personal user data

Legenda for Table 2: **CA**: Commercially available; **EP**: Experimental Project.

5 Conclusions and Future Work

The rationale of our investigation was to identify human-system interaction patterns (mediated by NFC devices) in services and applications. In our opinion, these patterns constitute a base to classify NFC services that are currently available in different business sectors, providing a primary benefit at a general level of communication among all NFC ecosystem stakeholders. Moreover, they can be used in most cases as an aid to design appropriate NFC interfaces to apps supporting services. In order to test the applicability of our model, we have selected and analyzed a set of real world cases of services and projects that have been considered relevant in main target industries. In future works, we plan to apply the model for the analysis of NFC interfaces of mobile services in agrifood systems [8] [9].

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Url references [u_] and paper references [p_], reported in the paper, can be retrieved at http://giuda.deis.unical.it/prove13/paper57/urlref.html

Modeling Service Life Cycles within Product Life Cycles

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Abstract. The delivery of product-related services is already a necessary commodity for most goods-producing enterprises [1]. These product-related services are regarded as necessary attachment to successful production of goods. Product and service management include different methods and tools that cover the whole lifecycle [2]. Information systems such as Product-Lifecycle Management/Product-Data-Management (PLM/PDM) systems help to support and implement these methods with the aim to raise efficiency and quality at affordable costs. However, there is a gap in modeling product-related services, with the aim to support the development and management of services. These services increasingly become a vital part for many companies, yet are often neglected. The objective of our paper is to reduce problems with product-related services focusing on the modeling of services and their lifecycles in companionship with the lifecycle of the products they support. It can help to solve problems such as fitting cost estimation, matters of quality control and communication in-house or with the customer. Therefore, modeling approaches of service engineering need to find their implementation in PLM/PDM systems, in the way, that the interrelationships between product and service (e.g. a maintenance service for a certain sold machine) can be accounted for. Our work derives from case study work realized in the field of engineering. Therefore, as result, we are able to show exemplarily how this model can be integrated in an existing PLM system [3].

Keywords: product-related services, service modeling, Service-Lifecycle Management.

1 Introduction, Purpose and Scope

To avoid stagnation in the goods-producing industrial sector, which is in many cases characterized through lower pricing margins and a high competitive pressure, successful producers of industrial goods have to look for new ways to sell. They often find a solution in offering hybrid solutions as an integrated bundle of services and material goods [4][5].

In order to provide hybrid solutions, producers of industrial goods have to focus to a greater extend on enhancing their product portfolio with services and bundle them in an appropriate matter to differentiate from competitors, raise customer satisfaction and achieve monetary advantages [5] [6].

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Services, which supplement a tangible good, will affect different product lifecycle stages or the whole lifecycle of the material good / product. For example, a producer of special machinery combines his products with services like consulting services, training services, maintenance as well as refurbishing / retrofitting and recycling. These services have to be taken into account during the entire product lifecycle, for example a better maintainability has to be taken into account while the product-planning phase to improve the service maintenance. Hence, if a company wants to manage these services and the service-enhanced products successfully, we need to understand how services and tangible goods can be combined taking into account their lifecycles. Based on a theoretical description, we present a way to model services and their lifecycles in the context of a tangible good and its entire lifecycle. Our purpose is the description of the linkages between tangible goods and services beyond their lifecycles in a theoretical – more general – way.

We premised our work on a case study work realized in the field of engineering, especially in the special machinery domain. The scope of our work is limited to the domain of industrial goods, characterized through high customized material goods and services, intensive information exchange with the customer, low production volumes as well as high technology know-how.

2 Problem and Aim

"The traditional boundary between manufacturing and services is fast becoming obsolete. Manufacturing has traditionally meant the production of tangible goods, but for today's customers it is the bundling together of the tangible object with an array of intangible services that makes for the most desirable, 'service-enhanced product'"[7]. In summary, we need to manage tangible objects and intangible services to be successful, yet most companies neglect these services and don't take them into account like they do for tangible goods. This phenomenon is called "servitization" and was firstly introduced by Vandermerwe and Rada [8] 1988, and it's still an important topic in research and practice [9][10][11], even if the existence is not as new as it seems to be[1]. Servitization means "[t]he emergence of product-based services which blur the distinction between manufacturing and traditional service sector activities" [12].

On the other hand, there are different tools and methods used to manage products and services over entire lifecycles [2]. For the support of such methods, information systems like a PLM/PDM are often utilized and implemented. These PLM/PDM systems are primarily designed to manage tangible goods, supporting BOMs (Bill of Materials), traditional supply chains as well as supporting tools like CAD among others. In this way the information system solutions for tangible goods are sophisticated. These systems can raise efficiency and quality at affordable costs.

However, there is a need for further research on product-related services, which are premature in PLM/PDM systems. Services are not only practically neglected, but also are not accounted for in the relevant information systems, which should support them. Tools for services are often isolated applications without integration in PDM/PLM

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[1] "'servitization' […] has antecedents that stretch back 150 years" [13].

solutions. Moreover, we need to rethink the modeling of PDM/PLM systems in a way that we can use them for services, especially for product-related services as well as for tangible goods. Therefore, the special characteristics of services need to be taken into account (like intangibility, perishable, inseparability and simultaneity [14]).

So far, we described the importance of product-related services for good producing enterprises. In a nutshell: services become a vital part for many enterprises and our objective is to reduce problems with product-related services.

In order to reduce these problems we need:

- a theoretical framework for the linkages between products and product-related services which take their lifecycles into account
- a model for this framework

Both, the theoretical approach and the resulting model will be essential parts of our paper. We will especially focus on the modeling of services and their lifecycles within a product lifecycle. Modeling product-related services helps to implement methods and tools into traditional tangible good based approaches. In that way we can solve problems for services like fitting cost estimation, matters of quality control and communication in-house or with the customer.

In order to archive our objectives, we formulate research questions. The following research questions will be answered within the scope of this work:

- How can product-related services be integrated in a Product-Lifecycle Management approach?
- How can product-related services be modeled for PLM/PDM systems?

3 Product-Service-Lifecycle Approach

Before modeling product-related services in a technical way, a theoretical framework for product-related services is needed. For the purpose of this paper we will name this framework the Product-Service-Lifecycle approach. Product-related services are understood as services performed in a product lifecycle, but having their own lifecycle as well (see Fig 1.)[15].

Both research objects – products and services – lifecycles contain different phases. For the object "product" the following phases can be classified: requirements, product planning, development, process planning, production, operation and recycling. For the research object "service" the following phases can be defined: definition, requirements, conception, realization, operational usage and change [16]. In every stage of the product lifecycle we identified different services, which have their own lifecycles. The different service and product lifecycles do not run synchronically. For example a service like a *customer consulting for product planning* is realized and operationally used in the product planning phase of the product. But a service like *maintenance* should be defined and designed in the requirements and product planning phase, and executed in the product's operational phase. Following the presented framework, we need to model product-related services in a PDM/PLM system.

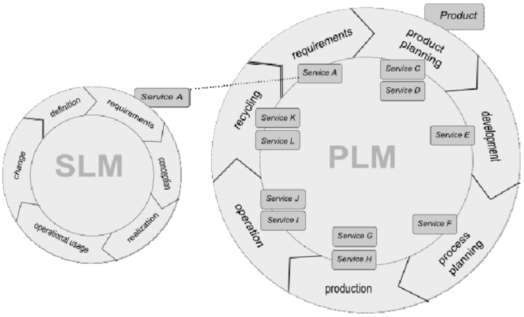

Fig. 1. Product-Service-Lifecycle

This approach is close to other scientific researches, namely the research on PSS (Product-Service Systems)[2] and the domain specific research on IPS² (Industrial Product-Service-Systems). PSS as well as IPS² have one lifecycle [17] [18] with different stages where PSS or IPS² service and product components are defined, planed and realized. The main target is to support the offering of product-service-bundle as one customer specific solution. Mainly, the design and modeling approaches focus on PSS or IPS² components [19] as new types of objects. In this paper, services and products have different lifecycles, which can be integrated and interlinked.

4 Model of Product-Related Services

Our modeling approach is use-case drive. Therefore, after a criteria-based evaluation we choose the Aras Innovator [3] for our approach. So, the Aras Innovator is our use case to show, how services and tangible goods can be modeled. Firstly, we introduce the product model of the Aras Innovator. Secondly we model product-related services and thirdly we combine it with the product model.

Tangible Goods

In Aras Innovator products – tangible goods – are mapped as a hierarchical product model. Thereby products are realized product models, which in turn are composed of product components ("parts"). Single components can represent different component types (e.g. "assembly"). Different component types have different connections to other item types[3] (e.g. the type "assembly" has a BOM[4] and a type "material" has no BOM). The product model as presented is component based, because the products consist of single clearly defined (modular) components with standardized interfaces [20]. The described model is visualized in figure 2. This schema can be visualized in a more standardized way, as an UML (Unified Modeling Language), as follows (Fig. 3).

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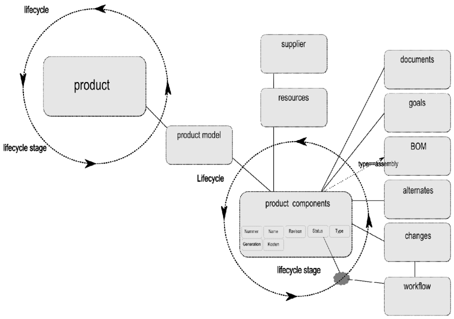
[2] PSS is defined as a realized value proposition, with the help of PSS-tangible components and/or software and/or processes and/or PSS-intangible components [18].

[3] An Item type is the base object in Aras Innovator.

[4] Bill of Materials.



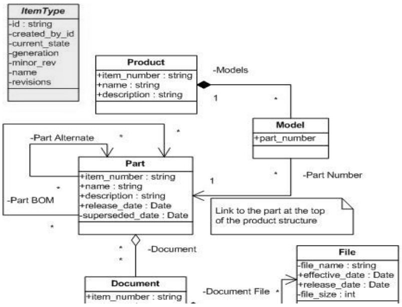


Fig. 2. Product model

Fig. 3. Product part UML [21]

Here we can see that a product has models, and a model is exactly one unit. These units can be single parts, complex parts or fully functioning machines. Thus, different parts can be reused in different products resulting in a modular product model.

Intangible Services

The described product model architecture is potentially able to be combined with service models. Therefore, we need a model for services (see Fig. 4).

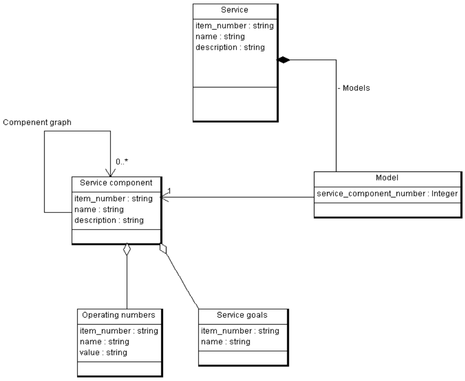


Fig. 4. Service components

The modularity guaranties the ability to join services to products. Services, in general, can be modularized, so services can be represented as components.

It can be seen, that the entity services includes service components, and service components can be linked with itself – service components. Thus, a service component tree is developed (see fig. 4).

It constitutes a simplified model of services, but presents the modularization, which allows integrating service modules in the PLM/PDM solution, namely the Aras Innovator. Integrating services allows us to use other Aras Innovator components like the lifecycle concept, the document management and the workflow engine.

Product-Related Services

In order to use the PLM-solution for hybrid products, both models have to be integrated. Therefore, we have implemented such an integration within the ARAS Innovator PLM systems. Firstly we visualize the integration of the models (see fig. 5).

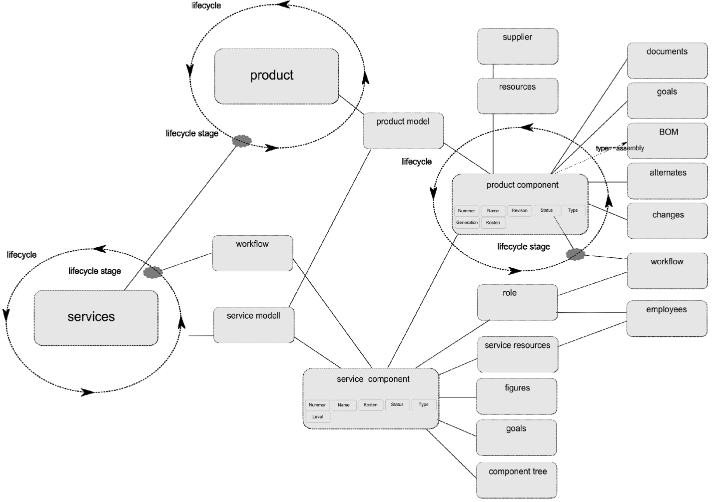


Fig. 5. Model of integrated services and products

Derived from our theoretical framework product-related services were modeled as services in single lifecycle stages of the product. These services have service components, which can be connected with product components, service goals and so on (see figure 5). Secondly, in a more formal way, it can again be visualized with UML as shown in figure 6.

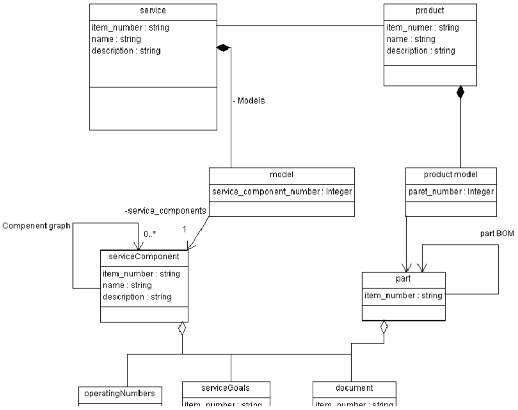


Fig. 6. UML product-related services

As result, we have exemplarily shown how our service model can be integrated in an existing PLM/PDM system in consideration of the different lifecycle concepts. Only a small part of the integration has been described, focusing on the linkage between services, service components, products and product components. It has been done as presented, because it's the basic requirement for a more complex model of service-enhanced products. Based on our use-case we showed a potential integration of services in a Product-Lifecycle Management approach. Furthermore, we modeled product-related services. In conclusion we could find answers for our research questions with the help of the selected case-study approach.

5 Perspective and Further Work

The presented model helps to integrate and manage services in PDM/PLM systems in general. This integration is one main step to enable computer-aided support of servitization in the direction of Product-Service Systems. With PDM/PLM systems extended according to the developed model, companies receive IT-Tools to create and manage the service and product portfolio for internal and external (customer) usage.

We identified two further steps that need to be taken, in order to model product-related services. On the one hand, our work has to be more generalized in order to use the framework and the model for further domains and applications. On the other hand, we are working on a full practical integration in a prototype to evaluate the benefit for enterprises with service-enhanced products. Therefore, we currently integrate service tools, like the service modeler [22], in the Aras Innovator. Furthermore, we will use the presented implementation for prototypical supporting a spare parts supply service in high technology special machinery domain.

In the future, the focus on tangible goods will be changed in a more general way and the supporting applications will include service and product lifecycle models. We are confident that this work can contribute to this path of development.

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Services II

Service-Oriented Approach Supporting Dynamic Manufacturing Networks Operations

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Abstract. In the current economic crisis, also the manufacturing sector is asked to evolve towards more dynamic organizational structures within which, composing manufacturing processes, almost in real time, will become a need. This work aims at introducing flexibility and dynamisms to current manufacturing processes by separating its tasks from its final performers. With the proposed approach, the performers' replacement can be done almost seamlessly. Additionally, the approach shows how dynamic negotiation and contracting, either for a whole process or a single activity, can be smoother if the task specification is based on a standard service interface defined at the ecosystem level. At the end, a prototype implementation is briefly described.

Keywords: Dynamic Manufacturing Networks, Service-Orientation, Cross-organizational Process Management.

1 Introduction

In terms of collaboration and dynamism, traditional manufacturing networks have been mostly characterized by stable and permanent relationships among its members. Changes in the network structure were not easy to find and a tight coupling between a required task and the expected performer was a predominant model.

However, perspectives on current economic situation require a more agile assembly, disassembly and re-assembly of manufacturing networks, by combining a set of specific capabilities being offered to third parties, almost 'on the fly'. New mechanisms for setting up and running more efficient and responsive organizational structures are needed. Focused on how to better synchronize their networked operations, these new organizational structures would also be able to provide:

- **Enhanced Organizational Permeability:** That is to make available more efficient mechanisms for dynamic partners' selection, almost 'on the fly'.
- **Extend the Potential Performers' Base:** Opening the networks to a higher potential number of members. For SMEs, a source of business opportunities.
- **"Plug & Play" Business Interfaces:** Understanding a business interface as the operational linkage that enables the connection of a company to an existing network, the design and implementation of such interfaces is aimed at being focused on interoperability for achieving greater flexibility.

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Based on these requirements, this work proposes an approach aimed at supporting the operations of Dynamic Manufacturing Networks (DNM). Such dynamism is expected to be achieved by selecting business partners and contracting their services at runtime, as a way of realizing the manufacturing process executions.

Thus, traditional modeling and execution of manufacturing processes is complemented with a service-oriented architecture design (SOA).

The rest of the paper is structured as follows: Section 2 introduces some background concepts which are used to assemble the proposal. Section 3 provides an insight on DNM, their context, operational requirements and the application of the Service Entities approach for process modeling and execution. Sections 4 and 5 briefly introduce the architecture and implementation of a software prototype.

2 Related Concepts

The overall framework inside which this work is developed, takes advantage of the synergies already described in the literature between Open Ecosystems [1], as manifestations of Virtual Organizations Breeding Environments (VBE) [2], [8], [9], [10], and Collaborative Networked Organizations (CNO) [2]. More specifically, this work may be considered a particularization of the framework proposed in [3].

Besides there exist several perspectives from which such synergies can be described, to the end of this work, authors have focused on the operational one, paying special attention to the role played by cross-organizational business processes and the performers of tasks as in [4] and [5].

In second place, this work adopts the *Switching Principle* introduced by Mowshowitz [6] who considers that it lies at the heart of the management of dynamic virtual organizations. According to the author, its main considerations are:

> *"Logical separation of need from need-fulfillment is the foundation of virtual organization. If a task or activity is managed by treating need and need-fulfillment independently, it is possible to think about switching or changing the assignment of need-fulfillment to need in a systematic way…"*

Finally, this work also explores the role of Service Oriented Architecture (SOA) in supporting the design of interoperable business interfaces, being able to realize the switching principle application. The Service Entities approach [7] is also used as main enabler of the whole architecture.

3 Dynamic Manufacturing Processes

Next sections will describe a proposal to provide dynamic features to traditional manufacturing processes. Such dynamism will be guided by the above described *Switching Principle* and it is expected those processes can be more flexible at both modeling and execution stages.

3.1 Manufacturing Ecosystems and Industrial Manufacturing Networks

This work focuses on a particular type of VBE manifestation, related to manufacturing activities called Manufacturing or Industrial Ecosystems [11].

Ecosystems are populated by unique individuals that belong to one of the species existing inside it. In turn, those species can be mostly described in terms of their distinguishing attributes and behavioral features. By nature, ecosystems are open spaces where new individuals have almost no restrictions to come in or leave it.

When translated to an industrial context, the significance of the term can be applied to all the possible resources that can be arranged together in order to produce goods or services that some end customer is demanding for. Such resources are also unique; belong to some ‘specie’ (i.e. they have a set of distinguishing attributes and a functional profile) and they may join or leave different business environment according to their strategies. When arranged in a new organizational structure, an industrial manufacturing network is created and ready to operate.

Despite there may exist many particular species inside the manufacturing ecosystem, some originating classification of them can be made: productive resources (with transforming capabilities); warehouse resources (they store produced materials or components); and transportation resources (moving goods among nodes).

3.2 Service Entities in Manufacturing Ecosystems

In past contributions [12], [13], [14], Service Oriented Architectures (SOA) have been proposed as framework for service-centric systems development in manufacturing contexts.

Besides this work also considers SOA a fundamental construct for the proposal, the Service Entities (SE) approach is adopted. SE are used for creating service-based profiles of companies that, later on, will be part of a service ecosystem.

Two different types of SE can be identified. Abstract Service Entities (ASE) refers to generic profiles of species populating the ecosystem. Those profiles are created by defining a set of attributes common to all the individuals and a set of service interfaces which will constitute their behavioral side (functional capabilities). Concrete Service Entities will be created by instantiating ASE, by selecting the corresponding profile, valuing attributes and implementations abstract interfaces.

When applied to manufacturing ecosystems, three main types of entities can be found (see Fig. 1):

- **Productive Entities:** entities in charge of transforming raw materials or semi-finished goods into a new component or finished good. Plants, factories, assemblies, lines, cells, machines, or even robots can be considered entities in this category.

$\text{ASE}_{\textit{Productive}}$ = {“Central plant”, “Subcontractor”, …}

- **Warehouse Entities:** these entities store both finished and semi-finished products along the network. They have not transformation capabilities and may be present along the whole network. Central warehouses or retailers are examples of this kind of entities. $\text{ASE}_{\textit{Warehouse}}$ = {“Central Warehouse”, “Distribution center”, “Retailer”,…}

- **Transport Entities**: entities are in charge of moving goods from any possible combination of the two aforementioned entities. In this case, two examples may be: $ASE_{Transport}$ = {"LogisticOperator", "InternalTransport"}

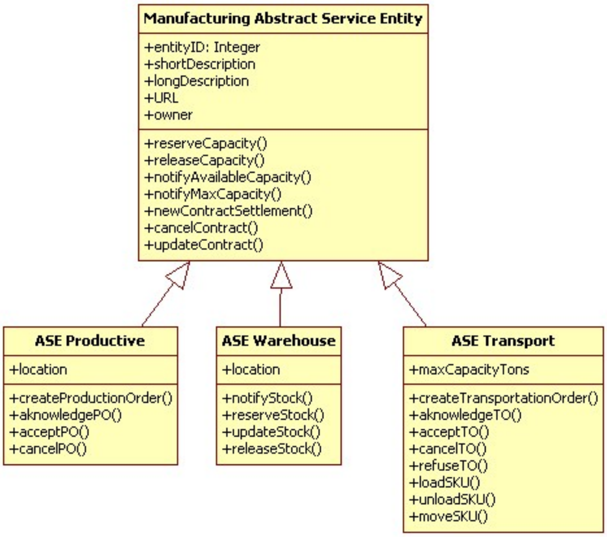


Fig. 1. Abstract Service Entities for Manufacturing Ecosystems

As previously mentioned, each ASE has a set of harmonized service interfaces, S = {s1, s2, … , sn}, which may encompass different business activities (or even whole processes). These interfaces are defined generically for the ASEs and they will be implemented for each CSE, depending on each node's requirements.

For the ASE identified above, some illustrative services may include (see Table 1):

Table 1. Service interfaces for different Manufacturing ASE

Service name	ASE		
	Productive	Warehouse	Transport
`reserveCapacity()`	•	•	•
`releaseCapacity()`	•	•	•
`notifyAvailableCapacity()`	•	•	•
`notifyMaxCapacity()`	•	•	•
`createProductionOrder()`	•		
`aknowledgeProductionOrder()`	•		
`cancelProductionOrder()`	•		
`notifyStock()`		•	
`updateStock()`		•	
`createTransportationOrder()`			•
`loadSKU()`			•
`moveSKU()`			•

The above list is not exhaustive. It must be considered as illustrative and it may vary according to specific modeling needs of each particular manufacturing ecosystem.

Service interfaces are defined by the ecosystem manager and they must be preserved when each concrete node performs their local implementations. Hence, a decoupling point is established here: all the ecosystem entities belonging to the same ASE profile will share the same set of interfaces but their local implementations will be done according to their specific needs.

Thus, ASE specifications will be acting in a similar way than, for example, a printer device driver does. A device driver provides the linkage between the physical devices and the operating system by implementing the set of functions that will be invoked when the OS needs some service from it. Each printer manufacturer performs their implementation of those functions according to each specific device.

3.3 Process Modeling with Service Entities

As it was stated in the introduction, this approach establishes a clear separation between process activities and their performers for both its modeling and execution.

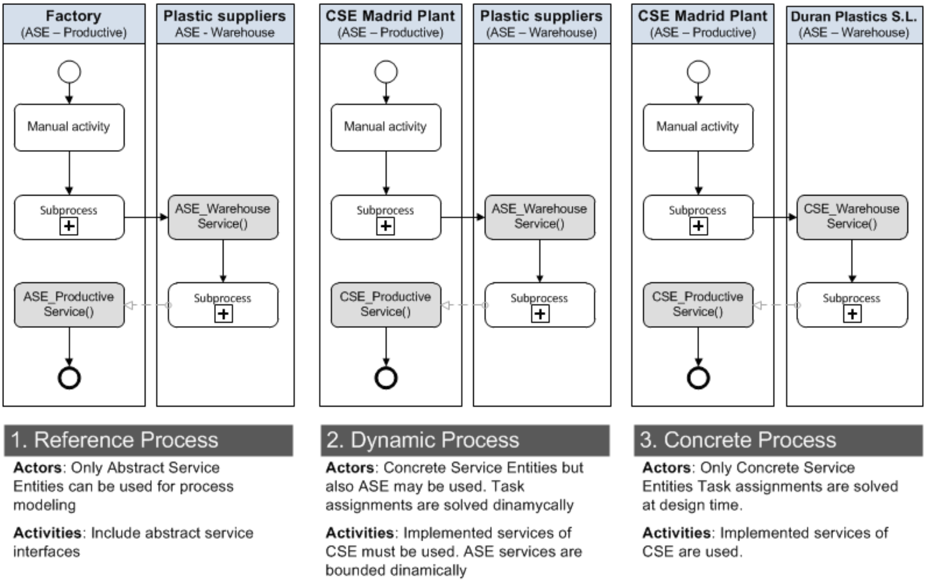
From a **structural** perspective, network dynamicity is expected to be achieved by enabling a seamless replacement among performers, in a cost-effective way. SE approach comes to support this requirement by allowing to select one performer among the whole set of CSE belonging to the same ASE profile.

The **functional** dynamism will be supported by enabling the selection of an individual performer for either a whole process or a single task for a single process instance. That means, from the SE approach, to select a CSE to carry out a process activity but only for this concrete process instance. Future instances may be assigned to another CSE sharing the same ASE profile.

Depending on the expected dynamism, the performers selection and the number of activities they will be requested to provide, three different cases are identified:

- **Static Process Contracting:** Performers are known and selected at process design time and that will be involved in all its future instances. They will carry out all the activities expected for each specific profile.
- **Dynamic Process-level Contracting:** Performers will be selected at runtime, for ‘this’ specific process instance. Dynamic process bidding will not ensure future involvements for them. They are contracted to carry out all the activities of the process instance.
- **Dynamic Service-level Contracting:** Performers that will be requested to provide a single service, for a concrete instance of a process. At different process steps (activities) they will be competing against all those similar nodes belonging to the same profile.

Next, how the SE approach can be used to support these requirements (see Fig. 2).



1. Reference Process

Actors: Only Abstract Service Entities can be used for process modeling

Activities: Include abstract service interfaces

2. Dynamic Process

Actors: Concrete Service Entities but also ASE may be used. Task assignments are solved dinamycally

Activities: Implemented services of CSE must be used. ASE services are bounded dinamically

3. Concrete Process

Actors: Only Concrete Service Entities Task assignments are solved at design time.

Activities: Implemented services of CSE are used.

Fig. 2. Different process types modeled with SE

In modeling such heterogeneity of dynamic manufacturing processes with SE, three different templates are supported:

- **Reference Process:** a reference process template is the one that is created only from ASE profiles. The process activities may include ASE services and performers are not specified.
- **Dynamic Process:** a dynamic process represents a combination of static and dynamically selected performers. Contracted performers may be asked to provide a single service or all the activities of a process. ASE interfaces will be used as task specification for negotiation, contracting and assignment.
- **Concrete Process:** this template is used to support static processes. Performers and task assignments remain unaltered at design and execution time. Process activities may include concrete service implementations.

3.4 Dynamic Manufacturing Process Models

As introduced in the previous section, SE approach provides different templates for process modeling. In Figure 3, how the Dynamic Process template is used to create a process model involving several actors is depicted.

The example illustrates how a concrete actor (Operations Planning Dept) is going to manage the incoming orders from a productive resource of its supply network. To create the process model, no additional concrete performers have been specified. Only a productive and a transport ASE profiles were introduced. The highlight (1) of the figure shows how service interfaces have been used to create the process model.

The highlight (2) of the figure introduces an additional element in dealing with the process dynamism. Since no CSE has been selected at design time, this may have to different implications, depending on each process specific requirements:

- A single performer will be decided at runtime and will provide the requested services to realize the process instance.
- At runtime, all the CSE belonging to the selected profile will be queried about, for instance, current availability of some component and further decisions will be taken based on the replies.

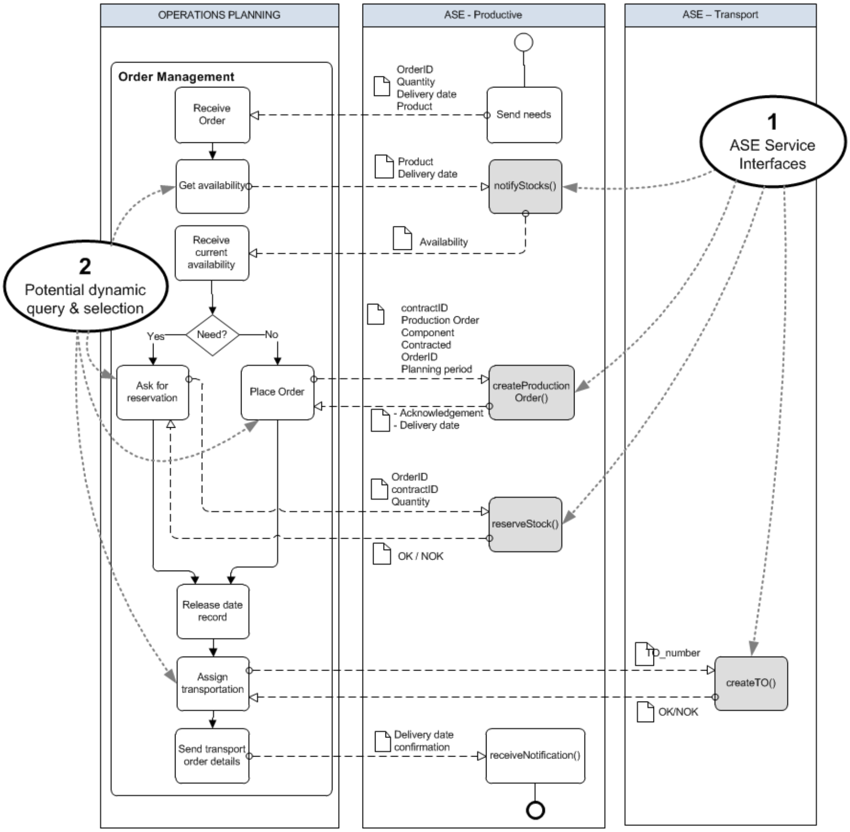


Fig. 3. Dynamic manufacturing process model including SE

4 Prototype Implementation

Next sections describe a prototype implementation of an IT platform aimed at supporting modeling and execution of dynamic manufacturing processes.

4.1 Platform Architecture

The platform architecture consists of four main modules (see Fig. 4):

- **ASE modeling** module is aimed at supporting the creation of all the different ASE profiles that will populate the manufacturing ecosystem.
- **CSE instantiation**: this module is in charge of managing the instantiation process of ASE into CSE. The ecosystem repository is fed new instances.
- **Process modeling**: this module consists of a BPMN process editor that provides manufacturing process templates as described in Section 3.2.
- **Orchestration engine**: the orchestration engine is in charge of supporting the execution of concrete process instances. The engine must include advanced negotiation capabilities and service-based business rules.

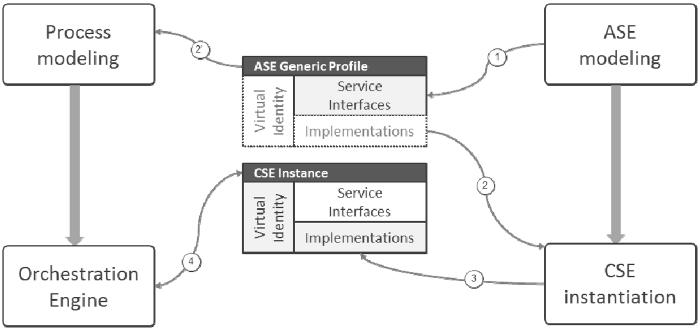


Fig. 4. Simplified architecture of the platform architecture

The functional integration of these modules aims supports the requirements of DNM. In the Figure 4 arrows schematically represent methodological steps to be followed. In (1), ASE modeling comes out with the ASE profiles which include attributes and service interfaces. Based on the ASE profiles, in (2) attributed are valued and concrete implementations of services are provided by each node. Depending on the process template, in (2') existing models of ASE and CSE can be extracted from the ecosystem repository. In (3) CSE instances become visible inside the ecosystem. From now on they can be asked to be part of a new manufacturing network or be part of an existing one, being asked to provide some specific service of their profiles. Finally, at runtime (4) the orchestrator engine request and consume concrete services of CSE being part of the Manufacturing Ecosystem, at that specific moment in time.

4.2 Technical Implementation

The technical implementation of the prototype has resulted in a web-based tool that exemplifies typical requirements of a manufacturing network which needs to perform its operations planning for all the network nodes.

The prototype has been developed by using .NET technologies. The programming language is VB.NET and the database supporting the implementation is PostgreSQL.

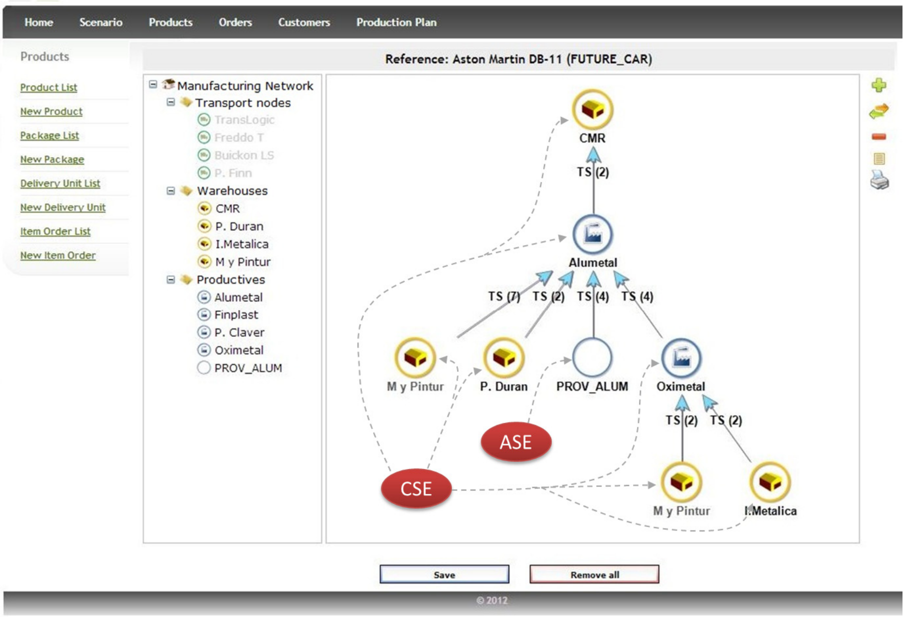


Fig. 5. Screen capture of the implemented prototype

The screenshot depicted in Fig. 5 shows a particularization done for this specific scenario that consists in creating a visual editor that combines both the product and the process structure definition.

5 Conclusions and Potential Contribution to Reindustrialization

The manufacturing sector needs more dynamic organizational structures. The approach introduced here provides flexibility and dynamisms to current manufacturing processes by separating its tasks from its final performers. With the support of a service-centric architectural approach, new requirements have been identified for future process orchestration engines.

By incorporating the SE approach for manufacturing process modeling and execution, the application of the Switching Principle of Virtual Organizations seems to be more achievable. As it has been highlighted, the performers' replacement can be done seamlessly, since the approach ensures the lowest interoperability effort. Additionally, dynamic negotiation and contracting, either for a whole process or a single activity, can be easier if the task specification is based on a standard service interface defined at the ecosystem level.

Concerning how this approach may be helpful in supporting the reindustrialization that this economic crisis is demanding from the manufacturing sector, authors believe that companies will need new approaches and tools that enable them to assemble and disassemble dynamic manufacturing networks with the lowest effort as possible.

This approach is aimed at providing a piece of the whole solution and perhaps its main contribution to solve the problem may be the permanent focus on an interoperability-based design of the whole approach.

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Managing Partnership Uncertainty for Sustainable Services: A Conceptual Model

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Abstract. The paper presents the findings of a qualitative analysis that makes use of literature to determine the nature of uncertainties that characterises industrial collaborations for providing sustainable services. It aims to propose a conceptual model of partnership uncertainty management for sustainable services. The analysis finds that managing partnerships uncertainty for sustainable services requires foci that reflect governance structure and relationships climate priorities. These priorities are life-cycle control, resource governance, capability focus and integrative operations with regards to self uncertainty, participative decisions, intervention mechanisms, idea linkage, consumption patterns, communicative structure, clear representations and relationship incentivisation in terms of relationship /behavioural uncertainty, and creativity leveraging, environmental profiling, systemic measuring and process learning as they relate to partner uncertainty. The paper concludes by highlighting research limitations and potential future research directions.

Keywords: collaborative networked organisation, sustainability, supply chains, virtual enterprise, product-services systems.

1 Introduction

Forecasts by organisations such as the United Nations suggest an increasing global population which is estimated to reach 8.9 billion by 2050 [1]. This trend underscores constraints and limitations on the availability of natural resources. The increased level of production and energy consumption due to the rising population also causes concerns due to the earth's inability to accept industrially generated waste. With this in mind, research has intensified into theories and philosophies that concomitantly deliver high quality services, efficiently apply resources, and minimise waste from production and consumption. A *sustainable service* (e.g. [2] and [3]) is an approach designed to capture this philosophy.

Sustainable services (also known as a 'sustainable product-service systems' [4] or 'eco-efficient product-service systems' [5], [6]), strategise the provision of results or functions and motivates firms to form partnerships and make decisions, under uncertainties, to creatively generate ideas that reduce the environmental impact of companies by factors between 4 and 20 [4]. These partnerships coincide and align with widely acknowledged notions that companies are increasingly competing as part

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 355–362, 2013.

of supply chains and partnerships to deliver customer solutions. In spite of this, to date, there has been limited coverage in the literature on the uncertainties that plague partnerships to provide sustainable services. This paper seeks to confront this gap.

The aim of this paper is to propose a conceptual model of partnership uncertainty management for sustainable services. Uncertainty is used in this context, as "the difference in the amount of information that is required to perform a task and the amount of information already possessed by the firm" [7]. Uncertainty is typically associated with production in collaborations such as supply chains [8] and with how sustainability policies are adopted and partners are chosen to deliver sustainable product-service mixes [9]. Consequently, the research is guided by the following research question: What is the nature of uncertainties that characterises industrial collaborations for providing sustainable services?

2 Background

In the provision of sustainable services, stakeholder participation is achieved through solution-oriented partnerships (SOPs) i.e. strategic partnerships that share common visions of delivery systems for sustainable services (e.g. [10], [11], [12] and [13]). These partnerships focus on multi-level communications and complex relationships among platform providers, other providers that are needed to complete the system, as well as intermediate- and end-users of the system. Communication and relationships among stakeholders encourages positive attitudes towards selecting products, combining products and services, and formulating regulations that promote lower environmental burden [11], [13]. SOPs – in view of uncertainties of partnerships – also fundamentally change producer-consumer relationships towards new notions of sale, ownerships and consumption in which functions are delivered and potentially leads to customer loyalty and innovation that causes behavioural and system-level changes [5], [6].

Uncertainty associated with partnerships is reflected in the variability of governance structure and climate of relationships [12], and researchers have used several terms to characterise this variability, as shown in Fig. 1. For instance, using uncertainty reduction theory, partnership uncertainty has been split into self uncertainty (individual's involvement in relationships), partner uncertainty (variance in partners involvement in a relationship), and relationship uncertainty (variance in the relationship itself) [14]. Relationship uncertainty (also termed behavioural uncertainty) refers to how adaptability partners are to specification changes at short notice and an awareness of partner's resources and goals [15]. Behavioural uncertainty, i.e. the variability of a partner's behaviour or the partner's changes in external environments, is also reflected in performance variations of partners during transactions [12]. While there is a common theme in the literature supporting the need to identify and mitigate uncertainty, these are predominantly studied in relation to manufacturing and product delivery processes [16]. In this article, current research is enhanced through the introduction of a conceptual framework that not only captures the forms of uncertainties that characterise SOPs but also identifies key factors for realising collaborations that provide sustainable services.

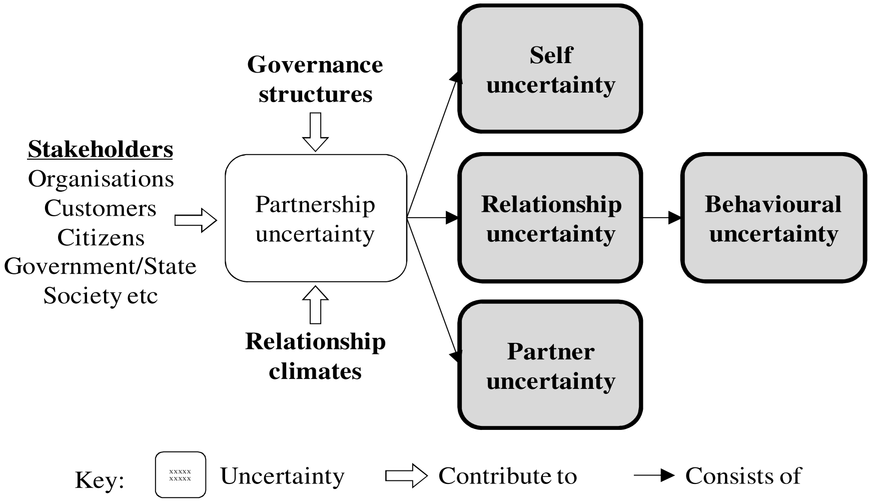

Fig. 1. Research model

3 Method

In attempt to offer insights into the nature of uncertainties that characterises industrial collaborations for providing sustainable services, this research is driven by the multi-case study logic [17] and relies on literature as secondary cases [18]. This logic was chosen because an assessment of the literature suggests limited studies to provide insights into partnership uncertainties for sustainable services. This motivation stirred the research towards case studies in an exploratory approach that captures the 'what's and 'how's of partnership uncertainty for sustainable services. Also, the use of multiple secondary sources was geared towards a holistic view with potentials to unearth uncertainties across discovery, design, development, delivery and disposal phases of service operations. Holistic in used in this context to mean connectedness among characteristics and phenomena, and is required for the integration of sustainable service elements such as goods, equipment, services, information or infrastructure. For this study, 17 research articles were selected based on a search for publications within SCOPUS, ABI/INFORM (ProQuest), Academic Search Premier (EBSCO Host), and ACM Digital Library. Selection involved an initial search and screening process using keywords: "sustainable product-service systems", "eco-efficient product-service systems", and "sustainable service".

Next, using the conceptual framework from Fig. 1, the main findings and discussions of the cases were analysed to shed light on key factors for realising collaborations that provide sustainable services and to refine the research model. This research is therefore positioned within an interpretive epistemology to make sense of partnership uncertainty for sustainable services. By applying the multiple-case logic, a range of management factors was explored and the study generalises at a level of theory as opposed to statistical representativeness or significance.

4 Findings

An analysis of the data showed several challenges faced by partnerships for sustainable service provisions, as described in Table 1. These challenges span several individual-, organisational- and institutional-levels of concern and range from human-related questions on the consumption patterns of consumers (e.g. [19] and [20]) to innovation-related problems of diffusion and idea generation (e.g. [4], [6] and [21]).

Table 1. Salient partnership uncertainty challenges for providing sustainable services

Case	Challenges for sustainable service partnerships
Halme, Jasch and Scharp [2]	Governance of resources to ease service accessibility
Heiskanen and Jalas [3]	Trajectory of eco-efficient service to establish necessary intervention mechanisms and to improve design practices
Roy [4]	Radical process ideas to consolidate waste reduction practices
Manzini and Vezzoli [5]	The development of business ideas that link sustainability to structural and behavioural changes
Ceschin [6]	Socio-technical experiments and societal embedding process for which actor networks, project visions and learning processes are critical factors for the diffusion of system innovation
Mont [9]	Readiness to adopt and accept sustainable service strategies
Krucken and Meroni [10]	Pro-active and participative attitude for customer solutions
Vogtländer, Bijma and Brezet [11]	Availability and use of information by stakeholders to make decisions.
Evans, Partidário and Lambert [13]	Realising solutions that incentivise organisations to be sustainable
Tukker [19]	Incentives for stakeholders to be sustainable
Briceno and Stagl [20]	Alternate consumptions patterns that reflect social strategies
Anttonen [21]	Management to integrate innovation and environmental policies
Maxwell, Sheate and van der Vorst [22]	Targeting companies for effective management of supply chains
Mont [23]	Consumption behaviour mainly in terms of institutional factors
Hu, Chen, Hsu, Wang, and Wu [24]	Overcoming barriers to implementing new business models
Geum and Park [25]	Clear representations for effective sustainable service design
Lee, Geum, Lee and Park [26]	Systematic approach to measuring sustainability

Based on the research model in Fig. 1 and findings from the case studies, a conceptual model of partnership uncertainty management was developed, as illustrated in Fig. 2. The figure attempts to map the various management factors (4 for self uncertainty, 7 for relationship /behavioural uncertainty, and 4 for partner uncertainty) analysed from the cases according to governance structure and relationships climate management priorities. These next sub-sections present the findings from the analysis under three headings that correspond to the main concepts from the research model in Fig. 1.

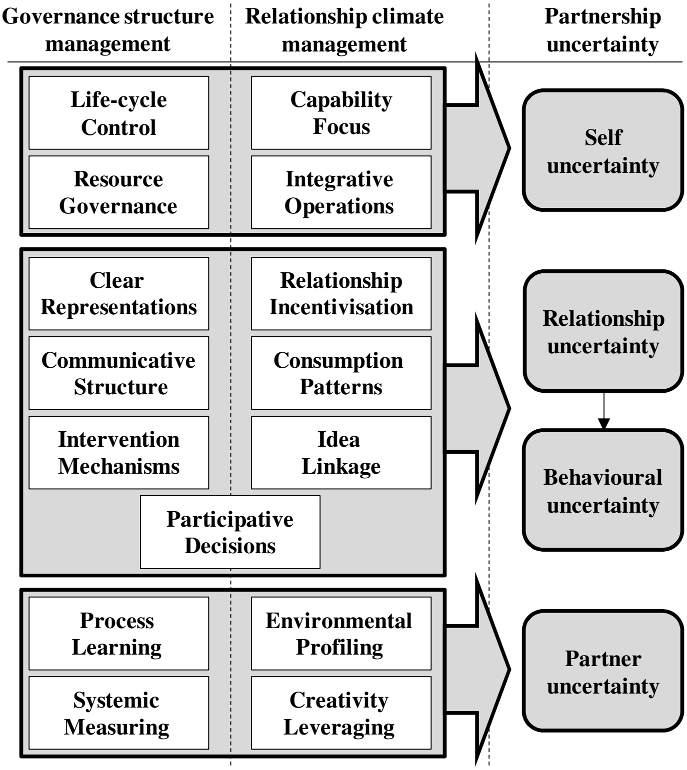

Fig. 2. The management factors model of partnership uncertainty for sustainable services.

4.1 Self Uncertainty

Self uncertainty in the cases was reflected in four main management factors: life cycle control, resource governance, capability focus and integrative operations. *Life-cycle control* is motivated by the need to target companies for the effective management of supply chains for sustainable services. It challenges firms to maintain levels of control (irrespective of size) over key life cycle stages. *Resource governance* stems from challenges for maintaining effective governance of resources. This factor enables and enhances how stakeholder access services but also heightens the need for institutional arrangements to deliver services directed to households. *Capability focus* recognises the need to overcome barriers to implementing new business models and stresses the importance of organisational factors relating to management capability and external factors. *Integrative operations* concentrate on orientations that combine innovation and environmental policies to create service profiles.

4.2 Relationship and Behavioural Uncertainty

Seven main management factors were extracted from the cases relating to relationship and behavioural uncertainty. The first, *participative decisions*, is concerned with how information is made available and used by stakeholders to make decisions. In this regard, stakeholder (consumers, business managers and governmental representatives) participation to influence eco-efficiency decisions is crucial. The second, *intervention mechanisms*, is motivated by potential variations in the trajectory of providing eco-efficient service and the influence of company activities on stakeholders. This makes it necessary for interventions, particularly guided by environmental potentials, to be in place to guide and improve service design and delivery practices. The third, *idea linkage*, prioritises the development of business ideas that link sustainability to structural and behavioural changes and this can be achieved through the involvement of stakeholders along value chains and life cycles. The fourth, *consumption patterns*, is driven by the need to improve consumption behaviours and emphasises business-to-consumer relationships to deal with unsustainable consumption patterns. Along these lines, alternate consumptions patterns can be formulated with new shared norms, attitudes, and social frameworks that aid in transitions to more sustainable practices. *Communicative structure* is the fifth factor for operations management and stakeholder empowerment that stresses a combination of pro-active and participative attitudes for effective and efficient delivery of customer solutions. Closely related to communicative structures are *clear representations*, the sixth factor, that are needed to effectively design sustainable services and to map the behaviour of actors and spatial relationships within delivery networks. The seventh factor, *relationship incentivisation*, concentrates on fundamentally changing the relationship between stakeholders by offering incentives to be sustainable. Incentives also act as relationship building avenues with clients to enhance customer loyalty.

4.3 Partner Uncertainty

With regards to partner uncertainty, four main management factors were captured from the cases: creativity leveraging, environmental profiling, systemic measuring and process learning. *Creativity leveraging* requires partners to understand and take advantage of creativity within their locus of control for generating radical ideas that promote cleaner processes and consolidate waste reduction practices. *Environmental profiling* encapsulates how firms are involved and are working closely with different stakeholders to improve product life span and efficiency of resource consumption. This profiling is also important for determining the readiness of a partner to adopt and accept sustainable service strategies. *Systemic measuring* of sustainability variables is a challenge for firms to develop approaches that measure their sustainability levels and to factor these levels into relationships and communication among stakeholders. *Process learning* centres on (re)discovering the scientific, social, economic, politic and cultural linkages within the network of actor for delivering sustainable services. It also promotes the use of socio-technical experiments for learning and improving partner's involvement in providing sustainable services.

5 Conclusions

Working at the right time, using the right resources and delivering the right results, is a major challenge for partnerships that requires multiple actors and joint effort. As mentioned earlier, when partnerships are forged for providing sustainable services, these partnerships tend to be plagued by uncertainties that make it difficult to extrapolate from past sustainable service operations – to make forecasts for future sustainable service projects. This is due to differences in variances and variability that create levels of fuzziness for collaboration among partners. Along these lines, this paper has attempted to shed light on "What is the nature of uncertainties that characterises industrial collaborations for providing sustainable services?" Using a research model grounded on literature and findings from secondary case studies, a conceptual model of partnership uncertainty management was developed according to governance structure and relationships climate management priorities.

The paper makes two useful contributions. First, it investigates the nature of partnership uncertainty within operations. Second, the paper analyses orientations for managing partnership uncertainties during the provision of sustainable services. It is however important to stress that practices and policies for uncertainty management should be treated on a case-by-case basis and with respect to leveraging the knowledge of domain experts to better understand uncertainties of transitions to more sustainable and service-oriented operations.

The study is however limited to a qualitative analysis that makes use of 17 secondary case sources and there is a need to widen the scope of the literature investigation. The management model also needs to be applied in real case-studies and quantitative studies to validate the hypothesis. Future cross-sector analyses that investigate trends across industrial sectors are also suggested. While factors of partnership uncertainty management for sustainable services have been highlighted in this study, their significance in short-, medium- and long-structures and behavior has not been ascertained. Future work is therefore needed to study these dynamics and their influences on service encounters, negotiations and innovations. Further research could also use the conceptual model of partnership uncertainty management in studies based on mathematical reasoning, expert systems and decision support systems for generating frameworks, tools and techniques that enhance decisions to join, leave, or remain in solution-oriented partnerships.

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Collaborative Services for Customized Production in Networked Companies

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Abstract. Increasingly, consumer demand of fashionable products is arising as significant challenge for company managers. In order to respond to this demand, companies are asked to supply small series of innovative and fashionable goods of high quality, affordable price and eco-compatibility in short periods of time and with high service levels. As a result of these rapidly evolving challenges, companies are forming collaborative networks in order to design, develop, produce and distribute such products and services in a collaboratively way. These highly integrated and dynamic supply networks depend intensively in new set of tools, methods and related services in which rely the collaborative networking operation. This paper presents a specific case study implementation of these collaborative supporting services, through the realization of a collaborative portal.

Keywords: Collaborative Networks, Collaborative Portal, Supply Networks.

1 Introduction

Due to social, technological, economical and financial changes, company managers need to re-invent the concept of enterprise. A new level of complexity emerged in the last decade, forcing managers to address the market and especially the individual customer with augmented care by putting more emphasis on the service levels they provide, by reducing response times and by tackling the specific needs of the diversity of customers. Added to this pressing necessity, the managers are realizing the fact that competition as well as collaboration schemes are transitioning from among companies to among supply networks, and management of both inter-organizational and inter-supply chain processes and information is even more critical for rapid response and quality assurance of products and processes specially when producing in demand driven supply networks.

Along this vein, consumer needs and expectations of specific target groups - such as elderly, obese, disabled, or diabetic persons - are arising as challenging

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 363–372, 2013.

opportunities for European companies which are asked to supply small series of innovative and fashionable goods of high quality, affordable price and eco-compatible in short periods of time and with high service levels. In order to design, develop, produce and distribute such products and services in a collaboratively way, a new set of tools, methods and related components of collaborative networking are required.

The main objective of the present paper, framed within the EU (European Union) funded project CoReNet, is to present an innovative Collaborative Portal for the TCF SMEs (small and medium enterprises) companies in collaborative networks to support the network formation, the knowledge sharing and the expertise in manufacturing of small batches of products addressing the need of the special consumer target groups. The aim of this collaborative portal is to equip fashionable and healthy footwear & garments network managers and stakeholders with the necessary guidance to address the combination of processes, functions, activities, relationships and pathways along which products, services and information move in and between TCF companies.

The remaining of this paper is organized as follows: first the existing related literature is shown as theoretical foundations, followed by an enumeration of the required services for collaborative networks. Finally, conclusions and final remarks are presented concerning the collaborative portal and the following steps regarding their development and improvement.

2 Foundations and Research Topics

Managerial Reasons. In recent years, it is emerging at industrial level, the awareness that full adoption of collaborative small series production methodologies and technologies are of decisive importance to European Manufacturing Industry, SMEs. In reality, companies urgently need to proactively respond to the high variability of the consumers demand and expectations, to reduce the risks of following too fast changing trends without appropriate basis, which cause serious limits in terms of both customer's satisfaction and enterprises competitiveness and sustainability This is especially true in consumer goods sectors, where customers' tastes change very quickly, and even more in the current economic situation of downturn, where the purchase capability of customers has sharply decreased and is this strongly focused on the high value products. In particular for fashionable sectors such as Textile & Clothing Industry and Leather and Footwear Industry (TCFI) the number of seasonal collections has been increasing enlarging the offer in terms of models along the year, and the number of sold products is decreasing in major markets, leaving best opportunities only for value added products. Moreover, social phenomena like ageing, increase of obese people and major sensitivity versus disabled people and versus eco-friendly products, are also key challenges to be faced by the considered consumers sectors, with reference to healthcare and sustainability. In order to address the new type of target groups (elderly, obese, disabled, or diabetic persons) demand, it is necessary to develop new collaborative supply chain solutions based on cost effective, social compliant and eco-efficient design and production of customized products that fully satisfy the customers, considering their health issues as well as their desire for fashionable products.

Recent research in the field addressed different forms of business networks and their structural forms of organization. The literature distinguishes for example by value chain orientation (horizontal, vertical, lateral), life span (long-term vs. short-term), and degree of virtualization or hierarchical structure (hierarchical vs. non-hierarchical networks) [1]. Nevertheless, the most common business networks are formed along the value chain and for enduring purposes [2]. In parallel, the current market trends demands for flexibility at the supply network level, the processes and the product designs in order to empower the companies to quickly adapt for new business requirements and sustainability challenges. This new demands are forcing business networks to have much shorter life-time existence and take advantage of new infrastructure technologies supported in distributed information systems and knowledge [3].

A new concept of demand-driven supply networks is emerging in literature as a collaborative approach in response to consumer's needs and expectations. In this new demand paradigm the value creation has shift from the traditional idea of value creation and has become co-creation, where customers actively co-create and re-create value with organisations [4]. Thus, all these changes are setting the stage for an expanded role for customers, changing the balance of power and forcing companies to provide new co-creation environments, where customers are no longer passive recipients of goods and services and instead customers are now active partners co-creating value with organisations [5]. In reality, many companies that embrace this paradigm transformed their operating systems from the traditional functional supply networks through a holistic approach that addresses demand and customer expectations in all of its dimensions. This implies different approaches to the market based not only on traditional sales channels (shops, retailers) but increasingly on an Internet mediated direct contact with consumers for product co-design and co-innovation, for product sales and consumers marketers support but also for after-sales services. Concurrently, consumers are increasingly valuing collaborative networks that endorse the sustainability challenges. These networks by seeing the world's present and future challenges seek to develop new products and processes that can be part of a sustainable solution. Namely, through a holistic view of the supply network it is possible to measure and optimize the overall impact of the "carbon footprint", to implement policies that seek recycling and waste prevention, product design for sustainability and the use of emerging clean technologies [3].

One of the major concerns in sustainable supply chain has been the supplier management. Several recent incidents related with sustainability have shown that the reason suppliers cause such environmental problems is because most suppliers are small and medium-sized enterprises (SMEs) which cannot sufficiently deal with the environmental management issues. These cases show how important supplier selection and support are. Even if such mistakes occurred in the upstream of a buying firm's supply chain, it is the buying firm's responsibility to the public. Such incidents cause damages to buying firms financially as well as damages on reputation [6].

From the production viewpoint, companies from different sectors in sustainable networks need to integrate their production systems in order to offer to the customer integrated solutions and innovative services and products.

Perspectives on Collaborative Business Networks . Growing competitiveness in the global market encourages manufacturing companies to form alliances among them for mutual benefit. Various forms of collaboration emerged as response to transformations in the business environment and the rapid developments in information and communication technologies (ICTs) [7]. Collaboration in the form of virtual organizations [8-9], virtual organization breeding environments (VBE), business community [10], business ecosystems [11], etc. are a powerful instrument to achieve strategic objectives such as short lead time, high quality, and cost competitiveness especially for SMEs which need to create critical mass to stay competitive. The multi-perspective approach on collaborative environment (technological, semantic, social and business perspective) emphasizes the importance of the business view that allows collaborative networks to be regarded as combinations of inter and intra-organizational business processes [12].

Forming Virtual Organizations (VO) can offer a new competitive environment and manufacturing agility [13-14). The VO is a temporary alliance of member companies which join to take advantage of market opportunities [15-16] as specific target market requirements can be. Within a VO, each member company will provide its own core competencies in areas such as research and development, marketing, engineering and manufacturing. One of the major issues in the formation and operation of VO is the rapid integration of the business processes of collaborative companies.

During business networking, it is critical that strategic collaborative relationships between partner organizations are developed both upstream and downstream the dynamic business environment. It is expected that participating companies must continue to revamp their business model in response to industry competitions and product lifecycle. From the perspective of SMEs, the collaborative business is an alternative to traditional supply chains, where they can manage the business better and increase their added value [17-19]. In regional or sectorial Business Communities, trust can be built and communication streamlined, creating an environment suitable for the fast and efficient creation of Virtual Organizations (partnerships or collaboration projects) to respond to specific business opportunities [9].

ICT Requirements. In order to develop a collaborative platform to support the intended high levels services it is necessary to start from the main requirements within the different user domains (manufacturer, suppliers, service partners, customers, etc.) as well as the technical requirements related to the software modules and involved data flows (and repositories). Also the middleware components devoted to provide general services to be used from different applications (authentication, workflow management and business document engines; product data handling, etc...).

A suitable approach to build the necessary architecture to support collaborative portal for customized production in networked companies is the Service Oriented Architecture (SOA). The SOA is an emerging approach that addresses the requirements of loosely coupled, standards-based, and protocol independent distributed computing. Typically business operations running in an SOA comprise a number of invocations of these different components, often in an event-driven or asynchronous fashion that reflects the underlying business process needs [20].

Service Oriented Architecture (SOA) is a flexible set of design principles used during the phases of systems development and integration. A system based on a SOA will package functionalities as a suite of interoperable services that can be used within multiple separate systems from several business domains. SOA architectures are generally based on several elements: (i) Services (usually web-services): they represent atomic functionalities offered by the system. (ii) Vehicle messages: they represent the information exchanged by the different services. They are based on XML. (iii) Enterprise Service Bus (ESB): it is the channel used to integrate together all the services and exchange messages.

Nowadays SOA solutions are very popular, because they offer several advantages over traditional architectures: (i) Loose coupling: services are no more directly connected each other, but instead they exchange messages using a service bus. This allows services to be updated and substituted without heavy impact on the whole architecture. (ii) Flexibility: the backbone of a SOA architecture is represented by the ESB. Adding or removing services and functionalities becomes very easy since it is just a matter of configuring the bus, while the services are not touched by these operations. (iii) Easy maintenance: functionalities offered by SOA are fruited using web services. End users don't need to install anything to use the services, and the maintenance is centralized in the hand of the developers. This allows end users and providers to cut dramatically the costs related to update and maintenance of software.

These three advantages, together with the easy configuration of modern Enterprise Service Bus (ESB) and development of services, decreed the success of SOA architectures. Another relevant ICT aspect in building and providing an infrastructure for collaborative networks is related with the use of open-source software solutions. As Frank Hecker point out, in the traditional software business models, software-houses provides all (or almost all) of the value to customers, and they realize their revenues and profits in return through traditional software license fees. On the other hand, in an open-source business model, much of the value provided to customers will not be provided solely by the software house developer, but rather by other developers and members of collaborative network who are attracted to work in open-source products and services and will thus help augment the overall resources available to specify and develop the collaborative solutions as opposed to traditional competitors' solutions. These "outside" developers may be motivated by the prospect of working with software tools that solves important problems for them and for others, the possibility of future gain providing related services and creating related products, the opportunity to increase their own personal knowledge, or the ego satisfaction of enhancing their reputation among their peers [21].

Framed in this objective it surfaces the concept of a collaboration portal. This collaboration approach seeks to provide collaboration mechanisms in single place, deploying collaborative capabilities that extend standard business applications.

A leading open-source portal framework for web content management (WCM) is the Portal Liferay®. The Liferay portal is in principle a stack of java portlets that provides a WCM system to support integrity of all functionalities of a collaborative framework. It is a software platform designed for creating dynamic websites and web applications. It can display different page content depending on whether the user is logged in or not. It is a good platform to start with development of collaborative web sites for teams and entire businesses or wiki pages. It also supports Social Networking, Mashups, Content Management and Document sharing out of box with integration with for example Microsoft Office® [22].

3 The Services for Collaborative Networks

The CoReNet project was conceived in order to address specifically the health sector, considering Textile, Clothing and Footwear (TCFI) consumer's goods for people like elderly, obese, diabetics, and disables. In the case of the TCFI companies, it is necessary to go further and consider cross-sector interactions since some activities like market trends and customers' needs analysis, products design, supplier's management and finite product delivery need to be synchronized and collaboratively integrated. The CoReNet collaborative project responded to such needs by conceiving a new holistic framework, meant as a set of methods, tools and technologies for sustainable small series industrial value creation of health fashionable goods enabling synchronized product design, production and delivery and functional answer to consumer needs. A key element in order to deploy these services for the supply networks stakeholders was the Collaborative Portal. The Collaborative Portal is the virtual place, where actors can find information, support and easy access to the tools and products developed and configured within the collaborative community.

The Collaborative Portal Structure. The Collaborative Portal represents an open space for actors active in the area of target groups like diabetics, obese, elderly and disabled people supporting the usage and validation of the CoReNet results and stimulating the discussions about topics related to personalization, design, production, sustainability of products.

The CoReNet Collaboration Portal is based on social networking approach to provide a friendly and collaborative environment in the Textile, Clothing and Footwear sector: consumers and companies can join different communities testing solutions and sharing needs and interests on healthy and fashionable products for specific market niches. Inside the Portal, the user can find open communities like Textile and Clothing community and Footwear community where it is possible to access demo trials, video and short presentations on innovative tools supporting design, profiling and production of healthy and fashionable products. It is also present four pilot communities for dedicated case studies where specific products are under development according to the needs of the target groups and the specific features of the companies analyzed.

The Fig. 1 presents the schema of the Collaborative Portal structure. This portal is accessed by an Internet connection through a browser application. The application server runs over the web content management framework of Liferay and supports legacy integration and messaging with companies external applications such as ERP's through a Enterprise Service Bus (ESB).

The CoReNet tools represent adaptable and agile instruments specifically tailored for the SMEs in the textile, clothing and footwear sector to support the revision of their business processes in a collaborative way.

CoReNet proposes a novel approach based on matching market needs with fashionable and functional products and related innovative technological solutions for textile, clothing and footwear industries. Within CoReNet Collaborative Portal, all partners of the value chain will be able to actively collaborate in value creation processes where the end consumer is the driving actor. CoReNet methods and tools will enable design changes and production processes adaptation for easy and sustainable product customizations.

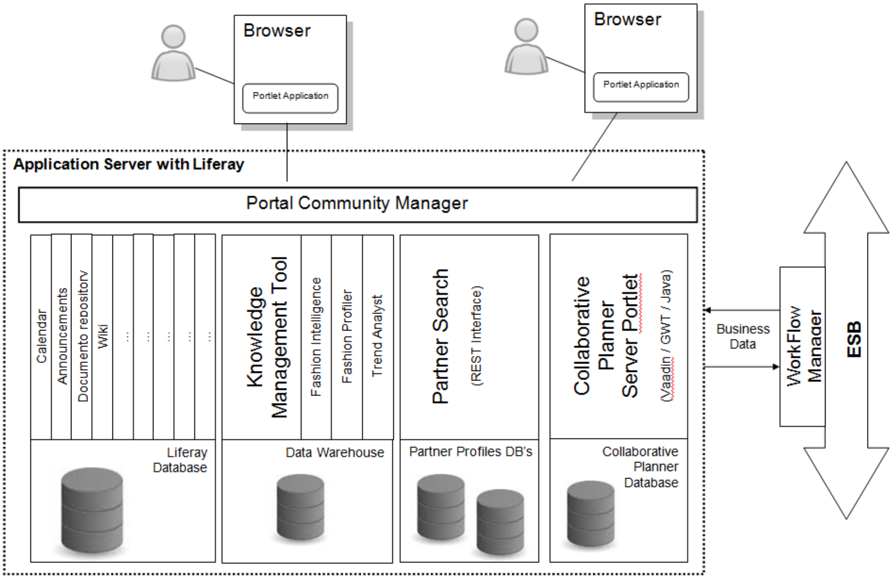

Fig. 1. Collaborative Portal Structure

Management of Market Trend Analysis. The Knowledge Management Tool (KMT) for cross-sectorial trends is a toolset based in new market information model collaboratively sourced from the unstructured information from consumers (aesthetic, physical parameters, comfort and health requirements), retailers (sales status and customer preferences), designers and suppliers interaction (sectorial requests and provisions), and within a social network environment, relying upon the use of semantic technologies for knowledge extraction and pattern matching for consumer trends identification.

The KMT application is composed of several tools and services integrated in the CoReNet innovative consumer-cooperative environment for product design. The components are:

- KMT Fashion Intelligence (FI) - The main features of this tool are: Data mart with transactional data organized for reporting and exploratory data analysis; Data mart with data collected from comments made in social networks (Pinterest.com, in particular) about the products and part of the transactional data. These data are integrated and organized for reporting and exploratory data analysis; Demand characteristics and social network comments exploration using OLAP; Demand characteristics and social network comments reporting using reports and dashboards.
- KMT Fashion Profiler (FP) - The main features of this service are: Automatic segmentation customer demand using clustering algorithms; Visualization of customer demand profiles;
- KMT Trends Analyst (TA) - The main features of this service are: Automatic identification of demand and social network comment trends using association rules mining algorithms; Visualization of demand and social network comment trends;

Supply Chain Configuration. The *Partner Search* (PS) is a web-based tool designed to help managers in the supply chain to configure the network by allowing the manufacturers to manage knowledge about its suppliers, by creating and updating Partners Profiles (a set of parameters describing competences and past performance), by visualizing data and key performance indicators (KPIs) and by providing search features to select those partners that best match the entered criteria.

Different typologies of indicators identified are:

- Quantitative indicators are based on historical data relating to the previous and existing relationships of a manufacturer with its partners;
- Qualitative indicators are based on subjective evaluation made by a partner (production managers, purchasing managers, buyers, according to who is in charge of the partner search in the company).

The *PS* can be used collaboratively after product design, before order collection and at the production planning phase. At these stages it is important to define the configuration of the supply chain for the targeted production season so that the best-suitable partner is activated on need (i.e any time new orders are collected). In case it is not possible to extrapolate the adequate partner from the list of former ones, the system allows also an *open* advanced search on the Internet. The *Partner Search* might be used also after order collection in case there are specific needs of customization and personalization of the product.

Data can be both manually entered by human users, (through a GUI implemented as a *portlet*) and automatically retrieved from legacy systems (e.g. manufacturer's ERP systems).

Collaborative Planning. The CoReNet Collaborative Planning approach is oriented to address the demand planning and demand fulfillment activities. The tool allows each partner to directly propose new delivery dates, lead times and costs, via a web-based planning graphical tool which is available and shared by all supply network partners.

The planning scheme is based on negotiations undertaken between all the core partners and potential partners. The main goal of this negotiation is to arrive to an optimized plan for the supply network, where all the required operations are characterized in terms of minimum and maximum lead times, minimum and maximum time overlaps and minimum cost, and other relevant negotiation indicators defined at the beginning of the negotiation.

The proposed approach provides several key benefits for manufacturers and suppliers of the TCFI sector that are looking for agile solutions for the order management and the production plan processes supporting the production of small series. The Collaborative Planner solution is:

- easily accessible and easy to use, as the tools provide advanced GUI and are available within a unique portal (thus no installation is required);
- supports the exchange and the automatic check of business information through well-known channels, like the emails (hiding technical details about the internal format of the exchanged documents);
- helps the selection of partners leveraging on information already owned by the manufacturer and provides an open collaborative environment where planning with the selected ones an agreed production plan.

The proposed planning approach integrates the partner profiling and search services and fits the needs of customer-oriented supply networks in achieving flexibility and responsiveness to the market demands.

4 Conclusions and Further Research

The ongoing European project “Customer-oriented and eco-friendly networks for healthy fashionable goods (CoReNet)” aims to provide TCF Industry companies with the tools and methods to face the challenge of working in demand-driven and customer oriented collaborative networks.

During the project test and validation of specific isolated tools on the pilot cases, arose the need to offer a virtual place, where all the actors involved in the collaborative network could find information, interact, obtain support and easy access to the tools and products developed and configured within the collaborative community. This need has led to the design and development of the Collaborative Portal. This new tool, evolved in order to support the network formation, the knowledge sharing and the expertise in manufacturing of small batches of products. The ultimate objective of this collaborative portal became the offer of an integrated set of collaborative services that equip fashionable and healthy footwear & garments network managers and stakeholders with the necessary guidance to address the combination of processes, functions, activities, relationships and pathways along which products, services and information move in and between TCF companies networks. Until now the project research work allowed the definition of a Collaborative Portal that set up the foundations for the development of future technologies and tools that support network operation and the instantiation of collaborative services. The undergoing phases include the evaluation of the current services and tools and the improvement of the concept inside the CoReNet project together with the industry partners and the customers. The final goal is to provide a sound customer-oriented Collaborative Portal suitable to collaborative network managers, stakeholders of TCF industry and customers.

Acknowledgments. The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° [260169].

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Services III

A Consolidated DaaS Model for Situation-Informed Incident Management

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Abstract. From Fukushima Daiichi nuclear disaster to the recent India blackout, industrial incidents are inevitable and once occurred, their impact on the society and economy can be catastrophic. In an end user perspective, reducing such impact relies on not only efficient service recovery but also effective public communications. To achieve the latter, it requires instant resource sharing in a collaborative network where effective data sharing, integration and management are critical. However, this is not an easy-to-achieve task in a complex system which involves a number of stakeholders. In this paper, we describe a consolidated DaaS model based on our previous work, which can be used to support effective communications in emerging situations and sudden events driven by incidents. We also provide an implementation based on a case study focusing on power incident management in the UK's national electrical system to demonstrate the usefulness of the model.

Keywords: Cloud computing, Situational applications, Mashup, Data as a Service (DaaS), Power grid, Incident management.

1 Introduction

Large industrial systems such as power grid or communication networks are becoming more and more complex so that industrial incidents are inevitable. An incident can make strong adverse impact on the society and economy when it is related to our everyday life [1]. More importantly, the economic cost is often tremendous and leads to catastrophic consequences [2] [3]. For example, apart from 3.5 percent of GDP equivalent direct losses through damages [4], the accident at Fukushima has resulted in radical community reaction due to the lack of effective communications from main stakeholders [5]. Therefore, reducing such impact relies on not only efficient service restoration but also effective public communications [26]. The latter requires ICT enabled instant resource access, sharing and collaboration in the collaborative network where effective data sharing, integration and management of complex systems are critical [27].

Following our previous study [24], this paper presents a consolidated DaaS model that can be used to realize effective incident management. The main contribution of

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 375–384, 2013.

this model is that it supports timely collaborations across all organizations in response of emerging situations and sudden events in an on-demand and cost-effective manner.

The paper is organized as follows. First, Section 2 describes the principles and rationale of the model. Section 3 provides an overview of the consolidated model. Section 4 conducts a case study focusing on the UK's national electric system and Section 5 presents the corresponding implementation considerations. Last, the conclusion is drawn in Section 6.

2 Principles

The principles and rationale behind of the three-tier DaaS model are web principles, service-oriented principles and autonomic computing principles.

2.1 Web Principles

A web-based system often emphasizes on open modularized architectures and rapidly changing technologies which make it flexible and easy to extend [6]. This also applies to Data-as-a-Service, a service model of cloud computing which allows data in various formats and from multiple sources to be provided through services on demand [10]. The goal of this model is to support effective communications from stakeholders to end users in a complex system so a prerequisite is that every partnering organization should be able to contribute effortlessly to the system despite their roles. In other words, the usage of the DaaS model must be simple, slick and unrestricted.

The model should support the collaborative process from several computing power to run a single task transparently and coherently. It also allows the transparent distribution of components over the network so that executing processes running in the middleware can be scaled across numerous physical servers that span across organizations in a cloud environment. Moreover, the integration of heterogeneous proprietary and legacy solutions should be supported through common interfaces. Additionally, interoperability on the web is usually platform- and vendor-independent which allows all providers and requesters of information to participate on a level playing field.

2.2 Service-Oriented Principles

Service-orientation provides a broad design paradigm that enables the separation of concerns by allowing using services as the basic building blocks of functionality [28]. It also provides a way to think about the design of a solution in terms of services, service-based development and the outcomes of the services. The DaaS model aims at providing enhanced efficiency, agility, flexibility and productivity by positioning services as the primary atomic functional elements [7]. These services are classified based on the functionality provided within the model, which can be distinguished between application, data, and middleware services.

- Application services, which are the top layer in the service oriented architecture, provide business logic. Moreover, they are the subject of integration and interoperation within the architecture and can provide a certain value for users.
- Data services provide on demand access to the user.
- Middleware services, such as services providing discovery and interoperation support, are used to facilitate the integration and interoperation of business services.

All these services should be designed and developed, according to a holistic approach.

2.3 Autonomic Computing Principles

The concept of autonomic computing was first introduced in [8] where autonomous systems were characterized as self-manageable systems. This is very important for services. Our model is supported by composing services offered by third parties. Such system does not necessarily have control on the way the component services are actually offered. Therefore, self-management capability is important for the system. It allows the system to react to the situation in which the services provide incorrect results or are unresponsive.

The characteristics of autonomous systems are being applied today in four fundamental areas of self-management to drive significant operational improvements. The four areas are related to different attributes of autonomous systems. The four capabilities are self-configuring capabilities, self-healing capabilities, self-optimizing capabilities and self-protecting capabilities.

3 Three-Tier DaaS Model

Fig. 1 shows the three-tier DaaS model featuring *data tier*, *service tier* and *interface tier*. First, member organizations in a collaborative network can publish their enterprise data which are relevant to end customers as individual data services. These services can then be hosted in a service cloud in either linked or centralized form so that they can be discovered and accessed by all members. After that, any member can identify emerging situations and inform its users through the use of mashups on-demand.

It should note that releasing certain business data stored in different enterprise information systems is a common practice for large and medium organizations. This is because an organization often needs data from various sources to be linked intra-organizationally to support its business functions and activities (e.g., presenting a new business model). This makes it possible to pull data from different sources, wrap them in a unified format and publish them as individual data services (e.g., Service A, B, C). Moreover, third-party Web services (e.g., Service D, E) can be considered for improving the flexibility and usability of final applications.

Once different services are published by organizations, it needs to consider the hosting architecture as it determines how these services can be discovered and accessed by all member organizations. In a DaaS model, it should consider two aspects: (1) services are only needed when necessary and (2) they must allow easy access when needed. For these reasons, the hosting cloud can be either in a linked service cloud or a centralized cloud form.

After all services are hosted and made available to discover, mashups can be used to support inter-organizational data activities through common access protocols. This weaving process allows member organizations to make use of all relevant services in the cloud and create business applications on behalf of their customers (e.g., Situational Applications A) on-demand [9][11]. The benefit is obvious as any member in the network can access any services from anywhere and form its own customized applications at any time.

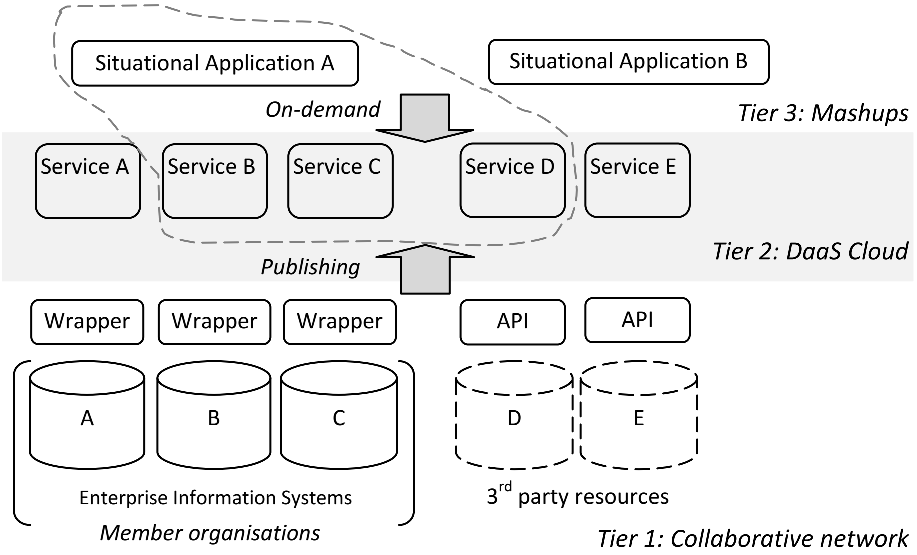

Fig. 1. The three-tier DaaS model (*bottom-up*) where data from different information systems of different organizations is gathered and processed (*Tier 1*), published as services and hosted in the cloud (*Tier 2*), used to form different situational applications (*Tier 3*). Services circled with the dashed line indicate a specific situation.

4 Case Study

In this section, the UK's national electrical system is used to demonstrate the practical use of the DaaS model during an incident.

4.1 An Overview of the UK's National Electrical System

UK's national electrical system is called the National Grid, which is operated by National Grid plc[1] as a result of the privatization of the Central Electricity Generating Board (CEGB) in 1990s. The three key stakeholder areas in the system are generators, distributors (DNOs) [2] and suppliers. Note that many large utility companies in the UK are vertically integrated. For example, Scottish Power[3] [12] operates separate businesses in the areas of power generation, supply and distribution at the same time.

The system operator, National Grid plc owns and operates the National Grid high voltage network in England and Wales. It also operates the transmission network in Scotland. There are seven distributors distributing electricity from the transmission grid to homes and businesses, who are prevented from supplying electricity under the Utilities Act 2000 [13]. There are currently 27 suppliers dealing with electricity supply [14], who make use of the distribution network. Since a distributor owns power lines, transformation centers and substations, it knows exactly how much electricity a household or a business site has consumed in its responsible geographical area but it does not know who is responsible for paying the bill. On the other hand, a supplier knows who is responsible for paying the bill for an address but they do not know how much energy they have consumed. For this reason, the two parties have to work together to bill a consumer correctly. For example, a consumer can submit meter readings to a supplier and a supplier can send inspectors to take meter readings for the consumer. All these information will be later submitted to a distributor for the accuracy check.

4.2 Incidents and Communication Issues

The electricity system is complex so incidents can occur at anywhere and anytime. Moreover, with more and more grids are interconnected, an incident in one region can trigger a domino effect that could result in supra-regional blackouts. A prime example is the recent India's blackout, which was initially caused by overloading issues in certain regions but eventually affected more than half the country.

Any incident must be coordinated at system level, which involves the system operator National Grid plc and all seven energy distributors due to regulations. Some industrial users and large business users with interruptible contracts [16] will be informed, too. However, domestic users and most business users will not be communicated promptly. Instead, these users are advised to check with their local distributors on their own no matter if the supplier owns other businesses or not [17] [18]. Nevertheless, timely updates of the progress are not possible for all users. Obviously, when a large power outage happens, it will trigger a chain reaction and eventually affect the whole community due to the lack of effective communication mechanism inter-organizationally and publicly.

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[1] `http://www.nationalgrid.com/`

[2] A distributor in the National Grid in the UK is also called a Distribution Network Operator (DNO) [15].

[3] `http://www.scottishpower.com/`

5 Implementation Considerations

In this section, we discuss a typical power cut scenario in a regional area in order to demonstrate how to use this model to create an effective communication mechanism between stakeholders and end-users.

5.1 Business Requirement

A power cut incident is actually a sudden situation during the normal power supply hence a stakeholder's situational awareness relies on instant discovery and notification of such incidents. This requires instant data access and sharing across all related industrial systems and owners (stakeholders) in the network. As discussed in 4.1, a distributor can discover the incident and rectify the problem but it does not know exactly who are affected and how to communicate them. On the other hand, suppliers have customer details and know how to contact them but they do not know who are affected. Therefore, the following requirements should be formed in an end user perspective:

- A list of substations and servicing areas should be obtained from the distributor.
- A list of affected substations should be obtained from the distributor.
- A list of consumers' addresses should be obtained from the suppliers.
- Consumers must be effectively informed with the problem and the progress through available communication channels provided by the suppliers.
- Consumer energy compensation claiming scheme should be worked out and made available by the distributor.

It should also note that the needs for such an application will only be temporary and these needs will be satisfied automatically when the incident is resolved. That is, the initial development should be reasonably simple and cheap so little time must be spent in the development [19].

5.2 Workload Analysis

When active, prompted communication is not available during a power cut incident, a common public reaction is that consumers tend to call their energy suppliers and use other emergency services like 999. The unexpected surge of phone calls often makes related call centers overwhelmed and generates a chain reaction to the community [20]. In this section, we will simulate a supplier's call center's workload for demonstrating why effective communications cannot be guaranteed during an incident and why our model will be useful for solving such issues.

Suppose that a call center takes 70,000 calls a month which indicates 250 calls per normal working hour [21]. Assume the incoming calls behave statistically like a Poisson process in a normal situation and the call center follows common industrial recommendations for services. For example, the SLA is **80/20** and the average call duration is **240** seconds (4 minutes). Using Erlang-C formula below, the number of agents needed is **21**.

$$E_c(m,u) = \frac{\frac{u^m}{m!}}{\frac{u^m}{m!} + (1-p)\sum_{k=0}^{m-1}\frac{u^k}{k!}}$$

With 21 agents, when the incoming calls increase to **315** calls per normal working hour, the average waiting time will be ***infinite*** as shown in Fig. 2. Note that in the event of an incident like Barcelona blackout affecting a high population, the surge of calls will be more radical [22] so that it can easily exceed the simulated critical point (350 calls per hour) within minutes. Therefore, the benefit of an intuitive notification process using available communication means, which is automatically triggered when an incident was identified, is obvious.

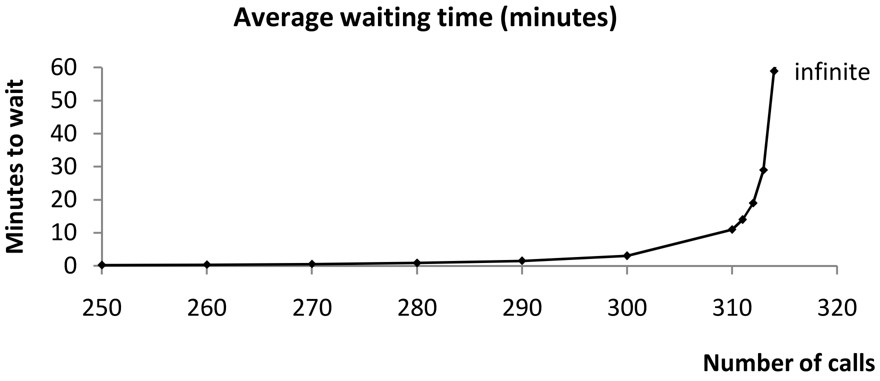

Fig. 2. The x-axis shows the number of incoming calls per hour and the y-axis shows the average waiting time in minutes

5.3 Situational Application

Based on the above analysis, the distributor needs to publish two data services: a substation-address service and an affected substation service. The suppliers need to publish one data service: customer-notification service. Then a situational application for customer incident notification can be dynamically created by using mashups to integrate these services (Fig. 3.). In other words, once the affected substation service starts pushing out data, it will trigger the execution of the application. Moreover, the application can be more interactive and user friendly by integrating third-party location based services. For example, in Fukushima nuclear disaster, Google Map has been used to report live nuclear pollution spread-out. A similar approach can be considered in this situation, too. Additionally, with the integration of social networking services like Twitter and Facebook, the application can also extend the reach.

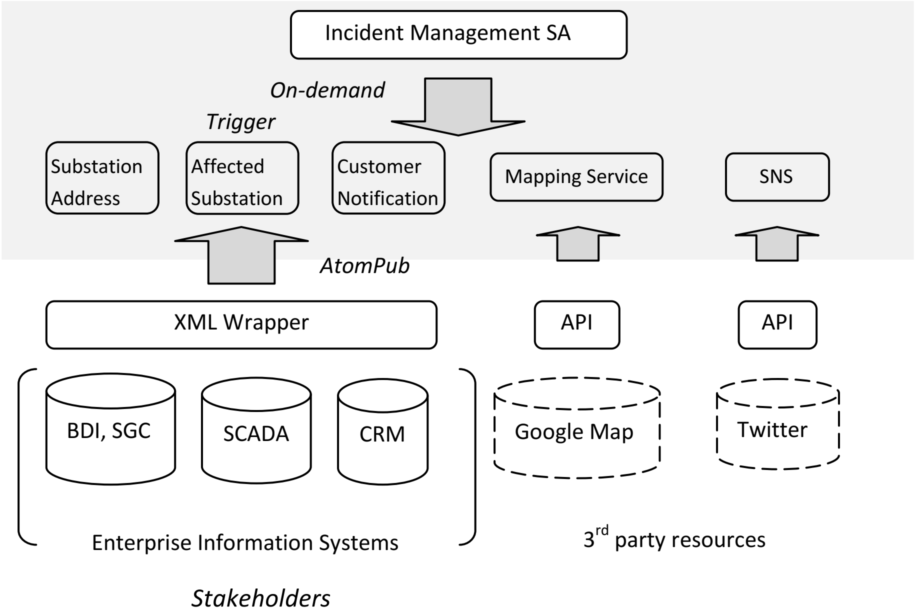

Fig. 3. The incident management SA is created with selected data services published by different stakeholders in the system. Their business data are sourced from different information systems owned by them and wrapped with a universal XML schema for data interoperability.

6 Conclusion

Effective incident prediction and forecast can be time consuming, labor intensive and even a mission impossible due to the complexity of large industrial systems. Thus effective incident management is always considered as a more cost-effective solution to reduce the adverse impact on the community and economy when an industrial incident occurs. In an end-user perspective, this relies on instant situational awareness and timely response. The core concept of our model is that it uses DaaS and mashups to help stakeholders respond to emerging situations more intuitively. The model also supports on-demand data access and flexible situational application development which can be used to address timely customer needs. The case study and the simulated analysis show the usefulness of this model in a real practice. It should also note that there are always some typical concerns for DaaS such as data quality and governance [25]. In this model where services are actually released by partnering members in a collaborative network, such issues can be easily resolved by appointing a central data managing unit to manage data services. Additionally, since user access control can be used for monitoring service access in this model [23], the service log file can also be used to track responsible stakeholders in case some customers are not notified effectively.

Acknowledgements. This work is made possible by the support of the Natural Science Foundation of China (NSFC) under Grant No.61150110484, ESSENTIAL: Enterprise Service deSign based on ExistiNg software Architectural knowLedge. In addition, the authors would like to express their appreciation to all reviewers in PRO-VE' 12 and 13 for their constructive comments.

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Understanding SLA Elements in Cloud Computing

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Abstract. Cloud computing security, interoperability, and vendor lock-in are likely to act as inhibitors of the widespread adoption of cloud computing in organizations. This calls for relational and contractual mechanisms to articulate the desired outcomes of service provisioning and acceptable behavior of service recipients and providers. In this paper we conducted a qualitative study interviewing industry experts to understand the extent to which SLA specifications in traditional IT services outsourcing can be applied in cloud computing, identifying elements becoming redundant or not applicable, and new elements capturing the specificity of the business relationships in cloud computing.

Keywords: cloud computing, SLA, IT outsourcing, contract.

1 Introduction

Cloud Computing (CC) is increasingly becoming a part of information processing in organizations. Forrester Research [3] forecasts that the global market for CC will grow from $40.7 billion in 2011 to more than $241 billion in 2020. There are many uncertainties surrounding CC, however, which may hinder this growth. Security, interoperability, vendor lock-in, and compliance, among others, are considered to be inhibitors of the adoption of CC [7, 9].

In traditional Information Technology Outsourcing (ITO), formal contracts are drafted in the form of a Service Level Agreement (SLA, [4]), which describes the specifics of the service(s) to be delivered and the engagement expectations of the service recipient (SR) and service provider (SP). In this context, one can ask whether CC changes the relationship specifics between SRs and SPs and, as a consequence, their engagement expectations, i.e., the elements of the SLA.

The core of the relationship between SRs and SPs in CC is not likely to change when compared to traditional ITO: party A requests a service to party B, who can provide this. However, the features of CC form the base for differences in outsourcing relationships that are observed in practice. CC features, such as rapid scaling, pay-per-use, and lower IT upfront investments are beneficial for companies, but also cause situations that did not occur in traditional ITO relationships. The often unilateral

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 385–392, 2013.

nature of the relationship in CC results in the SR being more dependent on the SP when compared to traditional ITO. Moreover, it is often unclear in CC what will happen to the SRs' data when power outages occur or when data are lost. Another critical aspect concerns interoperability and migration, that is, unforeseen events causing a SR to retract the service from one SP and transfer it to another SP. The issues created by this transfer, in particular about data, are likely to be more relevant in CC than in traditional ITO. Finally, differences between ITO and CC are also to be found in the cardinality of the relationship between the SP and the SRs. In CC this ranges from a one-to-many 'anonymous' relationship in case of a public cloud, traditionally referred to as the multi-tenancy model in the SP perspective, to a one-to-one 'close' relationship in a private cloud. The one-to-many case, in particular, is often not relevant in traditional ITO. Although the outsourced services in traditional ITO can run on the same software instance, e.g. in time-sharing mainframes or in the Application Service Provider (ASP) paradigm, the SP usually offers a dedicated infrastructure for each SR at least for what concerns data, i.e. a separate database instance for each customer.

In this paper we investigate the CC outsourcing decision process and the related content of SLAs. About the former, we present a framework analyzing the structure of the outsourcing decision making process. About the latter, we identify and define the list of elements required in a SLA regulating the relationship between a SR and a SP. In particular, we show how the content of the SLA in CC should differ from the one of SLAs in traditional ITO, which we retrieve from an analysis of the literature.

The paper is organized as follows. In the next section we discuss the research method that we have adopted in our study. Then we discuss the results of our investigation. Eventually, we discuss the evaluation of our results and draw our conclusions.

2 Research Method

The first stage of our research is constituted by a literature review, through which we analyze current published work on SLAs in traditional ITO. The output of this phase is a comprehensive specification of SLA in traditional ITO. In the second stage we conduct interviews with experts in the domain of CC outsourcing. Through the interviews we extend and customize the specification of SLAs in traditional ITO to the context of CC outsourcing, identifying original SLA elements specific to CC. We also exploit the coding of the interviews to design the Cloud Outsourcing Framework (COF), an instrument to support the CC outsourcing decision making process.

The potential interviewees in this stage are selected from the Cloud Computing taskforce within the Business Assurance Services (BAS) department at PwC Eindhoven, The Netherlands. Out of the 11 experts in CC identified among group leaders at BAS, 6 agreed to participate in our study. Each interviewee has a minimum of 7 years experience in ITO and/or CC in financial services, with an average experience of 13.7 years. The content of the interviews is analyzed using grounded theory [6], which is used to enhance the starting theory of SLAs in ITO, widening its scope in the context of CC. The content of the interviews is analyzed using directed content analysis [5], using both codes pre-determined from theory and codes derived from interview content.

Interviews and theory building imply a certain degree of subjectivity in our findings. Therefore, in the last stage we validate our output to assess the clarity, completeness, and usability in practice of the Cloud SLA specification and the COF framework. Validation is performed by interviewing experts with experience in practice about IT outsourcing and CC. The interviewees are selected among the members of the Dutch CIO platform, an independent association of CIOs and IT directors from Dutch private and public organizations. We conducted interviews with 4 experts, with an average executive experience of 16.5 years. We provided the preliminary version of the framework and SLA content analysis beforehand to the interviewees.

3 A Framework for SLAs in Cloud Computing

This section summarizes the results of our study. For a more in depth discussion of the codes determined through the literature review and the interviews and the way those have been exploited to construct our results, we refer the readers to [10].

Given the exploratory nature of our work, in this paper we consider only the most common CC deployment models: the Private and Public Cloud (Meel and Grance 2011). In the public cloud, the organization providing cloud services owns the cloud infrastructure and makes it available to the general public or a large industry group. In the private cloud, the cloud infrastructure is operated by the providing organization solely for one specific recipient. Given its exploratory nature, our study does not focus explicitly on the differences among different service models, i.e. I/P/Saas.

3.1 SLAs in ITO

In our literature review, we identified two main specifications for SLAs in traditional ITO, i.e. the ones proposed by Goo [4] and Jin et al. [11]. We argue that all the SLA elements identified by Jin et al. can be mapped to elements of Goo's framework. Therefore, we selected Goo's work as the starting point for SLA specification in our research. This mapping is described in [10] and not reported here for lack of space. The SLA elements identified by Goo are listed in Table 1.

Table 1. SLA elements in Goo's framework [4]

Foundation Elements	Governance Elements	Change Management Elements
Process Ownership Plan, Servcie Level Contents, Service Level Objectives	Enforcement Plan, Communication Plan, Measurement Charter, Conflict Arbitration	Future Demand Management Plan, Anticiapted Change Plan, Feedback Plan, Innovation Plan

3.2 The Cloud Outsourcing Framework

The objective of the COF is to understand the implications of the nature of the SLA on the decision making process leading to CC outsourcing. We consider a single perspective and multiple aspects. The perspective is the one of the decision maker in the SR organization. The aspects that we consider are:

- **Process**. The steps involved in the CC outsourcing decision making. We use a process model (flowchart diagram) to model this aspect;
- **Decisions**. The decision points involved in CC outsourcing decision making. We use a decision tree to model this aspect;

The COF is shown in Fig. 1, which reports the two models and their dependencies.

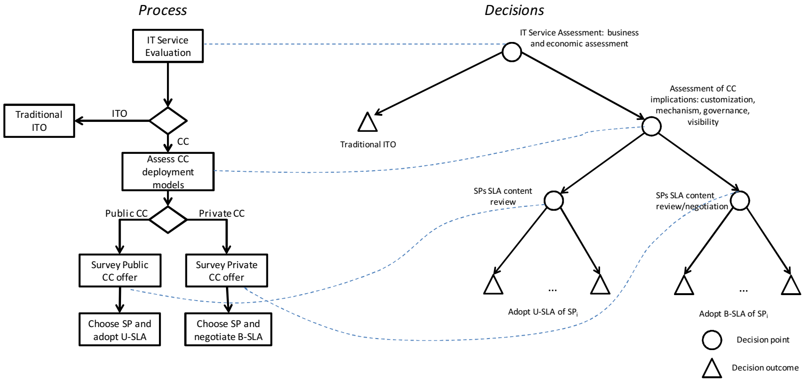

Fig. 1. The Cloud Outsourcing Framework (COF)

In the first step of the decision making process the SR chooses between traditional IT outsourcing and CC outsourcing. This decision is not driven by the nature of the SLA in the two outsourcing options. SR organizations decide to outsource their IT services to cloud SPs for economic reasons, i.e. to reduce IT costs or at least transform IT investments costs into fixed operative operational costs [1], and business-related reasons, e.g. achieving more agile IT services, which can scale and be reconfigured on-demand [2].

Once CC is chosen, the implications of the nature of the SLA start coming into play. The SR organization, in fact, needs to consider the implications of the CC deployment models on the possible SLA that they will be able to establish with the SP. The interviews show consensus along four dimensions along which SLA implications should be analyzed: (i) the degree of *customization* allowed by the SLA, (ii) the *mechanism* to obtain the SLA with the SP provider, (iii) the expected *governance* model of the SLA (which derives directly from the choice of the public or private deployment model), and (iv) the degree of *visibility* that the SR expects on its outsourced IT services entailed by the SLA.

The public cloud CCO is characterized by a (i) standard SLA, based on (ii) a take-it-or-leave-it agreement mechanism (no negotiation allowed), for which (iii) decisions, i.e. governance, are managed unilaterally by the SP, resulting in (iv) the opaque, i.e. non-transparent, visibility of the outsourced service for the SR. The private cloud CC is characterized by a (i) customizable SLA, based on a (ii) SLA negotiation process allowing for (iii) bilateral governance, resulting in (iv) a more transparent outsourced service.

In public cloud outsourcing the SP drafts a standard SLA that is usually downloadable from its website. There is no active role for the SR other than agreeing to the SLA. We label this type of SLA the U-SLA (Unilateral SLA). The bilaterally drafted SLA in the private cloud is renamed the B-SLA (Bilateral SLA), to underline that it remains a negotiable document. As far as SR's objectives are concerned, a SR in public cloud outsourcing uses the U-SLA to create internal awareness, compare SPs offers, and monitor the performance of the SP. The objectives of the B-SLA are comparable to the ones of SLAs in traditional ITO. The B-SLA, being drafted bilaterally, is used to better define the relationship between the SR and SP, in terms of structuring the relationship and negotiating the characteristics of service provisioning.

In the COF, therefore, when SRs choose for a public cloud solution, they have to evaluate the U-SLA defined by candidate SPs and choose the one that better fits their own expectations. When the private cloud is chosen, the process of choosing the SP resembles the one of traditional ITO, since the SLA would be the outcome of a negotiation between the SR and SP.

3.3 Cloud SLA Specification

Regarding the comparison between SLAs in traditional ITO and CC, interviews with domain experts revealed that the SLA specification in traditional ITO (i.e. [4]) is also applicable to outsourcing in CC. This is demonstrated by the fact that the codes from the literature review, i.e. Goo's framework, could be easily used to code the content of the interviews. The extent to which the SLA specification in ITO can be applied in CC, however, depends on the deployment model under consideration. The private cloud CC shares more similarities with traditional ITO and, therefore, it is not surprising that all traditional ITO SLA elements are applicable in the B-SLA. In the case of the U-SLA for public cloud CC, the interviewees identified two traditional ITO SLA elements that are redundant, and one that is partly redundant:

- *Innovation Plan*: There are two possible scenarios for innovations in the Public Cloud, i.e. incremental innovations that are rolled out in the background or innovations that are announced and rolled out at a specific moment in time (Marston et al. 2011). The SR has no influence on the service content in both scenarios; the SP determines the number and the nature of service innovations. Therefore there is no need for the SR to include the Innovation Plan element in a U-SLA;
- *Anticipated Change Plan*: in the public cloud the SP controls unilaterally the innovation of its services and such control applies also to unforeseen changes. When unacceptable unforeseen changes for the SR occur, the SR can invoke the Exit Strategy Plan element of the SLA, which is a new contractual element for the U-SLA defined later in this section.

The element that is only partly adopted in the U-SLA is the Enforcement Plan:

- *Enforcement Plan*: in traditional ITO the Enforcement Plan includes the exit strategy and reward/penalty specifics. In public cloud CC the penalty/reward specifics are not negotiable and are usually downloadable by the SR from the SP website. Therefore they cannot become part of a U-SLA. In the traditional ITO SLA specification, the Enforcement Plan includes also the Exit Strategy. A well specified Exit Strategy is the main countermeasure for SRs to overcome the problem of vendor lock-in. Given the importance of such issue in CC, the interviews suggest to include the *Exit Strategy* as a new and independent element in the Cloud SLA specification. As a result, the Cloud SLA specification includes the Enforcement Plan element only for the B-SLA, whereas the U-SLA will only include the Exit Strategy element.

The characteristics of CC entail the definition of two new SLA elements:

- *Data Code of Conduct*: CC inherently causes processes to become opaque (in public cloud to a larger extent than in private cloud). SPs are not or to some extent able to state the specifics of data policies. Compared to traditional ITO, where this was clear and did not require a separate contractual element, this must receive close attention. The Data Code of Conduct element includes the specification of boundaries for data storage locations (e.g., Europe only, exception for USA), and the identification of data access, change and deletion authorizations;
- *Exit Strategy Plan*: To overcome the issue of vendor lock-in, the exit strategy must become a first class citizen in the Cloud SLA specification. In CC it is of paramount importance to ensure the seamless subtraction of SRs data from the SP, allowing SRs to restore data at a different location/provider. The increased importance lies in the fact that data in the cloud are almost always intertwined with other customer data and their exact location is often unknown. This can cause issues when the SR wants to terminate the relationship. The element Exit Strategy Plan includes the specification of roles and responsibilities for the involved parties, time schedules for exit strategy activities, and conditions that cause the exit strategy plan to be invoked.

4 Evaluation

All CIO interviewees in the evaluation stage of our research considered the COF and Cloud SLA specification relevant and useful in a SR's perspective. We received comments mainly about the usability and the completeness of our results.

Usability. The members of the CIO platform acknowledge that they, as a platform, are working towards a checklist to assist companies in taking the necessary steps to be ready for the Cloud. The COF and SLA specification can provide a valuable starting point for such a checklist. They furthermore indicate that companies currently are struggling with the exact characteristics of services in CC and what the implications are for SLAs and contracts in general. Although, as discussed later, interviews remark the need to extend the breadth, i.e. more deployment models, and depth, i.e. service models, of our work, the COF and SLA specification can also be used as-is as an initial management tool. The companies that cooperated in the interviews, in particular, explicitly mentioned that they will distribute our Cloud SLA Specification internally.

Completeness. Comments about completeness have been interpreted as suggestions for possible improvement and extension of the framework and the Cloud SLA specification. Although they identified missing aspects in the framework regarding the deployment (community and hybrid) and service models (SaaS, PaaS, IaaS), the interviewees considered the study complete within its scope, with two exceptions related to (i) including industry specific aspects and (ii) the position of the CC outsourcing decision in the COF. The interviewees suggested that the SLA specification should take into account the specificity of the industry where the SR is operating. SRs in highly regulated industry, for instance, are more likely to focus their SLAs on security aspects, whereas providers of critical services will be interested in the performance and possible resilience of the cloud SP. A second important suggestion that emerged during interviews was to possibly delay the outsourcing decision point in the COF. Often, in fact, the decision to opt for a private cloud solution may be taken after a preliminary survey of possible SLAs offered by public cloud SPs.

Our work did not explicitly consider the impact of different service models (e.g., SaaS, PaaS, IaaS) on the content of SLAs in CC. There are, however, indications from the interviews that the different service models do influence the characteristics of SLAs. For instance, SaaS models may trigger further analysis of the SLA elements capturing policies about data management, i.e. data code of conduct and exit strategy. While IaaS and PaaS models usually consider data at a limited level abstraction, i.e. database instance, SaaS model introduce higher levels of aggregation, e.g. business objects in enterprise systems. Further investigation is therefore required to understand how to relate the management of low level database records to higher level entities, such as business objects, when services are retracted by the SR.

The U-SLA and B-SLA analyzed in our work can be used as a starting point for extending our work to include the service models as well. An extended version of our COF framework addressing these comments is presented in [10].

The scope of this research is restricted to the Public and Private Cloud deployment models. The interviews, however, have revealed that there is a practical need for the inclusion of the Community and Hybrid deployment models as well. Since these models derive from a combination of the two models that we considered in this paper, the results of our study should be applicable also to the other two deployment models with only limited further investigation. In particular, we argue that the Community deployment model can be assimilated to the Public Cloud model, provided that the SP has sufficient bargaining power to offer a U-SLA to the community of SRs. In the Hybrid deployment model, more attention has to be put on the analysis of those SLA elements that may cross the boundaries of individual clouds bound together in the hybrid model. The data code of conduct, for instance, should be drafted in such a way that data management policies become homogeneous across the SLAs established for each individual cloud entity.

5 Conclusions

In this paper we presented an analysis and specification of SLAs in cloud computing as compared to SLAs in traditional ITOs. We also discussed a framework to support the decision making process in CC outsourcing. The work presented here can be extended along several lines. From the research method perspective, our exploratory approach should evolve into theory building and hypotheses testing as more empirical data about CC adoption become available. From the research output perspective, we are currently working on extensions regarding different service and deployment models, the relative importance of SLA elements as related to industry-specific features, and new aspects and perspectives in the enterprise modeling of the CC outsourcing decision.

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Smart Home Information Management System for Energy-Efficient Networks

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Abstract. Energy efficiency of smart home systems imposes the intelligent management of a huge quantity of data and the collaboration between multiple stakeholders. Indeed, thanks to recent developments in ICT (Information and Communication Technologies) and IoT (Internet of Things), it is possible to achieve higher performances and offer new energy-control services. However, data must be not only retrieved but also translated into significant information and related to interoperable tasks. This paper focuses on smart home energy control and defines a methodology to improve smart home information management in order to create an extended energy-efficient network comprehending the distributed manufacturing enterprise as well as the energy utility and the consumers. The case study focuses on a sub-set of interoperable smart devices and shows how to apply the proposed information management model to make an extended virtual enterprise provide energy-control services.

Keywords: Energy-efficient networks, Interoperable smart home systems (SHS), Internet of Things (IoT), Virtual Enterprise (VE), Energy-control services.

1 Introduction

The growing attention to sustainability and the capabilities of recent technologies suggest creating intelligent networks to realize a more efficient use of the energy resources. Such an idea is particularly interesting if applied to smart homes due to the high environmental impact of the residential sector (about 20% of total consumption) and the direct involvement of the users and influence on their everyday life to realize energy efficiency. Indeed, a smart home system (SHS) has heterogeneous elements that need to perform joint execution of tasks in an efficient manner to be really interoperable. Nowadays, data aggregation and sharing within the networks can be guaranteed by modern Internet of Things (IoT) approaches and supported by available Information and Communication Technologies (ICT) tools. At the same time, networks are evolving from the traditional concept of distributed enterprise as an aggregation of manufacturing companies and their supply-chains [1] to a new concept of Virtual Enterprise (VE) based on open service ecosystems [2]: a distributed virtual network made up of devices, manufacturers, service companies, public entities, until

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 393–401, 2013.

customers and their homes. The high-level objective is creating a continuous flow of information within the VE that can be used to support real-time decisions, optimize the use of resources and increase safety and quality of life.

In this context, information management and interoperability are fundamental to achieve efficient solutions. Indeed, the rising intelligence of smart devices makes a large amount of data available, but their complexity hinders classification, transmission and interpretation of essential data. Both aspects may drastically reduce the potential benefits and limit the diffusion of smart home energy management [3]. As a consequence, devices' interoperability in smart home is still an open issue [4].

In this context, the paper proposes a structured methodology to properly classify significant information and intelligently manage the smart device information network according to the devices' interoperability potentials and the users' needs. The main scope is to make home devices really interoperable and provide energy-efficient services by involving all the network partners, which include also the final users. The paper considers the most popular home devices and proposes an information management model to be implemented by a knowledge-based tool. The case study shows how to use the proposed methodology in practice. In particular, it is adopted to investigate and manage a smart home network comprehending a set of devices and a set of actors to create energy-control services.

2 Information Management for Smart Home Interoperability

The smart home is a special place where all the sub-systems are interconnected allowing the users to save energy, to reduce operating costs and to improve safety, comfort and multimedia services [5]. It implies creating a distributed system with many entities working together about the home dwellers and managing the interrelations between different sub-systems (i.e. home automation, digital entertainment, assistive computing, healthcare, surveillance, energy management).

In recent years the attention is mainly focused on technological integration and sub-systems communication, that are based on device connectivity and home area network (HAN) [6]. A considerable amount of new solutions for smart home automation have been recently developed, but each of them generally has a different communication protocol and requires a specific architecture. There are open or proprietary systems: the former has public operating specifications and proposes a standard communication protocol that can be used by companies to develop compatible devices (e.g. Konnex, Lonworks, Zigbee); the latter are produced by a single company or consortium for specific home automation systems and the technical information are usually reserved (e.g. SCS by Bticino and Legrand, By-Me by Vimar, C-BUS by Schneider Electric). In both cases, the definition of standards and common rules almost within a certain VE are fundamental to make devices interoperable and integrate products from different manufacturers [7]. However the core difficulty is achieving interoperability inside the SHS that means among the home sub-systems [7], and within the VE that means among the involved partners, each of which has a specific roles). The connection between SHS and VE interoperability mainly consists of the ability to manage the home sub-systems in relations to the actors involved, which are internal (e.g. home dwellers) and external (manufacturing companies, maintenance service providers, energy utilities, etc.). The issue of interoperability is particular challenging due to the huge amount of data to manage, the level of complexity of the devices' integration and the different roles of the partners involved. As a consequence, even if the idea of smart appliances connected within a home network is not new, efficient smart home management has still numerous open issues.

In this context, the European Committee of Domestic Equipment Manufacturers (CECED) established a preliminary application profile for smart home to collect and transmit data. However, data are rarely converted into significant information and used for real time feedback. Recent studies proposed several system architectures for interoperability and energy management purposes [6,8], and several projects have been developed in different countries about these topics: Smart Energy 2.0 [9], Energy@home [10], E-Energy [11], ADDRESS [12], REserviceS [13]. Nevertheless, they deepen specific issues like monitoring, analyzing and estimating energy consumption [14], or investigate particular device applications (e.g. energy management by smart grids). None of them defines an overall and unique standard data management tool for high-level purposes. Other projects focused on data elaboration and data mining to realize services for different purposes, such as supporting manufacturing enterprises cooperation like MSEE [15], creating person-centric immersive environments like SM4All [16], or proving support to elderly people disabilities like HOPE [17]. However none of them cares about devices' interoperability and rule definition for information exchange between multiple partners. Furthermore TAHI (The Application Home Initiative) is working specifically on interoperability issues for the home [18], but VE is not considered.

In conclusion, even if different levels of interoperability have been recently defined (i.e. basic connectivity, network, and syntactic one) [6] and some companies have recently faced devices' remote control e.g. on white goods [19,20], real interoperability in smart home is not implemented yet due to: devices' regulation constraints, safety regulation constraints, and lack of interoperable system architecture. Indeed, interoperability tasks should be independent from the architecture capabilities and the devices' specific HW and SW characteristics [21]. In this context, applying a structured methodology for benchmarking smart home technologies and defining a successful knowledge management for smart home and connected VE is the starting point. The validity of such an approach has been demonstrated by past experiences in collaborative product design [22,23].

3 The Methodology for Smart Home Energy Management

The research presents a method to classify information for smart home energy management and define an intelligence-based model to manage interoperability and energy-efficiency in the VE. The approach can be synthetized in four steps:

1. Classification of smart home devices into homogenous classes (Tab.1): it considers the most popular devices in smart homes and catalogues them for typology, input and output data, and interaction modalities;
2. Identification of a set of significant information categories (Tab.2): it considers all the information to be managed in the smart homes for energy-control services;

Table 1. Information model device classes

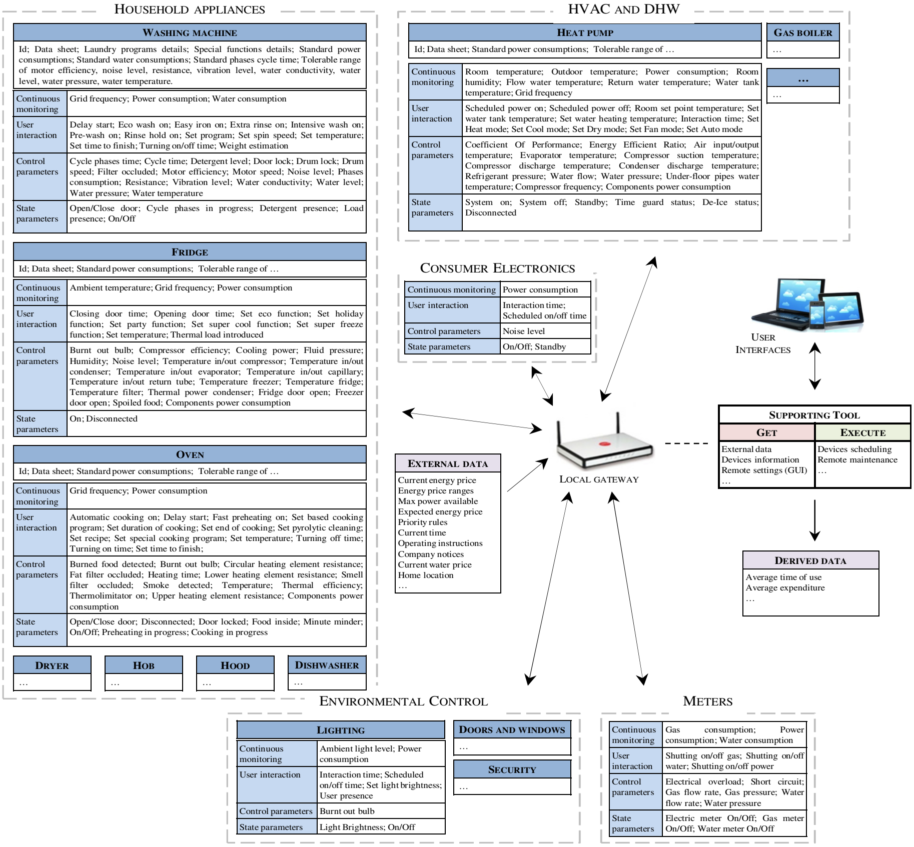
Device class	Description
Household Appliances (HA)	It includes different classes of devices such as refrigerator and freezer, oven, hob, hood, washer, dryer, and dishwasher, which are enhanced by a microcontroller to manage automatic operation mode and a communication node to make them connected (e.g. Ultra-Low cost Power-line (ULP))
Meters (M)	It includes electricity, gas and water meters, whose data are communicated through the home network and/or the smart grid in real time and can be remotely controlled. It can include also control and safety systems (e.g. electrical safety, gas leaks, water leaks)
Environmental Control (EC)	It comprehends common classes of components such as lighting, doors, windows, alarm system and sensors, window curtains and shutters, which can be grouped because they can be controlled by similar functions (e.g. turn on/off, intensity regulation, opening/closing control)
DHW and HVAC (HW)	It includes Domestic Hot Water devices (DHW), Heating, Ventilation and Air Conditioning devices (HVAC), and all the devices and sensors related to their functioning (e.g. sensors of indoor/outdoor temperature, humidity sensors)
Consumer Electronics (CE)	It includes a wide range of devices from entertainment (e.g. TV, game console, audio equipment and players) and small household appliances (e.g. coffee makers, electronic cutters or graters, toasters), which are characterized by constant and low energy consumption, and off/on switching

Table 2. Information categories

Information cat.	Description
Continuous Monitoring (CM)	It includes consumption information that is continuously monitored when the devices are turned on (e.g. energy, water), which can be used to provide a feedback to users and VE companies
User Interaction (UI)	It refers to all the information regarding the user-product interaction and characterizing the users behaviors (e.g. selected options, duration of use, time of use, frequency). Such data are used for statistic analysis and user behaviors investigation
Control Parameters (CP)	It considers the functional parameters of the home devices, which are continuously analyzed and compared with target parameters. Such data are used to predict problems, detect conditions, and supervise device functionality and user security
State Parameters (SP)	It refers to all information regarding the status of home devices, which is used to monitor a particular scenario or to carry out device remote control
External data (EXT)	It refers to data generated by external entities (e.g. building typology, occupants' characteristics, economic indicators, fees of utilities, climatic conditions) and device reference information (e.g. datasheets, standard consumptions, etc.), contributing to define the analyzed scenario
Derived data (DER)	It refers to data derived from post-processing elaboration and statistics analysis, which can be used for realizing specific service functionalities (e.g. average time of use, average expenditure over the time, use frequency)

3. Definition of an information management model (Fig.1): it correlates the information categories, the device functionalities, the input/output data and the VE actors for achieving smart home interoperability. For each device class, the information to be managed is identified. Also external and derived data are considered. At the same time, system actions are defined according to GET purpose (read and obtain information) and EXECUTE purpose (react and execute some commands). Also the data visualization for the different interfaces is defined. Finally, it allows defining the basic connectivity and network interoperability technologies to support the SHS design;
4. Definition of syntactic rules to create services: it provides a set of algorithms and interoperability rules to perform actions for energy-control services with reference to the VE actors (i.e. customers, energy utility, company depts.).

The smart home model proposed could be implemented exploiting the following technologies: power line standards for basic connectivity (e.g. X10, HomePlug), wired and wireless communication standards (e.g. TCP, Ethernet, USB, HomePNA as wired, ZigBee, Wi-Fi, Bluetooth as wireless) for network interoperability. Data are concentrated into a local gateway that bridges the HAN and the Internet [24].



HOUSEHOLD APPLIANCES

WASHING MACHINE

Id; Data sheet; Laundry programs details; Special functions details; Standard power consumptions; Standard water consumptions; Standard phases cycle time; Tolerable range of motor efficiency, noise level, resistance, vibration level, water conductivity, water level, water pressure, water temperature.

Continuous monitoring	Grid frequency; Power consumption; Water consumption
User interaction	Delay start; Eco wash on; Easy iron on; Extra rinse on; Intensive wash on; Pre-wash on; Rinse hold on; Set program; Set spin speed; Set temperature; Set time to finish; Turning on/off time; Weight estimation
Control parameters	Cycle phases time; Cycle time; Detergent level; Door lock; Drum lock; Drum speed; Filter occluded; Motor efficiency; Motor speed; Noise level; Phases consumption; Resistance; Vibration level; Water conductivity; Water level; Water pressure; Water temperature
State parameters	Open/Close door; Cycle phases in progress; Detergent presence; Load presence; On/Off

FRIDGE

Id; Data sheet; Standard power consumptions; Tolerable range of …

Continuous monitoring	Ambient temperature; Grid frequency; Power consumption
User interaction	Closing door time; Opening door time; Set eco function; Set holiday function; Set party function; Set super cool function; Set super freeze function; Set temperature; Thermal load introduced
Control parameters	Burnt out bulb; Compressor efficiency; Cooling power; Fluid pressure; Humidity; Noise level; Temperature in/out compressor; Temperature in/out condenser; Temperature in/out evaporator; Temperature in/out capillary; Temperature in/out return tube; Temperature freezer; Temperature fridge; Temperature filter; Thermal power condenser; Fridge door open; Freezer door open; Spoiled food; Components power consumption
State parameters	On; Disconnected

OVEN

Id; Data sheet; Standard power consumptions; Tolerable range of …

Continuous monitoring	Grid frequency; Power consumption
User interaction	Automatic cooking on; Delay start; Fast preheating on; Set based cooking program; Set duration of cooking; Set end of cooking; Set pyrolytic cleaning; Set recipe; Set special cooking program; Set temperature; Turning off time; Turning on time; Set time to finish;
Control parameters	Burned food detected; Burnt out bulb; Circular heating element resistance; Fat filter occluded; Heating time; Lower heating element resistance; Smell filter occluded; Smoke detected; Temperature; Thermal efficiency; Thermolimitator on; Upper heating element resistance; Components power consumption
State parameters	Open/Close door; Disconnected; Door locked; Food inside; Minute minder; On/Off; Preheating in progress; Cooking in progress

DRYER	HOB	HOOD	DISHWASHER
…	…	…	…

HVAC AND DHW

HEAT PUMP

Id; Data sheet; Standard power consumptions; Tolerable range of …

Continuous monitoring	Room temperature; Outdoor temperature; Power consumption; Room humidity; Flow water temperature; Return water temperature; Water tank temperature; Grid frequency
User interaction	Scheduled power on; Scheduled power off; Room set point temperature; Set water tank temperature; Set water heating temperature; Interaction time; Set Heat mode; Set Cool mode; Set Dry mode; Set Fan mode; Set Auto mode
Control parameters	Coefficient Of Performance; Energy Efficient Ratio; Air input/output temperature; Evaporator temperature; Compressor suction temperature; Compressor discharge temperature; Condenser discharge temperature; Refrigerant pressure; Water flow; Water pressure; Under-floor pipes water temperature; Compressor frequency; Components power consumption
State parameters	System on; System off; Standby; Time guard status; De-Ice status; Disconnected

GAS BOILER
…

…
…

CONSUMER ELECTRONICS

Continuous monitoring	Power consumption
User interaction	Interaction time; Scheduled on/off time
Control parameters	Noise level
State parameters	On/Off; Standby

EXTERNAL DATA

Current energy price
Energy price ranges
Max power available
Expected energy price
Priority rules
Current time
Operating instructions
Company notices
Current water price
Home location
…

SUPPORTING TOOL

GET	EXECUTE
External data Devices information Remote settings (GUI) …	Devices scheduling Remote maintenance …

DERIVED DATA

Average time of use
Average expenditure
…

ENVIRONMENTAL CONTROL

LIGHTING

Continuous monitoring	Ambient light level; Power consumption
User interaction	Interaction time; Scheduled on/off time; Set light brightness; User presence
Control parameters	Burnt out bulb
State parameters	Light Brightness; On/Off

DOORS AND WINDOWS
…

SECURITY
…

METERS

Continuous monitoring	Gas consumption; Power consumption; Water consumption
User interaction	Shutting on/off gas; Shutting on/off water; Shutting on/off power
Control parameters	Electrical overload; Short circuit; Gas flow rate, Gas pressure; Water flow rate; Water pressure
State parameters	Electric meter On/Off; Gas meter On/Off; Water meter On/Off

Fig. 1. Information management model for the smart home

The definition of a general model is the key point to realize intelligent-based services able to exploit device interoperability. Such a methodology supports the creation of a virtual smart home environment where systems data are managed and VE partners interoperate. It brings to the creation of a collaborative system for supporting dynamic virtual enterprise, similarly to recent experiences in product collaborative design [25].

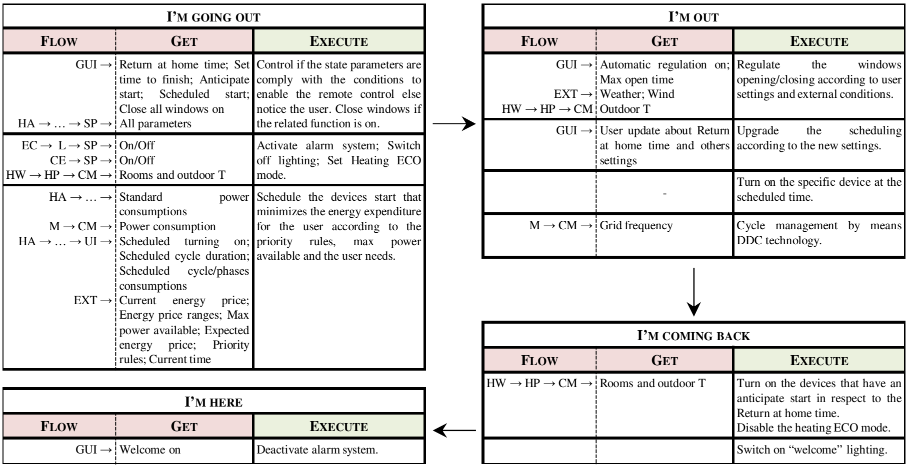
4 The Case Study

The proposed methodology is adopted to create an interoperable smart home network where all devices as well as actors involved cooperate to realize services. In particular, the case study focuses on energy saving and considers a set of appliances representing the most energy consuming and most popular devices in dwellings: heat pump (HP) for HW class; washing machine, oven, and fridge for HA class; lighting (L) for EC class; and a set of generic items for CE and M classes. Indeed, CE items can be generalized by considering a sub-set of information provided by a generic smart plug (e.g. energy consumption, interaction time and device status); similarly, M items can be represented by consumption and control parameters (e.g. short circuit, gas leaks, water leaks). The case study considers hypothetical system architecture as proposed in section 3: it is made up of a set of smart devices and smart plugs, a Zigbee communication node, a local gateway to collect all data and make them available to a central management system (i.e. Energy Manager), and a set of user interfaces (i.e. web or mobile apps). The Energy Manager can apply specific algorithms to properly manage data and provide commands. Interaction between the devices and the management tool is ensured by a dedicated application. Data can be accessed by dedicated interfaces, which consider the needs of the ecosystem actors: appliances producers (e.g. marketing dept., R&D, and service dept.), home automation supplier, energy utility, technical assistance companies, and the consumers. Two services are conceived and described below. Both services exploit the network interoperability to overcome the main limits of the existing systems, which usually provide just energy consumption visualization and regulation. The proposed scenarios offer advantages to all the ecosystem actors according to a "win-win" strategy. Obviously, private information and personal data can be properly treated to assure users' data security and protect private rights for the smart home dwellings.

Service no.1: Smart Device Scheduling
It offers an intelligent regulation of the devices' functioning to final users in order to save energy and reduce home consumptions. It indirectly allows also reducing the operational cost and improving the users' quality of life. The Energy Manager allows running specific algorithms for efficient device scheduling according to external parameters and user preferences. Figure 2 presents the *Out of home* scenario that consists of four modes: *I'm going out* is automatically activated when the user goes out; *I'm out* is activated during the absence to monitor the home devices according to the pre-defined preferences; *I'm coming back* is activated when the user comes back and uses internal and external data to enable the desired functions (e.g. turning on and preheating the oven according to the effective user's coming); finally *I'm here* considers the user's setting preferred when he/she is at home. For each mode, the system defines a set of actions (*EXECUTE*) to achieve the expected results according to the information received and read (*GET*). The service offers standard control actions (e.g. switching off lighting and alarm system), energy overload management and devices scheduling (i.e. according to the energy cost and user preference in terms of priority, start or finish time), upgrading according to real time user's notifications (e.g. change of the expected finish time for the washing machine), and grid balancing (e.g. windows opening regulation according to the weather).

Service no. 2: Recommendations for Optimal Use and Product Care
It aims to assure correct product maintenance and support the users in taking care about their devices by remote assistance and personalized recommendations. It finally

allows optimizing the devices' consumption and cost, and keeping the home safe. Such a service basically exploits CP data collected from the devices to automatically detect malfunctioning and run preventive or predictive actions. For instance, during washing machine operation "cycle phases time" and "consumptions" data can be transmitted to the technical assistance company or to the manufacturer to be analyzed.



I'M GOING OUT

FLOW	GET	EXECUTE
GUI → HA → … → SP →	Return at home time; Set time to finish; Anticipate start; Scheduled start; Close all windows on All parameters	Control if the state parameters are comply with the conditions to enable the remote control else notice the user. Close windows if the related function is on.
EC → L → SP → CE → SP → HW → HP → CM →	On/Off On/Off Rooms and outdoor T	Activate alarm system; Switch off lighting; Set Heating ECO mode.
HA → … → M → CM → HA → … → UI → EXT →	Standard power consumptions Power consumption Scheduled turning on; Scheduled cycle duration; Scheduled cycle/phases consumptions Current energy price; Energy price ranges; Max power available; Expected energy price; Priority rules; Current time	Schedule the devices start that minimizes the energy expenditure for the user according to the priority rules, max power available and the user needs.

I'M OUT

FLOW	GET	EXECUTE
GUI → EXT → HW → HP → CM	Automatic regulation on; Max open time Weather; Wind Outdoor T	Regulate the windows opening/closing according to user settings and external conditions.
GUI →	User update about Return at home time and others settings	Upgrade the scheduling according to the new settings.
	-	Turn on the specific device at the scheduled time.
M → CM →	Grid frequency	Cycle management by means DDC technology.

I'M COMING BACK

FLOW	GET	EXECUTE
HW → HP → CM →	Rooms and outdoor T	Turn on the devices that have an anticipate start in respect to the Return at home time. Disable the heating ECO mode.
		Switch on "welcome" lighting.

I'M HERE

FLOW	GET	EXECUTE
GUI →	Welcome on	Deactivate alarm system.

Fig. 2. Tool rationale of the "Out of home" scenario

Post-processing allows detecting whether the monitored parameters (e.g. motor speed, resistance) move away the standard or exceed the expected thresholds. Furthermore, analyzing the correlation between CP, SP, CM and UI data allows capturing also hidden malfunctioning (e.g. if the temperature in the oven is different from the set temperature, the system controls the program set and the resistance value and finally provides an alert). The user is noticed by messages about devices' troubles, necessary repairing actions or scheduled interventions.

5 Conclusions

The paper proposes a methodology to improve smart home information management by promoting device interoperability and network collaboration for energy efficiency. It aims to overcome the main issues of existing SHS by mapping the devices' functions and data, correlating the devices' functions with the smart home actions, and defining what information to send/receive to propose energy-control services. The case study shows how the proposed method can be adopted to realize energy saving services in smart homes by involving different network actors. The proposed examples highlight the achievable advantages: the customers have a continuous feedback on their product functioning, save energy and cost, and benefit from the reduction of failure rates and downtime; the appliances producers monitor their product by receiving useful information and can provide efficient and immediate assistance (Technical service Dept.), can highlight the most critical aspects to define design improvements (R&D Dept.), and can identify the users' behaviors to conceive new marketing proposal (Marketing Dept.); technical assistance companies and home automation suppliers can cooperate with the manufacturer to offer additional or customized maintenance services; utilities can create customized services and collaborate with the other ecosystem actors to create new business opportunities. Future works will be oriented to the development of a prototypal system to test services with the involvement of a real VE, and the definition of a proper data security protocol to protect the personal rights and privacy issues of the smart home dwellings.

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Service Design: Collaborative Methods and Tools

Service System Analytics: Cost Prediction

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Abstract. Services become every day more important for society. Cost prediction is one important aspect which has not received the required attention. Nonetheless, its impact on the economic success of service-based industries is considerable and, so, it cannot be overlooked. Therefore, in this paper we tackle the problem of cost prediction of service systems. Since previous work generally followed an ad hoc approach, we present a three layered approach based on customer factors to measure customer involvement since it is a good predictor for service cost. Service co-creation between customer and provider is the central concept of our costing approach. For service modelling we use Linked USDL, and to reason on costing data we use methods from service analytics. On the one hand, we reduce the uncertainty introduced by customers and can predict more accurate service costs. On the other hand, the systematic approach enables a better understanding of the costing problem and the service systems under study, and increases reusability of service analytics algorithms.

Keywords: Service cost modelling, service analytics, Linked USDL, co-creation, customer factors, service system, customer involvement, service modelling, business analytics.

1 Introduction

During service provisioning, provider and customer are part of a service system to co-create a service. The process of co-creation requires both partners to invest resources (e.g. human resources, knowledge, and energy). Co-Creation is a concept which is not limited to Business-to-Business (B2B), it can also be observed in the Business-to-Consumer (B2C) context. In B2B and B2C both partners participate and invest resources into co-creation. Service provisioning also requires a provider to integrate and account for providers' human resources and customer factors (CF). Customer factors are all the tangible and intangible aspects which influence co-creation and can only be provided by the customer. Examples of customer factors include information,

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 405–414, 2013.

knowledge, experience, and commitment that customers bring in during the co-creation. For a provider, customer factors are a source of uncertainty since they affect service performance and service costs [2]. To reduce the gap between forecasted and real service costs, the modelling and understanding of customer factors and their impact on costs is fundamental. This will increase the precision of service cost modelling.

We propose an approach to extend established service costing methods with customer factors. The approach requires modelling the concept of service systems to facilitate inferring service costs by means of service analytics. We model service systems using the Linked Unified Service Description Language (Linked USDL). Since the consumed time of a resource can be used as a proxy for cost, we will rely on the process model of USDL to calculate the required time to complete a service. In other words, USDL enables to build a process model of a service which can then be used for service costing.

To achieve this goal, an extension of the business process is necessary to integrate customer factors on service cost. In our approach, we extend processes by adding a new view for costing in the form of a function to measure a customer's individual influence on service performance. For each identified customer attribute a function is constructed and mapped on the customer factors. USDL serves as a service model which provides a schema that enables methods from the field of service analytics to derive cost information. As a result of our study, we concluded that Linked USDL provides a suitable logical framework to reason of services' characteristics such as cost. With our research we want to find answers to the following questions: Does a systematic approach yields a greater precision for service-based cost modelling? Can the element of co-creation and customer factors yield better models for cost modelling? We claim that a systematic approach 1) including customer factors, 2) using service schema/instance modelled with USDL, and 3) services analytics methods can provide a sound solution for service-based cost modelling.

Service costing and service analytics have a direct impact on the competitiveness of organizations and on the reinvigoration of service-based economies. A better estimation of the cost of services based on customer factors leads to more fit service offerings.

This paper is organized as follows. In section two we describe a maintenance service to motivate our proposed approach. Section three introduces related work. Afterwards in section four the concept of customer factors is presented. In section five we write about service modelling and show how customer factors can be integrated into Linked USDL. In the following section six we describe concepts of service analytics and finally we conclude in section seven.

2 Motivation Use Case

Our use case is based on a world-wide offered B2B maintenance service of a medium-size manufacturing company producing medical devices for laboratories. Co-creation starts when the customer contacts the provider since maintenance is due. We divide co-creation into provider and customer domains and analyse service activities which (1) are required for co-creation (2) and with a direct relation to the offered service. To co-create maintenance the provider has to perform all or only selected service activities. This means which business partner is responsible for, which service activity and, which service activities have to be performed, is defined and documented before co-creation. To document this kind of commitment the usage of a Service-Level Agreement (SLA) is a possibility. In our case identified service activities are check device status, send spare parts to customer, send technician to customer, install spare parts, update device software and teach the usage of new functions. To account for a provider's service costs, it is necessary to measure the cost effects on service performance during co-creation. For example to co-create service activity check device status the provider's performance, and activity time consumption, relies on a problem description submitted by an employee of the customer. Because the maintenance costs vary for each customer the provider requires a flexible costing approach. Furthermore, instead of having fixed costs for the maintenance service, the provider wants also to include customer depending factors.

3 Related Work

Activity-Based Costing (ABC) is a well-known approach to account service costs. ABC has its origin in the manufacturing industry [3]. A further development of ABC is Time-Driven Activity-Based Costing (TDABC). Here time is regarded as the leading cost driver. Because most of the supplied and consumed resources like employees and machines can be measured using time. In contrast to ABC, the approach of TDABC is easier to maintain and to keep the used costing data up to date [4]. In production theory a similar concept, compared to our customer factors, exists based on production factors and factor combination [5]. Production factors are split up in internal and external factors. A production factor can be, for example, a defective medical device, information, or the customer himself. The internal factors are entities that are provided by the producer. The customer supplies the external factors. It is not possible for the provider to produce or buy external factors on the market. Also the associated knowledge is under control of the service customer. The producer is forced to integrate it into the production process. Factor combination means that internal and external factors are combined to obtain the desired product. This implies that both sides have to provide resources during co-creation [6].

In contrast to ABC and TDABC we also consider customer introduced uncertainty. Compared to production factors, we present a concept extending to the customer domain, called customer factors.

4 Co-Creation and Customer Factors

We use the developed concept of customer factors to quantify the uncertainty introduced by a customer and rely on TDABC to compute service costs. Standardisation of service processes is difficult due to the heterogenic nature of services [7]. Because of heterogeneity, customer factors vary in quantity and quality. From a practical perspective it is impossible to model all the changing customer factors. Our research work is focused to measure the impacts on service performance and not the kind of individual customer factors.

To understand the monetary impact of customer factors we made a literature review with a focus on the following three aspects. (1) Is the exchange of resources associated with co-creation? (2) Are customer factors used to calculate services costs? (3) Which kind of customer attributes are used to describe customer factors? We can summarize that there is a common understanding about a necessary resource exchange between service provider and service customer. We could not find specialized methods trying to measure the impact of customer involvement on service costs using customer factors. In all selected articles we could find a, detailed or at least a vague description about the, correlation between customer involvement and costs. The kind of stated customer factors or customer attributes range from not precisely specified to concrete values [8], e.g. health care information [9], project complexity, company size, experience [10], commitment, information [11], co-creation activities [12] or knowledge about customer profiles [13]. Based on this input we argue that each customer provides individual customer attributes and it is necessary to consider them for performance measurement. We have derived four abstract customer factors: co-creation, information, technology and experience. They are conceptualized to measure the impact on activity time consumption. Subsequently cost can be calculated based on activity time using the associated resource cost e.g. the salaries of employees. We have defined customer factors which are easy to associate with customer related influence on co-creation process. From previous publications, e.g. [14], we know that a clear semantic of customer factors supports applying a costing method designed for services. Using individual customer attributes to describe the general concept of customer factors requires a generalized approach and stable mapping from attributes to factors and from factors to resources. Metrics for customer attributes must be defined for each service case individually. This procedure enables our approach also to provide reasonable values for changing and difficult to quantify customer input. The discipline of service analytics provides techniques supporting the identification and calculation of service attributes. We use three abstraction levels to map the concept of customer factors to service costs. The first level is used to capture customer individual attributes like company size or number of employees and map them to our four customer factors. Customer factors constitute the second level. The mapping of a customer attribute to a customer factor has to be decided individually and is based on the expressed semantic meaning. For example number of employees can be associated with information and capacity of internet connection with technology. For the third level, Time-Driven Activity-Based Costing, customer factors are then mapped to the concept of TABC. Customer attributes are not directly mapped to TABC to have a stable relation between customer factors and their impacts on service costs. We have selected the following four customer factors because (1) they provide a comprehensive selection, (2) their intention is clear, (3) they are applicable to different service cases and (4) are able to capture the complete range of possible customer attributes and service characteristics. The CF are:

Co-Creation (C_i): Describes the level of co-creation. A high co-creation level indicates a high level of customer involvement. The more activities are performed by the customer the higher the level of co-creation. Co-creation is the ratio between the number of involved service activities and the number of service activities performed by the customer. Compare also (2) where the first term is used to calculate C_i.

Information (I_i): For a provider, I_i measures the degree of dependency on external information. An example customer attribute from our maintenance scenario mapped to I_i is the average number of service activities per co-creation.

Technology (T_i): Indicates the importance of technology during co-creation e.g. infrastructure capabilities or IT service availability. From our service case we can map the average number of e-mails to T_i.

Experience (E_i): Indicates the degree of experience and competencies that are required by the involved human resources in co-creation. We can map the time being in relation with a customer or number of maintenance co-creations to E_i.

All four customer factors are applied on an individual activity A_i, see (1). Variables I_w, T_w and E_w are used to weight the impact of these three customer factors and enable weighting varying importance of customer factors. Please note that the weight of the customer factors can be different. Only the sum must be 1 to get a normalized value, which is subsequently comparable between service cases and customers.

$$CF_{Ai} = I_i * I_w + T_i * T_w + E_i * E_w, \text{with } (I_w + T_w + E_w) = 1 \quad \textbf{(1)}$$

To get individual customer factor values (I_i, T_i and E_i) we use the formula e.g. $I_i = \frac{\sum_{j=1}^{m} CA_i}{m}$ where CA_i are customer attributes and m is the different number of CA_i mapped to I_i. To map a customer attribute to a customer factor we use the injective function $f: CA_i \rightarrow CF_{Ai}$. The output of our service model for service S_i is a parameter value indicating the impact of customer involvement during co-creation, compare (2). Where $CF_{S_i} \in R$ and only activities A_i are including where C_i is 1. The value of C_i can be 0 (not an involved service activity) or 1 (is an involved service activity). The usage of C_i allows calculating individual service costing scenarios for different customers. To increase the importance of an individual customer attribute, it is also possible to weight the individual CA_i like described for CF_{Ai}. For this paper we have selected the average method to calculate a single customer attribute, which has no negative consequences to the semantic of this concept.

$$CF_{S_i} = \frac{\sum_{i=1}^{n} C_i}{n} + \frac{\sum_{i=1}^{n} CF_{A_i}}{n}, n \text{ is the number of service activities} \quad \textbf{(2)}$$

5 Service Modeling

So far, current approaches for service analytics look into developing algorithms to provide insight on, e.g., cost estimation and service performance. Nonetheless, the object of analysis, the service system, is not conceptualized. This leads often to the development of algorithms which are hard to reuse since they are developed to analyze particular services. Therefore, we propose and rely on the adoption of an abstraction by using a “master schema” for representing services. For our work, we use Linked USDL (the Universal Service Description Language, www.linked-usdl.org), one of the most comprehensive service models developed up to date when compared to WSDL, OWL-S, SAWSDL, hREST, MicroWSMO, WSMO-lite, or WSMO [15].

Considerable improvements were made to technology with the introduction of Service-Oriented Architecture (SOA) concept. Nonetheless, one of the main limitations is that service-orientation was introduced to solve integrations problems. SOA was biased by an enterprise-centric vision. Linked USDL was developed as an answer to this partial view by bridging a business, an operational and a technical perspective on services. The language models service concepts and properties such as service level, pricing, legal aspects, participants, marketing material, distribution channels, bundling, operations, interfaces, resources, etc. Linked USDL is a language which has evolved from USDL [15] by using a semantic representation for the schema.

5.1 Linked USDL and Service Costing

Linked USDL provides a wide range of concepts which can be used for costing. These are organized in 4 modules: core, pricing, service level, and legal. In this paper we will only use the core module to provide illustrative examples, namely:

- `usdl:service` & `usdl:InteractionPoints`. A service is described by a set of interaction points. Interaction points have been introduced in the context of service design and blueprinting [16] and have gained a wide adoption in service marketing and operations management. Each service activity from our scenario has a set of interaction points. Using Linked USDL, these points are identified and represented with USDL.
- `usdl:InterationType`. An interaction is characterised with a mode (manual, semi-automated, human-machine, machine-human, or automated) and a space (on-site or remote). Both, the mode and the space, provide additional information on an interaction which enable a better cost estimation.
- `usdl:receives` & `usdl:yields`. An interaction involves the exchange of resources (e.g. information. documents, knowledge, etc.). The concept receives captures the resources needed for an interaction to take place, while the concept yields describes the resources that are generated.

During service provisioning, information pertaining these concepts is captured and integrated. It constitutes a base for a systematic service costing and service analytics.

5.2 Questions Answered by Linked USDL

The Linked USDL can "answer" to various competency questions [17]. For example, "*which participants were involved during the interaction points of the service activity process customer inquiry*". These can be seen as primitives that service analytics can rely on to identify hidden patterns associated with cost. In this section, we illustrate how they are related to service costing. Examples were selected to answer to three types of questions (identified with CQ1-3) which involve the concept `usdl:InterationPoints`: *who*, *how*, and *what*.

- Who (CQ1). *Who was involved during the provisioning of a service or a particular interaction point?* An answer to this question provides information for the CF co-creation C_i and CF experience E_i. Two types of information can be obtained. On the one hand, the role of a business entity involved (e.g., customer, provider, observer, or third party supplier) and, on the other hand, the role taken when participating in the interaction. For example, if the interaction role was 'observer', then the impact of the customer on co-creation and service cost would be lower than if its role would have been an active 'participant'.

- How (CQ2). *How was the interaction conducted?* The degree of automation of an interaction (e.g., manual, semi-automated, or automated) is related to service cost, but the relationship is not always trivial. An answer to this question provides information for the CF co-creation C_i and CF technology T_i. .
- What (CQ3). *What resources were used during interactions*? The use of more or less resources influence the cost and complexity of an interaction. Therefore, resources need to be an integral part of a CF evaluation function. An answer to this question provides information for the CF information I_i, CF technology T_i and CF experience $E_{i.}$

It should be noticed that the variation of the cost and customer factors associated with the situations described by these questions is context (service, customer) dependent.

5.3 Using Linked USDL for Service Analytics

Once Linked USDL is populated with instances which represent the provisioning of services, it can be queried by algorithms from the field of service analytics. In this section, we will provide an explanation of the underlying idea. The following example illustrates the application of competency question CQ1 to identify the roles of the stakeholder (i.e. entities) who were involved during the provisioning of the service `Maintenance` by executing the various activities of the associated process (i.e. from check device status to teach the usage of new functions) from our motivation use case (see Section 2). We use SPARQL to define queries since this is the language commonly used to query RDF structures, the underlying representation format of Linked USDL.

```
PREFIX usdl: <http://www.linked-usdl.org/ns/usdl-core>
prefix gr: <http://purl.org/goodrelations/v1>
PREFIX rdf:http://www.w3.org/1999/02/22-rdf-syntax-ns#

SELECT ?ip ?interactionRole
WHERE{
   ?service gr:name ?name .
   ?service usdl:hasInteractionPoint ?ip .
   ?ip usdl:hasInteractingEntity ?ie .
   ?ie usdl:hasEntityType ?businessRole .
   ?ie usdl:hasInteractionRole ?interactionRole .
   FILTER regex(?name, "Maintenance") .
}
```

The query starts by identifying all the interaction points executed during the provisioning of the service `Maintenance`. Afterwards, for each interaction associated with, e.g. checking devices status or sending spare parts to customer, the query identifies the business roles of the stakeholders involved using the variable `?businessRole` (which can take the form of a regulator, a producer, an intermediary, etc.) and the interaction role involved using the variable `?interactionRole` (e.g. an observer, a participant, an initiator, a mediator, etc.). This information about *who* was involved during the realization of interactions points is then used by algorithms from the field of service analytics, e.g. clustering and classification algorithms, to extract new knowledge which enable to create better cost estimates.

6 Service Analytics

Within the process of co-creation, where both partners bring in their knowledge, skills, and resources, both partners form a service system [1]. For realizing service analytics for cost accounting, there is a need to capture, process, and analyze data within such a service system. This application where analytics supports services systems has been proposed as services analytics [18]. Service analytics can be decomposed along two different dimensions. The first dimension distinguishes the different types of data sources, whether the data was tracked within the provider organization, at the customer side, or during the encounter between both partners. Therefore, section 6.1 illustrates potential data types which could be used. The second dimension to distinguish service analytics is based on different levels of maturity of applied methods, from basic analytics (reports and queries) and advanced analytics (statistical analysis and data mining). Section 6.2 therefore illustrates a method of applying advanced analytics which could be used for service costing.

6.1 Mapping Data Sources to Customer Factors by Means of USDL

We propose a semantic layer on top of the different data sources, which enables the mapping of data sources to customer factors, by specifying the calculation of customer metrics which refer to customer attributes.

- *Co-Creation* (C_i): A good source for deriving metrics for co-creation would be historical encounter data, containing information on the past interaction between the customer and the provider organization through different channels. Using USDL, this interaction data can be analysed in order to derive meaningful metrics for interaction, such as analysing participants and their roles in meetings.
- *Information* (I_i): For deriving metrics related to customer information, analysing documents of past customer projects could be helpful. Using USDL, it would be possible to identify the documents required in each step of the process. Afterwards the quality of these documents could be benchmarked and compared to the average quality.
- *Technology* (T_i): Using USDL, which allows modelling technology as a resource, enables an analysis of technology involvement in the past customer projects. A potential data source to investigate would be vouchers of invoices, if the usage of specific technology has been billed individually in the past.
- *Experience* (E_i): As USDL allows modelling individual participants, the experience of each involved human resource in a specific point of the service process would be possible. A good data source would be a time tracking database, where employees track their specific activities for a customer project.

6.2 Applying Analytics

We propose using data mining for predicting customer attributes and finally estimating service costs. Data mining targets at discovering patterns in data in order to derive predictions [19]. The input for running data mining algorithms is a set of instances. Each instance consists of values of a fixed, predetermined set of features, called attributes. An algorithm is then applied to the set of instances to discover patterns and structures that can be used to make predictions about unknown data. In our case, we would analyse data from past maintenance services and services provided to the same customer, of which we want to forecast service costs. The calculated metrics and historical service costing results would serve as our attributes. Forecasting costs requires the prediction of a numeric quantity. However, we cannot assume a linear correlation between calculated metrics and costs. Therefore, non-linear methods are required. Potential algorithms are e.g. Neural Networks, Polynomial Regression, or k-Nearest-Neighbour. The derived models are then applied to new cases where service costs need to be estimated.

6.3 Example of Customer Factor Calculation

Based on input from the customer care database, we can define nine different customer attributes (three for each customer factor). Examples for this nine attributes are (1) the quality of the problem description for I_1, (2) the number of required diagnostic devices for T_1, and (3) the experience of the contact person for E_1. For each customer attribute we have used an individual metric, e.g. the length of a problem description for (1). With a forecasted weighing (I_w=0.4, T_w=0.25, E_w=0.35) and a C_I=3.33, we obtain customer factor values for ten different co-creation instances (CC_i) of (43,43,40,40,30,33,30,30,30,30). From these results, we can conclude a varying customer involvement from CC_1 to CC_6 and stabilization from CC_7 to CC_{10}. The decreasing customer factors suggest a decreasing customer attribute quality with negative consequences to reach forecasted service costs. To identify the cause of change a drill down to individual customer attribute values is possible and necessary.

7 Conclusions

From provider side service costing needs more attention. Since current models, such as Activity-Based Costing (ABC), lack accuracy when applied to services and ABC ignores the central aspect of co-creation. Our work tries to overcome these problems using the concept of customer factors to decrease uncertainty about service performance. With our customer factors (co-creation, information, technology and experience) we are able to measure a customer's individual impact on co-creation. Customer factors are integrated into our three layered approach using customer attributes, customer factors and Time-Driven Activity-Based Costing. Another aspect which has not been explored, is the development of a systematic approach to analyse service systems. In this field, we proposed an abstraction layer (by relying on Linked USDL) which mediates the data sources and enterprise information systems which store service instance data. This layer serves as a conceptual model which simplifies the development and reuse of algorithms for service analytics. In the future, we will exploit the potential of service performance measurement by combining our proposed approach with methods from operations research.

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The Struggles of Co-creation – The Highs and Lows of Involving Stakeholders into the Service Design Process

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Abstract. This paper presents our experiences from a research project on how to co-develop new methods for idea generation within a service design practice. As an example the paper describes how service designers used two visual inquiry methods together with customers and employees in different service situations. The results show that that there is great potential in developing methods for co-design work based on design approaches. This project relies on a mindset where materials of different kinds, that can be organized and reorganized in different ways are used. This supports a way of creating knowledge that facilitates production of other results than the purely verbal. We have also realized that it requires a great amount of work to achieve a great result.

Keywords: Business Development, Co-creation, Co-Design, Idea Generation, Visual Methods, Service Design.

1 Introduction

In this paper we present our experiences from a shorter pilot study on how service designers can use visual inquiry methods to engage with and create knowledge about people's service experiences, needs and expectations.

The main objective with the study was to explore and develop two methods for idea generation in the beginning of a service design process. The aim was that these methods would be based on co-design, i.e. to let customers, employees and other stakeholders create knowledge together, which many consider to be a very successful approach to create innovative solutions [10], [12]. Researchers from various fields have for many years claimed that the design praxis is undergoing a radical transformation and therefore needs new relevant design methods [10], [3]. Some of the newer methods that are used in design and service design processes have their

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roots in ethnology and are considered to support the understanding of user needs and their preferences. Other methods have a background in marketing or business development. Often methods with very different ethos are mixed without awareness of the methods' different intrinsic approach. Design work creates awareness of future opportunities. In this knowledge based work, it is an advantage if people with many different skills and experience are involved. Co-creation and co-design is considered by many to be very successful approaches in order to create innovative proposals. Others believe however, that it is too costly and time consuming to involve many different stakeholders in the design work. The focus of this project was therefore to experiment with and analyze the processes of co-design and co-creation and try to create a methodology and comprehensive approach to this work be performed in an economically satisfactory manner.

Within this research project focus has been on methods that are design-related, i.e. methods that support work with a design point of ethos. The learning is largely taking place by simultaneously working with the proposed solution and the severity of the situation, which is often referred to as a “wicked problem” [7]. Assessments are the only way to evaluate, because within this design approach there’s no right or wrong way, only better and less good suggestions seen from a specific perspective [1]. The work of this research project is characterized by the exploratory approach using visual and physical tools. The knowledge created often contained more useful nuances than words alone.

The design approach can be perceived as imprecise and uncertain by people from other backgrounds used to solve distinct and well-defined problems. It is therefore important to be able to demonstrate the results of these methods and their ability to create knowledge and ideas for desirable, profitable, future products and services. We begin by describing the project background, and then describe the two visual methods and our experiences using them in a research project. We conclude by suggesting how others can use the method and describing how we hope to use it in the future.

2 Project Background

The study was a collaboration project between a group of design researchers from two universities; Linneaus University (Lnu), and Konstfack (KF) and a group of design practitioners from Transformator Design AB (TD). The study of the methods took place during a five month period inside a real design case called ABC that TD was responsible for. The aim of ABC was to help a service provider (the client) to create significantly better service experiences for its customers. In order to create knowledge about how both TD and the other stakeholders experienced the two inquiry methods, we visited different service situations where we tested, analyzed and interviewed both service providers and service buyers.

2.1 Aim and Research Questions

- How will service designers perceive visual inquiry methods?
- What usability and experience issues will be found from the method prototypes?

2.2 Method

This study consists of the design and evaluation of two visual inquiry methods.

3 Prototype Development

In order to test and evaluate the two inquiry methods, a series of different paper prototypes was designed and used in live settings.

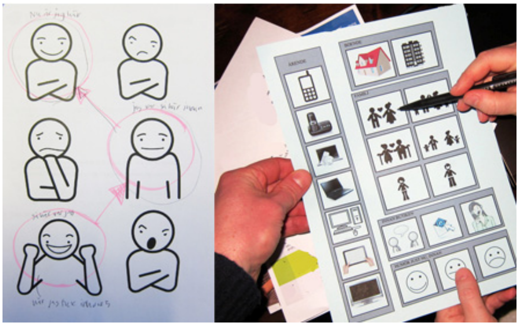

Fig. 1. Discussions among the project participants about the first versions of prototypes 1 and 2. By ensuring that all participants could see and touch the prototypes, the group could empathize with how the methods might be experienced in different contexts.

3.1 Prototyping Method 1

The inspiration for the prototypes of method 1 comes directly from Lucy Kimbell [2]. It is a method founded on an icon-based interface. The method supports both designers and non-designers to start building a better understanding of how people/customers are a part of a large network and the fact that they are not independent actors. Every human being is always and all the time linked with a number of people, organizations and objects.

These people, organizations and objects can act as generators to create new ideas. By bringing together or replace any of the above things, new ideas and design opportunities will emerge. This phenomenon is called bisociation in the field called collective creativity [10].

Story world can be used as an aid in both individual interviews and in collaborative design activities. In interview situations, the method is meant to be used as a support and basis for the questions by the interviewer to the interviewee.

By using the different icons in the method you will create a collaborative picture of how things fit together. Both the one who asks the questions and the one who answers are given the opportunity to generate new ideas.

"With this method services can become more valuable to customers and users, Easier-to-use, with fewer resources wasted on implementing the right ideas in the wrong way (or on the wrong ideas entirely)"

(Kimbell & Julier 2012).

3.2 Prototyping Method 2

The inspiration for the prototypes of method 2 comes from a tool that was already part of TD's work process. It was a LEAN inspired whiteboard where employees of TD could use colored post-it notes to show the executed and non-executed tasks [4]. The aim of method 2 was to use a version of TD's Lean-inspired whiteboard as part of communicate and move idea generation to where the employees context.

The boards described a number of tasks, both using images and text that the customer service employees in the ABC project should test in their meetings with the customers. When the customer service staff in the ABC project performed tasks they wrote down what they did and how they felt on post it notes and then placed them on the board where they thought they belonged. The idea of the boards was that they should work both with and without support from TD. Once a week TD would visit the workplaces to collect the thoughts and ideas that the employees had created. These ideas were then refined by TD and reused in a variety of collaborative design activities with participants in the ABC project.

4 Testing the Method Prototypes

The first method tested in the study was method 1. It was tested in stores by three designers from TD. The test opportunity was a half-day activity where TD could try out the method on six different customers. The method is also used for a longer interview. Because of the tight schedule of the ABC project, there was no time for any follow-ups to further test the method in stores. The material created during the tests were picked out and reused in another activity the next day.

Fig. 2. The second generation of method 2 was tested on employees in the customer support. Method 2 became a meeting point for TD and the ABC Company. The boards created a curiosity among the staff and this led to new dialogues between the different departments.

During the tests of method 2 the boards were placed in both stores and in the customer support office. In the shops the boards were cramped in to already minimal coffee and lunch rooms therefore they were hard for the employees to use. But in the office of customer support the boards could take a more central role. It was placed on the middle of the customer service staff workroom, where it was visible from all sides.

5 Evaluating the Prototypes

The methods and results were mainly evaluated continuous throughout the project, both by TD and the researchers. But at three specific occasions the team earmarked time to reflect and evaluate the results.

The first occasion was a collaborative mapping activity that the researchers had created and led. In this activity, all project participants created a large map of the things they had done and experienced so far during the project. By using this way to create knowledge, the researchers could visually follow the participants' perception of where the problems, ideas, conflicts, comments, mistakes and creativity had occurred during the project. This way of evaluating the methods gave us a good picture of the context and network that the methods, project and the people belonged.

The second evaluation time was an anonymous questionnaire that was sent out to all project participants from TD. The idea of the survey was to focus the questions and answers only to method 1 and 2. Because of the tight schedule of the ABC project this survey was not prioritized by TD. Only one survey came back to the researchers.

The third and last assessment was an attempt to move both the participants and the methods out of the ABC project and into a lab environment at Konstfack. The purpose of this was to get away from the frames of the ABC project put on the research project. We wanted to see if we could lift the methods from a specific context and evaluate and develop them from a more general perspective. Three of the participants from TD and researchers attended the meeting. The activity lasted for about two hours and during that time managed the group discuss the methods and developed the icon tool into four new concepts on how the tool could work in a digital environment, like the iPad.

6 Results

Based on the three evaluation assessments, we can only highlight a few, incomplete and general conclusions about the methods. But after listening and reading TD's opinions on method 1, we can generally say that the method was appreciated in particular the icons with different facial expressions. The icons change TD's normal work process where visualization and idea generation usually comes more towards the end of the design process. But because of facial icons TD started to create and use ideas and visual solutions at the beginning of the ABC project. Another noticeable change was that the face icons gave TD a more nuanced picture of the client's situation than what TD usually gets when they use other methods. Through facial icons customers were forced to really think about which emotion best matched their experiences.

Method 2 was perceived by TD as stiff and sometimes hard to use. When TD was not in place, the methods were not used. In the stores, they were not used at all. But as soon as TD was in place and was able to coach the employees, the boards worked much better. The boards became a place where both TD and the employees could interact. The boards could be seen as boundary objects [11].

What was perceived as bad with the method 2 was that it did not encourage a dialogue between TD and the employees. It was also difficult to understand the pieces of information that the employees posted on the board. Although there were many new and exciting ideas it was in the end difficult to trace them to the person and context. The methods were overall appreciated by TD but they will need more time and experience to refine them. The fragments that we managed to gather during the research project suggest however that the methods succeeded in generating relevant ideas and involve more stakeholders in the TD-design process.

7 Reflections

The conditions for implementing this project have been very good. Service designers with highly relevant knowledge and experience have been working closely together with scientists who have extensive experience in the development of design methods. The ABC project, where the exploratory work has been conducted has offered a great complexity and many diverse environments and situations to work with method development.

7.1 Conflicting Goals

The designer often empathizes with the end-user (customer's customer) but often the client has the most say in the project. It may seem like conflict to choose whether to focus on what is valuable to the "end user" or the company's sales and profits. The concept of value is itself an example of the different discourses used. A common discourse argue that value is created in the moment of use, ie. when the end user uses a product or service that creates value for this person [3]. This can be seen as a relational and constructivist approach, which believes that individuals perceive certain events as meaningful and that give people value. Products and services have meaning and value is created when used [3]. This approach is advocated widely including one of the most important business thinkers of our time, CK Prahalad. He wrote that "value is based on unique, personalized experiences of consumers." And "even companies serving 100 million consumers need to focus on Individuals." [6]. In design, with its focus on the "end user", it is obvious that the value is created during use. Both these approaches have their own logic, but if these two very different approaches to the concepts of value occurs in the same project, it is easily creates confusion and uncertainty. In the past decade we have increased our understanding of the above dilemma when forced to choose the focus on either the user or the others involved, such as the employees. In order to work against several unclear interlinked objectives, we believe that a tangible exploration approach may have more success than one that relies on only verbal arguments. But the language is of course extremely important, and it is of the utmost importance that the work gives heed to the concepts of different and constantly changing interpretations and reinterpretations.

7.2 Co-design, Does It Mean Extra Work?

The work with co-design in this research project has taken much more time than estimated. It seems that the work has given very good results in terms of knowledge of customers and employees, and also concrete concepts for improving the customer service of ABC. This preliminary study has shown that there is great potential in developing methods for co-design work based on design mentality. I.e. that projects uses a mindset where materials of different kinds can be organized in different ways, thus supporting a different way of creating knowledge than the purely verbal.
We have also realized that it requires a great amount of work to achieve a great result.

Transformator Design had already good experiences of having the customers' involved in the design process, but they partly lacked a clear methodology and comprehensive approach on how this work can be done in an efficient manner. This project has demonstrated that a co-design work can give very good result, but it takes a lot of work. In conclusion, we believe that it is possible to further develop and refine these methods so that they become more efficient.

8 Conclusions and Further Research

This paper has presented a project that should be seen more as a pre-study and the results indicate interesting possibilities for future explorations. Co-design was the overall approach and the way of involvement was through a visual thinking approach where materials were used that afforded to be organized and reorganized in different ways. This enabled stakeholders to contribute with relevant input and reflections to the larger commercial project that this study was part of. The emphasis of the final workshop was to develop opportunities for further research and here it was obvious that some kind of development of software support for service design processes is desirable. The challenge here will be to support the ease of manipulation, structuring and restructuring of the information that seems to be key affordances of the methods being developed, while at the same time integrate the possibilities that software has over physical artifacts.

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Adapting Service Design Tools for the Media Industries

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Abstract. The paper raises questions concerning how Service Design tools and methodologies might be adapted to the particular needs of industry, enabling their autonomous use by non-designers. The potential for incorporating Service Design thinking into the creative media industries through the development of tools tailored to the industry needs and aspirations is here narrated through the experience gathered by the Moving Targets project, which has been developing a series of tools that merge basic design tools with the development of 'props' specific to the field of creative media and audience involvement. Reflecting on the project's work embedded in industry and design-led research processes used in the development of those tools, this paper offers a critical analysis of the value and challenges of this type of work, where the transformational role of design can be at odds with the traditions and cultures of industrial processes.

Keywords: Service Design, Tools, Media Industries, Knowledge Exchange.

1 Introduction

This essay reflects on some of the work developed by Moving Targets - a three year Knowledge Exchange project based in Scotland and funded by the Scottish Funding Council through the Horizon Fund. The project partners are University of Abertay and University of Edinburgh in liaison with industry, agencies and audiences.

This research project was triggered by the increasing pervasiveness of digital devices and the expansion of broadband internet which are changing the ways in which media content is consumed and produced. Moving Targets takes a cross-sector approach to these transformations in industry and explores the development of innovative models for audience engagement in the digital era.

The project was conceived with a 'fuzzy front end' approach [1] [2], placing the emphasis on the framework –a multi-disciplinary team and a series of knowledge exchange methods – leaving the outcomes undefined. This demand-led approach ensures the continuous adaptation of the project to current and relevant issues in the rapidly shifting technological and social contexts faced by the creative industries. Moving Targets' research – mainly of a qualitative character – includes literature review, semi-structured interviews with practitioners in the creative industries and the analysis of case studies. Participatory observation and 'design-led research' [3] was undertaken in collaboration with Scottish media partners through placements, design and strategy consultancy, the development of prototypes and workshops where discussions and collaboration between participants are driven by tailored activities.

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The scope and impact of the research are limited to the companies engaged in the activities proposed. Working across diverse industrial and cultural sectors – from videogames to theatre and poetry to film – enabled us to identify common gaps and challenges. However, the Scottish media industries are largely comprised of micro-companies, often with very small numbers of permanent staff. Therefore, the development of autonomous tools is sought with the transformational aspiration of building "organisational capacity for on-going innovation" on audience and content strategy employing a user-centred and holistic approach to the media experience [4].

This paper responds to Daniela Sangiorgi's call for reflection and evaluation of the contexts in which design acquires a transformative role [5]. Thus the focus of this essay is not to describe the tools developed, presented elsewhere, but discussing the value and challenges of applying a Service Design approach to media production and the potential for adapting its tools to the needs and inspirations of the industry.

2 Steep Learning Curve

Knowledge Exchange projects begin by placing participants out of their main domain of expertise so as to identify issues within actual commercial contexts and explore how their skills can serve to support industrial activities. This is a challenging approach and has an implicit steep learning curve, demanding an adaptive researcher who can rapidly acquire knowledge of the methodologies, languages and tools used by a specific industry. In this case, Moving Targets has taken a cross-sector approach, multiplying the need for understanding the processes followed in different sectors and communicating effectively across them. Unless the appropriate knowledge is acquired and relationships built any transformational aspirations are worthless as they will not be inspired by truthful insights and thus not be supported by the stakeholders.

In order to engage companies, academics need to be able to offer concrete services that demonstrate the value of that collaboration in advance. However, in the early stages of a project that potential value is the object of research and what is being explored. During this learning or adaptation period there is little else but good will and uncertainty. Researchers are familiar with dealing with uncertainty and the academic environment embraces exploration and is adept at managing failure. The difference is that in industrial contexts such uncertainty can represent an unacceptable risk. We must therefore reflect on the ethics and repercussions of this kind of work. Academics are exempt of many types of liability, beyond their individual reputation – though to be fair so are industry consultants. But there is also a collective academic reputation. Companies may become reticent to engage with academia if previous experiences did not satisfy their expectations. The practice-led approach offers a solution through learning by doing, but that entails risks that not every company is willing or able to take. At this point of the argument we have reached the 'knowledge exchange paradox': What came first, knowledge or practice?

Looking at our experience, the resolution of that paradox seems an inevitably iterative process in which the degree of exploration is gradually increased. It is only when an essential understanding and knowledge of the industry is constructed that the researcher can gain the trust required for a successful embedding. In order to build that basic understanding, together with reading and training in specific areas of media production, our initial effort was invested in exploring and becoming knowledgeable around the trending topics in the different industries, being up-to-date with the latest developments. This enabled the researchers to integrate themselves in a variety of media and creative communities, achieving insight through informal conversations at networking events. Furthermore, the tension between exploration and instant tangible value was resolved through two knowledge exchange mechanisms.

On the one hand, the participation of industry partners in shaping the project brief aided giving focus and establishing collaborations in advance. The researchers were embedded within companies through placements. Businesses benefit from having an extra pair of hands working on their projects, while the researchers can experience the industry dynamics from within. However, prior to this embedment some preparation is required so as to avoid any negative impact on the company's work flow.

On the other hand, 'unobtrusive consultancy' was provided early on – meaning that the work was undertaken outside the company. After a few meetings with the company, to identify their needs and the potential value of the researcher's contribution, work could be developed independently and reported back. This type of work enabled us to identify the value of certain Service Design tools, such as the development of stakeholder-maps, personas or user-journeys, which proved useful for gaining insight for content development and audience strategy. Further 'hands-on consultancy', in the form of workshops tailored to the companies' needs, could be undertaken once these benefits became clearer. Note that it was only after eight months of researching media initiatives and working with industry that the potential value of adapting Service Design tools arose. Thus the initial focus on learning moved towards more exploratory and collaborative models of design-led-research.

3 The Trigger for Change

Audiences are taking a more active role in the production and consumption of media. The development of new technologies have offered the public access to user-friendly production tools, networked communications, collaboration and distribution platforms[6] [7]. This has blurred the boundaries between consumers and producers, giving rise to terms such as "prosumers" [8]. The proliferation of user-generated content through the internet, spontaneous creative communities, crowd-sourcing and public interactions through social media, have triggered a desire within media companies to incorporate these new forms of participation into their traditional models.

Businesses and creators now have the chance to

- engage users in more meaningful and direct relationships,
- learn from them in order to provide better experiences
- and sustain their engagement beyond a specific media project.

The consumption of media is no longer a one off event, as these relationships become extended in time. Our understanding of media moves from product to experience. This longitudinal dimension and the new interest in using participation as a means of enhancing engagement have provided our project with the context to explore the incorporation of Service Design thinking. The development of a visual taxonomy for audience involvement led to the generation of a card-based tool (Fig. 1) to explore alternative approaches to audiences and mapping the users' relationships with content. This tool is a first step to introduce the user-centred and holistic approaches into the industry, but we continue developing similar work focused on understanding users.

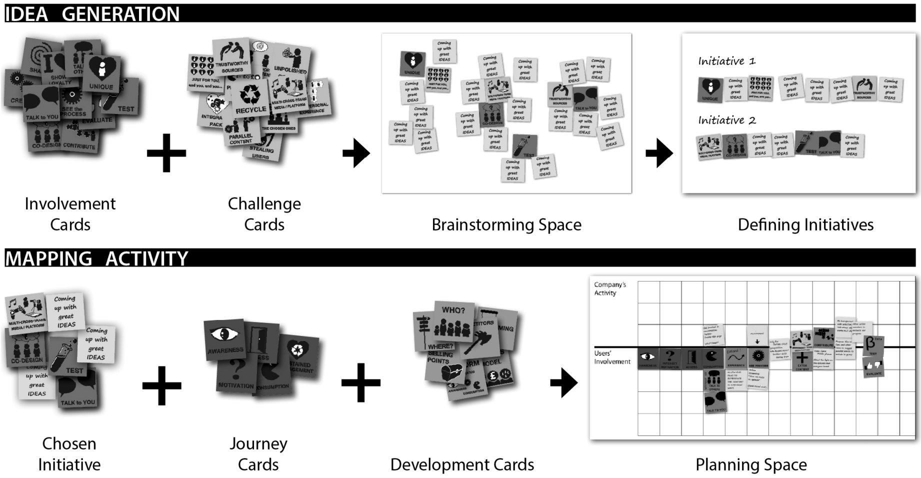

Fig. 1. In order to provide some context on the kind of tools developed by the project, the image above represents the props and activities designed for the Audience Engagement Tool

4 Value and Frustrations of the Service Design Perspective

Some of what we consider to be the most relevant applications of Service Design methodologies to the production of media are also some of the most frustrating when it comes to their actual incorporation into existing industrial processes. Some of these contributions imply a change of culture and therefore their integration takes more than just the development of suitable tools. In this section we will comprehensively reveal industry needs identified through our research, the value in applying a Service Design approach and the challenges of their integration with existing systems.

4.1 Users at the Core of Any Activity

Traditional media companies are concerned with re-engaging the 'missing audience' that migrated to the internet and never returned to traditional media. Media analysts speak of the fragmentation of audiences and the increasing challenge of engaging audiences who are willing to contribute to the costs of production in a digital environment. These media debates are primarily concerned with the development of audiences, their engagement with media content and monetisation.

However, our experience within the media industries suggests that the creative processes of media production rarely start out focused on users but, more often, begin with an idea for a piece of content that the creators find of interest. Consideration of the audience doesn't tend to materialise during the design and development stages but is left to later stages concerned with product placement and marketing. The key question in this context is: To whom and how can we sell our existing content? However, a Service Design approach might ask earlier in the process: How can we implement our idea to satisfy the motivations and expectations of our potential users?

Aiming at exploring the value of this approach, two different tactics have been employed. Initially, externally developed reports were delivered which included qualitative research on users and competitors, user-personas and journeys as well as design insights drawn from the research. Further integration of this approach is sought through facilitated sessions were the tools are used by the creators. In both cases the knowledge generated has proven to be useful for content and strategy development.

However, a key frustration for the Service Design approach is in arguing against the preconception that user research and understanding only has a role in developing marketing strategies and is not required for the generation of content. The only established 'early' involvement of users we have observed is that of testing digital interfaces, but this is usually focused on testing the usability of technology rather than the ideas or content it carries. For many media creators the idea of actively involving, or trying to empathise with, users in the conceptual stages of a project is perceived as diminishing the value generated by the unique artistic vision of the creator. This attitude contradicts the creators' desire for developing meaningful relationships with audiences, leaving those interactions restricted to post-development phases.

4.2 Beyond Consumption

An emphasis on implementation leads companies to consider the media experience limited to consumption. This approach overlooks relevant gaps in the experience that may entail a loss of users even before they reach the content. However, by taking a Service Design approach and without playing down the relevance of the content, the media experience is comprehended as an integral journey from initial awareness to sustained engagement. Ideally every step in that journey considered relevant by the user should be so for the creators. Aside from the fact that some sectors have a greater control of the pre- and post- content consumption experiences, simply mapping out the users' journeys has proved useful, whether companies control every step or not.

For example, by developing the emotional journeys for avatar creation in a fashion game, it was foreseen that the questions proposed and transitions through the steps in the body-shape definition may be perceived as invasive by some users. However this issue was not dealt with until the data returned proving that an 80% of users left the game at this stage. was considered merely as a routine step towards accessing the content and not especially relevant. This indicates not only the value of using a user-centred approach and tools to empathise with users but a mistrust of qualitative analysis by industry.

Understanding the users' decision making processes and their pre- and post-consumption journeys have proved useful for other companies in informing their strategies, strengthening motivations for specific users or developing complementary services. Thus we claim the value for media production in breaking down the user's experience into coherent journeys where 'touch points', or elements of interaction, can be identified and designed, depending on the user. Communicating that value to companies might be challenging but the real challenge is to embed this procedure as a way of working rather than as an externally developed asset.

4.3 A Holistic Approach to Making

The lack of integration of different implementation aspects and stages, is another issue encountered in the production of media. Design studies indicate an increase in quality and decrease in development issues, when time is allocated for design and planning considering all aspects involved [9] [10]. However, small companies tend to concentrate their resources on production *stage by stage*, failing to sustain a holistic vision of the creation processes. This narrows the vision of the project and entails a de-contextualisation of problem solving and thus risks incoherent strategies.

We have witnessed how the detachment between design and technology can generate delays due to gaps between visual content and display platform. Similarly, not establishing an initial set of values – building on user understanding and the content qualities – has led to develop incoherent marketing campaigns that attempt to grab users' attention through the wrong means, attracting the wrong type of users or creating unrealistic expectations. Identifying early in the process which elements of the experience will not be affected by the technology has enabled to start producing content wisely before a final decision on an appropriate platform is made.

Despite the value of establishing connections between all aspects of production to explore more coherent solutions before initiating implementation, few companies involve experts from different departments in strategy development. This is perceived as a 'managerial' activity and does not provide an instant tangible outcome.

In the production of media content many creators face a constant tension between artistic and commercial value. These two sides of the same coin clash and companies find themselves compromising the integrity of one to fulfil the requirements of the other. Many companies define projects as 'commercial' or 'commissioned' (those that bring in revenue) and 'our own' (those through which they express their creativity). We suggest that artistic and commercial values can be complementary if both aspects are considered equally and integrated into the creative process from the beginning and the focus is placed on the users rather than on the implementation of the content.

5 Contributions to Sustainable Reindustrialization

Our work within the media industries is proof of the value of incorporating Service Design thinking into the production and commercialisation of media. The shift from product to service is being pushed by the development of digital technologies and the increasing users' expectation of being provided with seamless experiences. Increased sustainability in media production could be seen reflected through several aspects:

- improved quality of the media services provided and associated audience strategies by deepening the creators' understanding of and empathy with their users and taking a more holistic approach towards the users' experience
- deepening their relationships with audiences by exploring new models for co-creation, feedback and involvement during the creation processes

- improving the creative and technical development of the content by taking a more holistic approach to the different aspects of implementation

But our desire for incorporating these transformations does not override the fact that the determination for change has to come from within and the integration of these new approaches will not happen immediately. We appreciate how the developments of new technologies, specifically the internet, are accelerating the evolution of these mind-sets and more user-centred and holistic thinking are now taken by both large companies and open-minded individual creators. But their full integration in the industry is likely to require of the renewal of the core understanding of media – from sole-creator and mass-consumed to collaborative and personalised. A few generations may be required for these methods to become part of the 'media language'.

6 Conclusions

Reflecting on this work we can now speculate on the long and short-term value and challenges of incorporating Service Design thinking into various aspects of the media industries and through different means, which may be transferable to other industries.

Small companies often identify their lack of users' understanding or global strategy as being due to a lack of resources - mainly time, budget and expertise. We believe the first two issues respond to a question of priorities and have pointed out the lack of value given to intangible outcomes, such as strategy, or the mistrust towards qualitative design research techniques. Therefore, shifting these approaches requires a change of mind-set that will only come with proven value.

It is, however, in the field of building expertise that we see the short-term value of adapting Service Design tools to media production. But tailored easy-to-use tools do not seem sufficient for the integration of design thinking, as its application requires of the development of a variety of skills, of which some entail extensive learning through practice or could be considered as natural qualities. What would be the value of these tools without the capability of translating insights into design or strategy specifications? Empathy, for instance, is an important skill in a designer. Being able to understand and experience a product or service as its users would do is a valuable capability when it comes to developing quality experiences. But how is this taught, especially in an environment where time is a scarce resource? These are the kind of issues our research is only beginning to explore.

However, the complexities inherent to this process do not overshadow the potential value of integrating Service Design into media production. Developing autonomous tools that embed a smooth learning curve is a challenge we are willing to take, and the enhancement of Service Design thinking in media studies is worth pursuing.

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From Service Design to Innovation through Services: Emergence of a Methodological and Systemic Framework

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Abstract. The current crisis conducts companies to seek new solutions for growth. In this context, the still new field of Service Design (SD) is gaining more and more attention. Easy to use and based on collaborative processes, it enables to achieve quite quick results. However the SD process is mastered by few actors inside organizations. There is a need to scale up the process to the whole organization. To achieve that goal, SD needs to undergo an industrialization process. What's more, doing SD projects is not enough to change a company. SD has to be linked to transformation strategies. This paper introduces a dedicated framework which is based on four basic components all along the Service Design process: Knowledge, Software tools, Communities and Places. The paper mainly focuses on the first two components. It will be illustrated with a complete demonstration during the session.

Keywords: Service Design, Knowledge Management, Service innovation software, service strategy, collaborative process and tool, innovation places.

1 Introduction

Considering the manufacturing slowdown of these last decades [1], the deep change of our economy and society towards services, and the policies that have been advocated over the world, the reindustrialization is still a challenging topic. Service appears as an interesting economic, social, emotional response. Companies seek for new sources of growth beyond the mere production of tangible goods and value of utility. They have discovered the strategic role of services and try to strengthen their culture and strategy towards this direction [2]. But they are completely disarmed against this fuzzy notion and the way of finding opportunities, developing and deploying them [3], and even more against the required global transformation.

Service Design [4] is useful to address these issues. It is a relatively new approach. Most of the Service Design process is done during collaborative workshops, with the use of tools and methods helping the co-design of the service. But they are still handmade. Capitalization, semi-automatic analysis, process acceleration, remote collaboration, indicators recovery in real time, etc. are thus not possible. Moreover launching a service (successful or not) does not mean for a company to undergo a sufficient transformation to survive or grow on a long run. Some Service Design projects enable to reach both goals (as the Gjensidige insurance company project, in

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Norway, that has succeed in shifting from a pure insurance point of view to the design of new services for people aged 20 to 30 based on a banking and insurance bundle [5]), but most of them don't.

This paper introduces a systemic framework to bring a comprehensive and equipped approach of the service innovation process to companies. To respect the paper format, we only present some screenshots but the session will be the occasion of a case study demonstration. Section 2 presents the service innovation [6] approach as a holistic and opened [7] but still handmade practice. It starts from the general Double Diamond diagram and proposes a framework that deals with the necessary construction of a long term strategy. Section 3 details two main components of this framework: Knowledge and Tools. It gives an overview of the exiting tools and presents Umagus, a dedicated software. It also introduces the two other components: Places and People. Finally, Section 4 concludes and gives some perspectives.

2 Building a Holistic Approach for Service Innovation

2.1 A Service Innovation Knowledge at the Scale of the Whole Organization

Even if is a quite general guide applicable to all design tasks, most of the academics and practitioners agree to describe the global Service Design process in the Double Diamond shape proposed by the British Design Council in 2005 [8]. It is based on 4 major phases: Discover, Define, Develop and Deliver (figure 1).

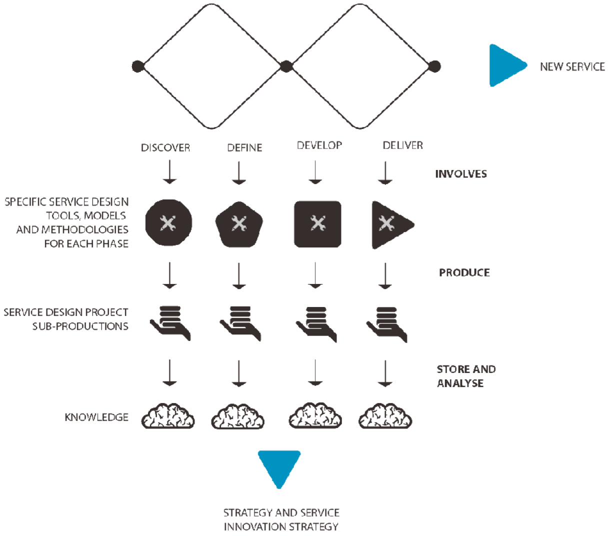

Fig. 1. The Double Diamonds shape within a global strategic reflection

Each phase allows achieving new steps in the innovation project. At the end the company should had a clear outcome: a brand new innovative service. But the Service Design process has to be kept alive after the end of the project... There are still very few companies having a real service innovation department, policy and/or strategy. Moreover, many valuable outcomes (knowledge, deliverables and interactions) are lost after the double-diamond process.

2.2 A Handmade Practice That Requires a More Structured Approach

To do Service Design [4], most of actors regularly use a common set of tools and methodologies such as personas, customer journeys, stakeholders mappings, service blueprints, prototyping (storyboards, mockups, aso.) and business model canvas. This Service Design methods and models are often used during collaborative workshops to find opportunities/ideas and/or to conceive a service. They vary from phase to phase. Sometimes the tool is an outcome that may be used directly all along the innovation and the delivery process (eg. Personas). Sometimes the tools are just a way to achieve a step (eg. stakeholders maps). But they all are rich findings and productions gathering a lot of information and knowledge that are lost or unused due to the nature of the materials (post-it, paper, etc.) and the temporary nature of the moment (fig.2).

Fig. 2. Examples of handmade persona and customer journey

We argue that these findings and productions are largely underestimated on a long run, and very rarely used to build a long term strategy. That's why we propose the following framework to store, manage and analyze all service innovation projects' findings and productions to "feed" a continuous service design portfolio management linked to the global organization strategy, and to be able to achieve its transformation. Moreover, companies' service design stakeholders often are a distributed and multi-disciplinary (engineers, sociologists, economists, etc.) community who has to describe and analyze complex phenomena. This leads to a lack of collaboration and consensus, and a risk for the service and product-service launched on the market.

2.3 A Framework to Define a Transformation Process through Services

These difficulties lead us to the assumption that there is a need for a comprehensive approach of the service innovation process and for an appropriate way of spreading a real service design culture among a company. Taking this into account we propose a new framework (figure 3) that will be partly developed in section 3. It aims to enrich the Double-Diamond horizontal logic (figure 1) with a vertical and systemic logic.

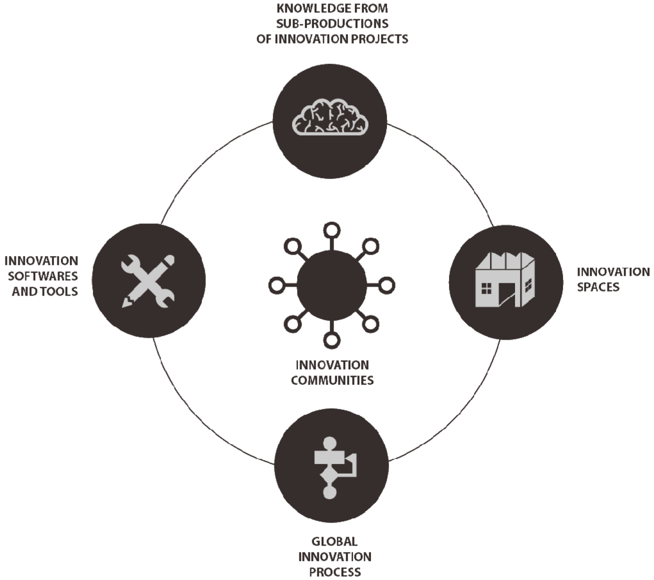

Fig. 3. Methodological framework for a global transformation through service

The systemic perspective of this framework aims to ensure the consistency between the transverse processes of innovation and capitalization, the findings and productions it generates, the tools that are used to industrialize it, the places and the communities that use them. We are developing each inter-related building block according to this systemic perspective. The global innovation process relies on a very iterative approach to design and test new services based on the users knowledge and, at a higher level of abstraction, to consider all strategic and organizational insights and constraints to implement a successful transformation. This paper focuses on two findings/productions and softwares/tools, and briefly presents the two other blocks.

3 Using the Framework to Foster Service Innovation and Companies' Transformation

3.1 The Knowledge Findings and Productions of Service Design Projects as Key Elements to Identify the Strategic Constants

The findings and productions of Service Design projects is the container and revealer of all the knowledge and data of the under construction service. In a non-exhaustive way and in relation to the Double Diamond phases, it takes the form of:

- « discover »: a set of ethnographic « traces » such as photos, videos, verbatims, etc. ; a set of knowledge data stemming from the watchful activities ; a set of discovery deliverables such as personas, maps… ; a set of outcomes from the co-design workshops such as reports, posts-its photos…
- « define »: prototypes, tests reports, more advanced deliverables, strategical reports, design constraints, service blueprints, user experience repository….
- others phases: service specifications, touchpoints, job descriptions…

The definition, capture, treatment and reuse of these materials (cards, post-its, recordings, photos, videos, logs, etc.) within each service design project are essential to ensure the successful design and delivery of the service and the global transformation. Indeed, these elements have to allow the identification of strategical constants. They put forward insights, concepts, moments of truth, user perceptions, risks, cultural and organizational failures...revealing the need for strategical decisions, processes improvement, human resources recruitment and training, technical development, and so on. Thus service design methods and tools have to be part of a decision-aided approach that intends to bring growth and differentiation to companies.

3.2 Existing Tool-Related Works to Support Some Service Design Phases

Few works exist on the capture and semi-automation of required elements. Most of them propose creative methodologies and toolkits but few works really speak about a technological and complete solution. However, it is essential to capture/accumulate a lot of service design knowledge and data within a specific database to envisage the comparison and analysis of designed services or service design processes.

We can cite an Austrian initiative called myServiceFellow [9] and stemming from the results of a research project of the Management Center Innsbruck – MCI Tourism, financed by the Tyrolean science fund and the hardware kindly supported by mobilkom Austria. myServiceFellow was a mobile ethnography application for smartphone. It allowed the capture of customer journeys and their enrichment (photo, video, voice). We can also quote the well-known Swiss works on the automation of Business Model Canvas modeling/use [10] through an application available on iTunes. Another interesting project is the European project MEPSS (Methodologies for Product-Service System) that has worked on a web-based tool for the development of product-service systems. MEPSS proposed a modular approach to guide companies in the process of “developing and implementing a successful and sustainable product-service system”[11]. The Creative Design Institute of the University of Sungkyunkwan is also working on intelligent tutoring systems that aim to investigate computer-based aid to product-service systems design. This Korean team is developing a software primarily based on the service blueprint [12].

In another field than Service Design, there are also some initiatives within the SSME (Service Science Management and Engineering) community. For example SOMF (Service Oriented Modeling Framework) has been proposed by Michael Bell and implemented in EA8 of Sparx System [13]. But, even if it is dedicated to the modeling and specification of high-level service systems thanks to a specific language and a diagram of interconnected atomic and composite entities, it is still IT-oriented.

3.3 Umagus, a Way to Scale Up and Automate the Overall Service Design Process

As part of a research and development project on the transformation process through services, and in order to implement the second building block of our framework (softwares and tools) which is still not completely addressed, we have worked on the conception of a specific tool and its database called Umagus (figure 4). Umagus aims to scale up and shift from the current handmade approach to an industrialized approach with a structured and semi-automated process. In its first version, it is a web-based platform to support the innovation process and keep the value of its findings and productions. Technologically speaking, it has been developed as a SaaS platform with a graph-database given the nature of the studied phenomena as heterogeneous and interconnected entities [14] and given the few constraints of this kind of database which does not require joint relationships between pre-established tables and which can store a huge amount of data.

Permettre à des personnes d'entreprises de discuter affaires dans un cadre convivial.

Fig. 4. Some screentshots of Umagus (projects, dashboard, persona and journey creation)

Umagus is a comprehensive "user experience-oriented" solution for services innovation and management. It enables to capture, organize and visualize "a large amount of information about the targeted company, its value chain, its activities or its users' profiles and usages" [15]. Umagus also facilitates inter-trade co-creation. Indeed, service design is natively a co-design approach. Thanks to collaborative and versioning functionalities, Umagus manages the cooperation of multiple participants in a project, allowing them to share their individual production and interact over it in a synchronous or asynchronous way, but also to think about and produce directly together. It improves the flow of data between distant stakeholders and helps them to appropriate new methods and models. It is thus a good solution to capture, store and visualize complex systems and to facilitate calculations on these systems thanks to algorithms. Key functionalities have already been implemented, tested, validated and used by some companies: service innovation projects management, heterogeneous data and knowledge management (user, market, aso), key methods and models integration and enrichment (persona, service journey with key stages and moments of truth, service blueprint, storyboarding…), dashboards generation (for services managers), service visualizations for different stakeholders, technology or product functionalities specifications from a service system perspective.

Umagus aims to become a key help for companies and service designers to do projects quickly and to don't lose any data and any value from the findings and productions of the service innovation process. But, to go further than the functionalities, our R&D project now focuses on analysis and comparison of all the data that are generated by service design projects and capitalized into Umagus. We are also developing calculation methods for identifying value and innovation forms. This is a work in progress based on all the data and productions we have already captured during more than three years. It will be described in further publications.

3.4 Innovation Places and People

Innovation places play a more and more important role within organizations. As a short illustration, we are running a research and development project with a company in the field of aeronautics that aims to create a place and a team dedicated to innovation through services. This project has led us to translate the global service innovation process into specific spaces to meeting the needs and constraints of each phase of the double-diamond. These arrangements are built to enable the physical regular encounter between people, knowledge, tools and process. They are a real proof of the will of companies to change from service design projects to a global transformation through services.

Beyond the places, people are one of the main service innovation pillars. As for technological innovation, companies are starting to create dedicated communities for service innovation. These communities are organized around service design projects, but they are also the backbone of the organizational global change. They need specific animations and motivational tools that we are currently working on and will be the object of further publications.

4 Conclusion and Perspectives

Starting from the traditional Service Design process, which is based on an existing set of tools and methodologies, we have seen that companies tend more and more to develop a more comprehensive approach of service innovation, in order to achieve a global transformation of their business. Service Design needs to adapt to that trend, scaling up in terms of adoption. That's why we believe that automated solutions for service innovation and design will be more common in the future. They will be linked to global innovation solutions enabling to keep and build on the value of findings and productions of all service innovation projects. What have been done in technological innovation seems to happen also for services innovation. It is just in its early stages.

Umagus is now used during service design projects within industrial and servicial companies. We have now to pursue its use to feed the database and to integrate new kinds of analysis and calculation to make it more automated, collaborative and robust.

Other current works concern the deployment and test of dedicated places. These perspectives and their implementation will be the objects of further publications. An oral presentation would be the occasion to concretely demonstrate our works through a simple service design case.

Finally, it seems also interesting to consider Umagus and the overall framework we conceived as possible supports for service design education since this field courses and programs are still under development and will benefit from it.

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Stimulating Collaborative Relationships

Simulating the Influence of Collaborative Networks on the Structure of Networks of Organizations, Employment Structure, and Organization Value

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Abstract. From the perspective of reindustrialization, it is important to understand the evolution of the structure of the network of organizations employment structure, and organization value. Understanding the potential influence of collaborative networks (CNs) on these aspects may lead to the development of appropriate economic policies. In this paper, we propose a theoretical approach to analysis this potential influence, based on a model of dynamic networked ecosystem of organizations encompassing collaboration relations among organization, employment mobility, and organization value. A large number of simulations has been performed to identify factors influencing the structure of the network of organizations employment structure, and organization value. The main findings are that 1) the higher the number of members of CNs, the better the clustering and the shorter the average path length among organizations; 2) the constitution of CNs does not affect neither the structure of the network of organizations, nor the employment structure and the organization value.

Keywords: employment structure, organization value, collaborative networks, job reallocation, simulation, clustering coefficient, small-world, network model.

1 Introduction

Industrialization has given birth to an economic world in which manufacturing of goods and services is the base of the society. In many industrialized societies, major economic changes, such as globalization and specialization, have led to a shift from an industrial economy to a more service-oriented one. This evolution is referred to as *deindustrialization*. A commonly accepted definition of deindustrialization is "the decline in importance of manufacturing industry in the economy of a nation or area" [1]. Two processes are at work during deindustrialization [2]: on the one hand, specialization of organizations on their core competences increases their productivity. Next, this increase of productivity leads to a reduction of the quantity of human resources needed to create a given value. Therefore, less people are needed in the industry. On the second hand, the wages are superior in the service sector than in the

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 441–450, 2013.

industry. As a consequence, a reallocation of workers from the industry to the service sector may be observed. These two processes combined together lead to a decrease in the number of employees working in the industry, associated with a reduced number of industrial organizations. In parallel, there is a rise of the number of organizations and employees in the service sector [3].

It has been argued that deindustrialization has dramatic effect on many economic and social aspects of local, regional, national and transnational economies. Besides the rise of unemployment, deindustrialization leads to strong limitations with regards to innovativeness: the lack of industrial partners to design, develop, and prototype new products is a strong brake to innovation [4].

Therefore, in many post-industrial countries, the process of *reindustrialization* is currently under scrutiny. Reindustrialization is the renewed development of the industrial sector. Although the idea of reindustrialization is not new, the rise of the economic importance of the People's Republic of China, especially with regard to the industrial sector, has given rise to a debate on the importance of reindustrialization.

The question of the importance of reindustrialization is often related to employment which is still at the level of 10.12% in 2010 in the Euro area, 8,18% among the G7 members, while at the level of 4.1% in the People's Republic of China, according to the International Monetary Fund [5]. In this context, there is a need for a good understanding of the variables that may influence the reallocation of workers. Pastore [6] has studied the relation between the level of unemployment at the regional level and the reallocation rate in Italy. Worker reallocation in Canada have been studied by Morissette, Lu and Qiu [7], taking into account many variables, such as workers' age, organization activity sector, organization size. A similar study has been published by Liu about China [8]. Martin and Scarpetta [9] have a different approach to the question of employment and reindustrialization: they have addressed the question of the links between regulations for employment protection, workers' reallocation, and productivity. Bartolucci and Devicienti [10] have demonstrated that better workers are found to have a higher probability of moving to better firms. Gianelle [11] has studied in details the structure of workers reallocation in the Veneto industrialized region of the north of Italy. He has shown the importance of hub organizations, i.e., highly connected organizations bridging distinct local clusters of organization, for workers' mobility. In this work, connections among organizations represent reallocations of employees: each reallocation of an employee from an organization O_1 to an organization O_2 is represented as a link $O_1 \rightarrow O_2$ between these organizations.

None of these studies have considered the potential influence of cooperation among organizations on the dynamics of employment. Specialization, which is one of the two pillars of deindustrialization, is also a key reason for the decision of some organizations to collaborate with other organizations. By collaborating with other organizations, creating a *collaborative network (CN)*, on the one hand, organizations focus on their core competences and benefit from their competitive advantage, while, on the other hand, the group of collaborating organizations, i.e., the CN, is able to produce complex products or provide complex services. Intuitively one may expect a relation between the existence of CNs and reallocation: workers are probably more willing to move to organizations that they have already collaborated with, than to move to unknown ones. However, to our best knowledge, the relation between the existence of CNs and the dynamics of employment has never been studied.

In this paper, we take a theoretical approach to this question. We propose a model of the dynamics of employment in a networked ecosystem of organizations tied by their collaboration in CNs. We further use the model to run simulations to evaluate the influence of CNs, especially their size and their constitution, on the structure of the network of organizations, on employment and on the value of the organizations themselves.

In Section 2, background on network structure and chosen metrics, i.e., clustering coefficient and degree distribution, is provided. Next, the proposed model is detailed in Section 3. In Section 4, the results of the simulation experiment are presented. In Section 5, the results are discussed. Finally, Section 6 concludes the paper.

2 Background on Networks

The word "network" refers to the notion of a set of interconnected objects, referred to as nodes, that may be material or immaterial. Networks are ubiquitous and have been the object of research in various disciplines, such as computer science, sociology, biology, and medicine to name a few [12-14].

It has been demonstrated that many of these networks share a set of common characteristics: their average shortest path is relatively low, therefore two nodes of the network are connected by a small number of links. Additionally in many networks, the immediate neighbors of a node tend to be connected to each other, i.e., their clustering coefficient is higher than in random networks. Such networks are referred to as "small-world networks" [15,16] and their structure and functioning have been the object of numerous works since Watts and Strogatz's article [15] published in 1998. Networks have also been studied with regard to their dynamics. As an example, network percolation, with its potential application to explain disease epidemics and gossip propagation, has received significant attention [17-19].

Among key characteristics of networks, the *clustering coefficient*, the *scale-free* and the *small-world* properties of some networks have been intensively scrutinized. The clustering coefficient is a measure of the tendency of nodes to connect to other nodes within groups of nodes. Formally, the clustering coefficient C of a graph $G = (V, E)$ has been defined by Watts and Strogatz as follows: "Suppose that a vertex v has k_v neighbours; then at most $k_v(k_v - 1)/2$ edges can exist between them (this occurs when every neighbor of v is connected to every other neighbour of v). Let C_v denote the fraction of these allowable edges that actually exist. Define C as the average of C_v over all v." The higher the clustering coefficient, the higher the number of connected triplets of nodes. Scale-free networks are networks in which the probability that a randomly selected node has k links, i.e., degree k, follows $P(k){\sim}k^{-\gamma}$, where γ is the degree exponent. In scale-free networks, a limited number of nodes have a large number of links (a large degree), while a large number of nodes have a small number of links (a small degree). Small-world networks are graphs in which the clustering coefficient is high and the average path length is small. In small-world networks, a relatively small number of nodes separate any two of them, even if most nodes are not connected to each other.

Popular models of structure of networks are:

- the Erdős–Rényi model: this model is a random model in which the links between nodes are added in a random manner. Both clustering and average path length of Erdős–Rényi networks are low;
- the Barabàsi-Albert model: in this model, a newly added node is connected to other nodes of the network, such that the probability to connect to a given node is proportional to the degree of this node. Barabàsi-Albert networks are scale-free and their clustering coefficient is higher than in Erdős–Rényi networks.

More information about social networks analysis may be found in [20].

3 A Model of a Dynamic Networked Ecosystem of Organizations

3.1 Assumptions of the Proposed Model

The proposed model is based on the following set of five assumptions.

Assumption 1 – ***Synergy:*** *Collaboration among organizations increases their value.*
The synergy assumption is based on the idea that having organizations collaborating towards the achievement of a common goal by sharing their competences brings an added value to each of the collaborating organizations. So some extends, this assumption lies at the bottom of the concept of collaborative networks.

Assumption 2 – ***Erosion:*** *The part of the value of an organization originated by former collaboration with other organizations fades out when this collaboration ends.*
The erosion assumption takes on the idea that when organizations are not collaborating anymore, the synergy value created during their collaboration time, sustains in time. However, this synergy value vanishes over time. Therefore, the synergy value created by collaboration is fading away as the employees are not collaborating any longer.

Assumption 3 – ***Specialization Advantage:*** *The value created by an employee is maximal when (s)he has the same profile as the organization that employs her/him.*
The specialization advantage assumption is based on the idea that when an employee is working in an organization with a different profile that his/her own, the adaptation of the employee's professional culture and how-to to the culture and how-to of the organization comes with a cost. For instance, an IT professional is less efficient when working at a pharmaceutical organization than at a software organization.

Assumption 4 – ***Local Preference:*** *an employee quitting a job preferably moves to an organization that has a collaboration history with the left organization.*
The local preference assumption is related with the works on job mobility by Holzer [21] and Bewley [22], who have identified that 53% (resp. 60%) of the employers are seeking future employees on the social networks of their employees.

Assumption 5 – ***Profile Preference:*** *an employee quitting a job preferably moves to an organization whose profile is that same as her/his own.*

The profile preference assumption is related to the idea that the specialization advantage leads to a higher efficiency of the employee, potentially related to higher wages. For instance, an IT professional will rather move to a software organization sharing his/her culture, instead of a pharmaceutical organization.

3.2 A Model of a Networked Ecosystem of Organizations

In the proposed model, an ecosystem of organizations is modeled as a triplet: a *network of organizations*, an *employment structure*, and a *set of collaborative networks*. In the network of organizations N, the nodes represent the organizations, while the links represent the collaboration history of organizations. Let O denote the set of organizations of the ecosystem, with o_i being the i-th organization. The total number of organizations in the ecosystem is assumed to be fixed.

Let $l_{ij} = l_{ji} \in L$ denote the link between organizations o_i and o_j representing collaboration between organizations o_i and o_j collaborate with each other. The network of organization is undirected as the collaboration relation is symmetric, i.e., if the organization o_i collaborates with the organization o_j, then the organization o_j collaborates with o_i. The network of organizations is then $N = \{O, L\}$.

The employment structure E of a networked ecosystem of organizations is modeled as a matrix of dimensions $(|O| + 1) \times |P|$, where $|O|$ is the number of organizations in the ecosystem, and $|P|$ is the number of profiles of employees in the ecosystem. $P = \{p_1, \dots, p_{|P|}\}$. Examples of profile are “IT professional” and “Accountant”. The elements of the employment structure E are positive integers, such that,

$$e_{ij} = \begin{cases} \text{the number of unemployed people of profile } p_j, \text{if } i = 0, \\ \text{the number of employees of the organization } o_i \text{ with profile } p_j, \text{otherwise.} \end{cases}$$

The total number of employees in the ecosystem is assumed to be fixed.

The profile of an organization is defined as the predominant profile of its employees, i.e., $p_{o_i} = p_j \Leftrightarrow e_{ij} = \max(e_{ik})$, for $k \in \{1, \dots, |P|\}$.

Let CN denote the set of collaborative networks. Each collaborative network is a triplet $cn_i = \{\theta_i, CO_i, d_i\}$, where θ_i is the point in time in which the collaborative network has been created, CO_i is the set of organizations collaborating within the collaborative network, and d_i is the duration of the collaborative network. Therefore, the collaborative network is dissolved at $t = \theta_i + d_i$.

3.3 Organization Value

Finally, let v_i denote the value of the organization o_i. The value of an organization should encompass both the value created by its employees and the value created by synergy with other organizations. Let v_i^e denote the value created by the employees of the organization o_i, and v_i^s the value created by the synergy with other organizations.

The value created by employees supports the specialization advantage assumption. In our model, the value brought by an employee to the value of an organization with the same profile is normalized to 1, while the value brought by an employee to the value of an organization with a different profile equals $0 < \rho < 1$. The total value of an organization created by its employees is then $v_i^e = \rho \sum_{\substack{i \neq 1 \\ i \neq p_o}} e_{ij} + \sum_{i = p_o} e_{ij}$.

The value created by the synergy with other organizations has to support both the synergy and the erosion assumptions. The synergy assumption implies that each new collaborative network within which an organization is collaborating increases the value of the organization. The erosion assumption assumes that when an organization is not collaborating with any other organization, its synergy value is fading out. The synergy value created by an organization o_i collaborating with the organization o_j equals to $v_{ij}^s = 1 + \log(|CN_i|)$, where CN_i is the subset of collaborative networks in which the organization o_i participates. Therefore the synergy value of an organization collaborating with another organization in one collaborative network equals $1 + \log(1) = 1$, the synergy value in 5 collaborative networks equals $1 + \log{(5)} \sim 2{,}6$.

When an organization is not participating in any collaborative network, its synergy value is decreasing in time. Let $t_{\omega_{ij}}$ denote the last time when the organization has participated to a collaborative network with organization o_j, with potentially $t_{\omega_{ij}} = 0$ for organizations that have never participated to any collaborative network. In our model, the synergy value is defined as follows:

$$v_{ij}^s(t) = 1 - \frac{1}{1+e^{f_s \cdot \left(\frac{f_d}{2}+t_{\omega ij}-t\right)}}, \qquad (1)$$

where f_s is the fading slope, and f_d is the fading duration. Additionally, a threshold f_t is defined to filter out old, insignificant relations among organization. Therefore, if $v_{ij}^s(t) < f_t$, then the link l_{ij} is removed from the set of links L. The function defined by the Eq. 1 and threshold filtering are illustrated in Fig. 1.

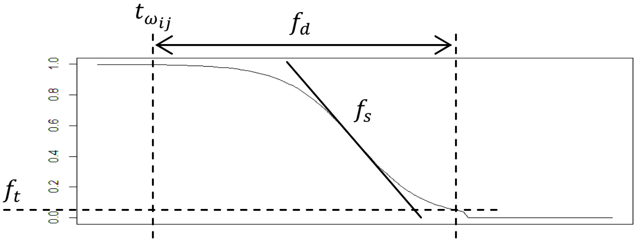

Fig. 1. The fading function (Eq. 1) of the synergy value for organizations that are not participating in collaborative networks

Next, the total value created by the synergy with other organizations may be calculated on the bases of the values v_{ij}^s. In out model, we distinguished collaboration between same-profile organizations from collaboration between organizations having different profiles. In terms of synergy, collaboration between organizations having different profiles is more valued than collaboration between same-profile organizations.

Therefore, with $0 < \theta < 1$, $v_i^s = \theta \sum_{\substack{j \neq i \\ p_{o_i} = p_{o_j}}} v_{ij}^s + \sum_{\substack{j \neq i \\ p_{o_i} \neq p_{o_j}}} v_{ij}^s$.

Finally, the total value of an organization is defined as $v_i = v_i^e + \alpha v_i^s$, where α is the weight of the synergy value with regard to the value created by the employees.

4 Dynamic Networked Ecosystem of Organizations

4.1 Employees Mobility in a Networked Ecosystem of Organizations

The dynamics of employees is modeled with three basic operations: *hire* (an unemployed person is hired by an organization), *fire* (an employee is fired by his/her organization), and *quit* (an employee is moving to another organization).

In the proposed model, we do not consider employees which are removed from the labor market, for various reasons, including retirement, death, and accidents leading to severe disability. The hiring rate is proportionally dependent on the ratio of the value of an organization to the number of employees. The higher this ratio is, the greater the productivity of the organization that may want to hire more employees. Similarly, the firing rate is proportionally dependent on the ratio of the number of employees to the value of an organization. The higher this ratio is, the lesser the productivity of the organization that may want to fire more employees. The quitting rate is different than the hiring and firing rate, as it is an employee's decision, instead of an employer's decision. In our model, the quitting rate is proportional to the ratio between the mean value of the neighbors of the organization in which the employee works to the value of this organization. Therefore, if the mean value of the neighboring organization is higher than the value of the organization in which the employee is working, i.e., "surrounding" organizations are doing better than the employee's organization, than the employee is more willing to quit.

In the proposed model, the choice of the organization in which the quitting employee will work has to encompass both the local and the profile preferences. Therefore, a quitting employee should prefer local organizations, i.e., organizations in the neighborhood of his/her current workplace, over other, distant organizations. Here, neighbor organizations do not have to be geographically close, but they have to be tied with regards to collaboration. Additionally, a quitting employee should prefer organizations with which (s)he shares the same profile. These preferences are captured in our model by π_l and π_p being the probability for a quitting employee to choose a local organization and the probability to choose a same-profile organization.

4.2 Dynamics of Collaborative Organizations

In the proposed model, collaborative organizations are created according to the following algorithm. At each discrete time moment t, each organization has the possibility to create a collaborative organization with a probability π_{CN}. The duration of each new collaborative organization is chosen randomly, according to the uniform distribution between $d_{\min}$ and $d_{\max}$. The number of collaborators is also chosen randomly, according to the uniform distribution between $CN_{\min}$ and $CN_{\max}$. The set of potential members of the collaborative network consists of the neighbors of order 2 of the organization, that is the immediate neighbors of the organization as well as their neighbors. Additionally, randomly picked organizations are added to the set of potential collaborators, with a probability π_{random}. Finally, the members of the collaborative networks are picked from the set of potential members formerly identified. The given percentage π_{same} of the members of the collaborative network shares the same profile with the creating organization, while $1 - \pi_{\text{same}}$ of the members of the collaborative network has a different profile than the creating organization. A collaborative network created at time θ_i with a duration d_i is active, i.e., participates actively to the synergy value for all $\theta_i \le t \le \theta_i + d_i$. After the time $\theta_i + d_i$, the collaborative network is dissolved and does not participate directly to the synergy value of the organization.

5 Simulations

The proposed model has been implemented in the R language and environment [23]. The following independent variables are manipulated in our experiment:

- the number of members of collaborative networks $d_{\min}$ and $d_{\max}$,
- the probability of the presence of randomly picked members of collaborative networks π_{random},
- the percentage π_{same} of the members of the collaborative network sharing the same profile with the creating organization.

The dependent variables to be measured are:

- the clustering coefficient of the network of organizations,
- the average path length of the network of organizations,
- the employee distribution,
- the organization value distribution.

Two starting configuration of the ecosystem has been tested: in 50% of our simulations, the starting ecosystem was an Erdős–Rényi network; in the remaining 50% of our simulations, the starting ecosystem was a Barabàsi-Albert network. In both cases, the starting ecosystem contains 100 organizations and 197 links.

Three profiles have been used during our simulations, referred to as “red”, “blue”, and “green”. The initial population has been created as follows: for each company, the number of employees for each profile is following the normal distribution with a zero mean and a standard deviation equals 70. Such a distribution creates a high number of micro and small enterprises. The type of each organization is defined at starting time. The number of unemployed people is set as 3% of the number of employees at starting time and is equally distributed among all the profiles.

For each configuration of the model, 25 different ecosystems have been generated. For each generated ecosystems, 500 iterations of the system have been performed before measuring the values of the dependent variables. The measured dependent variables have been further aggregated by processing their geographic mean.

We have found (cf. Table 1) that larger CNs in terms of number of their members (increases of $d_{\min}$and/or $d_{\max}$) leads to an increase of the clustering coefficient and a decrease of the average path length. As a consequence, larger CNs lead to a small-world of organizations, in which, on one hand, organizations are working in cluster, i.e., the collaborators of an organization are usually collaborating with each other, on the other hand, organizations are relatively close each other, i.e., an organization can reach any organization by a small number of collaborators of collaborators.

Large CNs leads also to the emergence of organizations with a large number of employees. It can be explained by the local preference assumption of our model, which encourages the mobility towards neighboring companies, and therefore, organizations that have a large number of collaborators are more willing to be the destination of quitting employees than organizations with few collaborators. The rise of the organization value is not surprising as an important part of the organization value depends directly on the number of its collaborators.

Modifications of π_{random} and π_{same} have no influence on the structure of the network of organizations in terms of clustering coefficient. The average path is influenced by π_{random}, as adding links to non-neighboring organizations creates "short-cuts" in the network of organizations. The number of employees per organization and the organization value are influenced by neither π_{random} nor π_{same}.

Table 1. Influence of the size and composition of CNs on the structure of the network of organizations, on employment and on the value of the organizations themselves

Dependent variables	Clustering coefficient	Average path length	Employees per organization	Organization value
d_{max}	↗	↘	↗	↗
d_{min}	↗	↘	→	↗
π_{random}	→	↘	→	→
π_{same}	→	→	→	→

6 Conclusions

A major contribution presented in this paper is a theoretical model of ecosystems of organizations, encompassing employee mobility and collaborative networks. Our simulations based on this model provide some original insights concerning the influence of collaborative networks on the structure of the network of organizations, on employment and on the value of the organizations themselves. We have found that the size of the CNs operating on the business ecosystems has an importance influence on the structure of network of organizations: larger CNs lead to a small-world network of organizations. The constitution of CNs does not affect neither the structure of the network of organizations, nor the employment structure and the organization value.

Among future works, there is an important need to confront the results of our simulations with data from real-world cases. However, a major obstacle to this confrontation is the lack of dataset concerning collaborative networks and their employment structure. Another interesting research area is the potential application of the proposed model to simulate the mobility of employees and understand the potential influence of collaborative networks on this mobility.

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Anything Relationship Management (xRM) as Management Layer for the Hyper-connected Society

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Abstract. There is a strong consensus that collaboration and co-creation will become one of the main business drivers in the future. However, the question of how to set-up inter-organizational relationships and involve stakeholders in an efficient way still remains largely unsolved. This paper proposes Anything Relationship Management (xRM) as managerial and technological foundation and platform providing interoperability between different stakeholder groups. It provides an overview of the evolution of the relationship management concept, analyzes the current status of the xRM solution market and proposes an xRM-framework for collaborative networks and cyber-physical systems.

Keywords: Anything Relationship Management, Collaborative Networks, Cyber-Physical Systems, Internet of Services, Internet of Things.

1 Introduction

Collaborative networks (CNs) have been long since recognized as an essential scientific discipline [1] with an important industrial impact [2]. However, looking at practice, failure to achieve successful relationships and collaborations still remains very high: empirical studies show rates reaching 50-70% [3; 4; 5].

At the same time the digital revolution is accelerating, the pace of technology is changing so rapidly that our skills and traditional organizations are not keeping up [6]. Recent advances in the domain of cyber-physical systems (CPS) that are built from and depend upon the synergy of computational and physical components demonstrate this clearly. In the recent past, we have seen a plethora of isolated projects in this domain. Examples of the CPS application areas include the smart electric grid, smart transportation, smart buildings, smart medical technologies, and advanced manufacturing. The combination of the technical innovations in CPS and scientific organizational advancements in CNs will lead to a new societal paradigm, the long foreseen hyper-connected world [7].

However, most approaches taken so far are isolated; complex business scenarios involving large collaborative networks as organizational basis for collaborative CPS societies are not adequately tackled. Interoperability across CPS, standardized management approaches for the targeted hyper-connected world are not yet adequately

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 451–458, 2013.

deployed and accepted. Therefore, especially small and medium-sized companies are reluctant or fail to have the resources to engage themselves in the intersection of CNs and CPS.

The authors propose Anything Relationship Management (xRM) as management layer for the hyper-connected society. The paper provides an overview of the evolution of the relationship management concept, analyzes the current status of the xRM solution market and proposes an xRM-framework for CNs and CPS.

2 Relevant Definitions

In this chapter, we will point out some important definitions concerning the hyper connected society and Anything Relationship Management.

Relationship Management (RM): According to Smyth [8], Relationship Management includes the following aspects: "Developing close relationships and understanding of client and stakeholder expectations […]; Developing services to match expectations where realistic […]; Delivering services to engender client and stakeholder satisfaction, which includes promise fulfillment […]; Increasing satisfaction and long-term maintenance of relationships to engender loyalty, repeat business and/or increased referral business, which concerns internal stakeholders; Increasing satisfaction to maintain and preferably increase market reputation, which concerns external stakeholders."

Collaborative Network (CN): A collaborative network is a network "consisting by a variety of entities (e.g. organizations and people [or intelligent machines]) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital, and goals"; that network collaborates to better achieve "common or compatible goals, and its interactions are supported by a computer network". [1]

Cyber-Physical System (CPS): According to Lee [9], cyber-physical systems are "integrations of computation with a physical process. Embedded computers and networks monitor and control the physical process, usually with feedback loops where physical processes affect computations and vice versa." CPS integrate the dynamics of physical processes with those of software and networking, providing abstractions and modeling, design, and analysis techniques to an integrated whole.

Internet of Services (IoS): According to the European commission, Internet of Services "is a vision of the Internet of the Future where everything that is needed to use software applications is available as a service on the Internet, such as the software itself, the tools to develop the software, the platform (servers, storage, and communication) to run the software." [10]

Internet of Things (IoT): According to Martinez [11], the Internet of Things "is a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'things' have identities, physical attributes and virtual personalities and use intelligent interfaces and are seamlessly integrated into the information network."

3 Anything Relationship Management

3.1 Evolution of the Relationship Management Concept

xRM builds upon the basic logic of RM solutions and the focus on profitable long-term relations with existing customers [12]. Since its introduction in the early 1980s, the theoretical concept of relationship marketing has been further developed and increasingly supported by software solutions. By the end of the 1990s, these solutions were rebranded as "Customer Relationship Management" (CRM) [13]. CRM systems put the emphasis on the customer side and experienced a period of high popularity growth around the millennium [14]. CRM was designed to mainly deal with conventional cross-enterprise relationships between two parties, typically between one buyer and one seller organization (1:1 relations). Thus, the complexity of relationships and the diversity of relationship entities covered can be characterized as rather low.

Already early, parallel to the rise of CRM, several companies promoted a concept for the management of a broader variety of stakeholders [15]. This approach was titled "Extended Relationship Management" (XRM, with a capital "X") and was firstly analyzed in detail by Forrester Research in 2001 [16]. Starting around 2005, XRM-labeled systems for different stakeholder groups and different kinds of organizations appeared on the market. They had in common that they transported the CRM ideas to different environments, resulting in solutions for Member RM, Citizen RM, Employee RM, etc. Also, due to the growing availability of new technologies like mobile high-speed data connections, navigation services, and social media, the possibilities of relationship-based solutions reached a new quality: relations could now be maintained anywhere, in real-time, with a broader data basis, on a more fine-grained entity level, and through interactive social media channels involving communication between one sender and many receivers and vice versa (1:n and n:1 relations). In sum, the complexity of relationships and the entities involved in relationship structures had started to increase significantly. This trend has continued in the last years. Particularly since 2008, the idea of a holistic and integrated management of all stakeholder relations of an organization has been receiving growing attention [17]. Promoted by Microsoft as "Anything Relationship Management" (xRM, now mostly with a lower-cased "x"), this new concept attempts to design and optimize complex relationship structures [18]. By shifting away from a single system towards a customizable platform/app architecture, xRM solutions provide a means with which various relationship-specific application scenarios can be realized. xRM supports the vision of the networked organization in which all levels of relationships involving organizations, human beings, intelligent objects, object service providers, and ubiquitous computing are coordinated and transparent, interactive, many-to-many relations and processes are created. Future xRM platforms are therefore likely to link both real and virtual entities dynamically with respect to the context, using a variety of applications including CNs and CPSs.

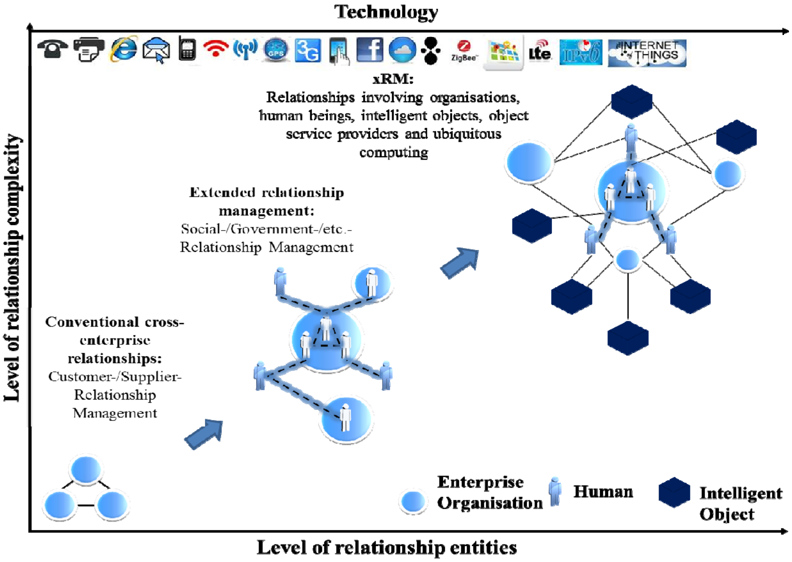

Fig. 1. Evolutionary steps of relationship management

3.2 Market Overview and Use Cases

The evolution of a RM concept is linked closely with the market for its underlying IT solutions. The table below shows an excerpt of the worldwide market, covering ten producers of popular RM software as well as two producers of social collaboration software. Based on the producers self-description on their web pages, the authors ranked the scope of relationships which are covered by the solutions, and the usage of the label "xRM" (emphasized: ++, mentioned: +). There has been a notable shift in the market in the last years: none of the solutions sighted is limited to the exclusive management of customer relationships anymore. At least, relations with other stakeholders like employees, partners, suppliers, or – in industry-specific offerings – with members, patients, citizens, etc. are covered. Also common today is the integration of virtual assets (documents, events, patents, trials, etc.) in relationship structures. The possibility to manage physical assets (inventory, not intelligent objects) is frequently mentioned as well. Most solutions are however still marketed under the label "CRM"; the diffusion of the term "xRM" is rather low. Interestingly, solutions for social project management like Basecamp or Podio, which originally focused on employee management, are also heading into the xRM direction. The similarities with tradetional RM solutions can be observed in the feature list depicted in table 1.

Most producers emphasize their solutions to be easily customizable platforms, not standardized single CRM systems. Deployment in the cloud as Platform-as-a-Service (PaaS) has become the norm. On top, most platforms offer a marketplace for first-party and third-party apps, which allow enhancing the solutions according to customer's needs. The integration of social media, e.g. though activity streams, social media analysis, etc. is mentioned by more than half of the companies in the sample.

Table 1. xRM solution market: scope of relationships covered, usage of xRM label

Maker	Solution	Stake-holder	Virtual Assets	Physical Assets	Label xRM	Plat-form	Cloud	Market-place	Social Media
CAS Software	Open	++	++	+	++	++	++		
Infor	Epiphany	++	+						++
Microsoft	Dynamics CRM	++	++	++	++	++	++	++	
Netsuite	CRM+	++	++	++		++	++	++	
Oracle	CRM On Demand	++	++	+			++		
Sage	CRM	++	+			++	++	++	++
salesforce.com	Platform	++	++	+		++	++	++	++
SAP	Business ByDesign	++	++	++		++	++	++	
SugarCRM	Sugar	++	+	+	+	++	++	++	++
Zoho	CRM	++	++	++		++	++	++	++
37signals	Basecamp	++	++			++	++	++	++
Citrix	Podio	++	++	++		++	++	++	++

Looking at the broader market, many smaller software producers and consulting firms offer xRM software and services for different industries and target groups, mostly based on the listed platforms of the bigger vendors. In practice, xRM use cases can be found in many areas:

- A non-profit organization has developed xRM apps "to organize charitable events, grant management and outreach for fundraising efforts" [19].
- A health care company has designed RM applications to manage patient intake and streamline operations. Among other things, the xRM apps provide "a real-time view of the availability of each bed at its facilities" [20].
- A government department has developed multiple RM solutions using an xRM platform, "including a consumer affairs reporting tool, an energy safety intelligence application and a grants information management system" [21].
- A logistics company has designed an xRM solution for its truck drivers. The drivers can interact with local operations centers and select their preferred choice of loads [21].
- A manufacturing firm has implemented xRM-based apps for customer service and order management, inventory and warranty management, production planning, etc. [20].

3.3 Derivation of an xRM-Definition

The analysis of the software producers' web pages has indicated that the market for RM solutions is currently in an early transition phase between XRM and xRM. RM is not limited to customers anymore, it is increasingly offered as scalable PaaS, it is extensible through apps, and it covers the real-time analysis and management of complex relationship structures. These features build an optimal basis for a future integration of intelligent objects, object service providers and ubiquitous computing and are the basis for collaborations between entities. As a conclusion, we define xRM as:

Anything Relationship Management (xRM) is the next evolutionary step of CRM. The concept describes the holistic management of relations within and between organizations, human beings, and virtual and physical objects. Linking IoS and IoT, xRM provides the management layer for CNs and CPS. The implementation of the xRM concept is based on platforms and modular, domain-specific applications building upon these platforms.

4 Framework Proposal

In this section, the authors propose an xRM framework as a Management Layer for the hyper-connected Society. In our case, the framework is a layered structure indicating what kind of applications can or should be built and how they would interrelate. The framework should indicate a set of functions within the system and how they interrelate, the layers of an application subsystem, how communication should be standardized at some level of a network, and so forth.

xRM platforms can be highly connected and integrated in multiple ways, even across business operations and domain boundaries. Achieving effectively networked, cooperating, and human-interactive systems will be an integral factor in the adoption of such solutions in the future. Some of the key questions to be considered include what is needed to enable streamlined and predictable development, and evolution of networked and integrated xRM solutions – particularly as systems become interconnected with legacy systems and across industry boundaries. How to effectively achieve compositionality within heterogeneous, dissimilar but connected systems? How to model and integrate the role of humans in systems with variable levels of autonomy?

New solutions will have characteristics that enable compositionality within dissimilar but connected systems, while also considering the integration of humans into systems with variable levels of autonomy.

So far, the technical environments do not have governance or business models in place to motivate the development of networked, cooperating, human-interactive systems. Developers must assume the risk of sharing proprietary information with competitors and the liability of integrating their systems with external systems to ensure high levels of performance and functionality. Building an infrastructure foundation that is interoperable, contains open source and proprietary information in balance, and operates under the same standards will provide a protected starting point from which interoperable issues are minimized and system development could be profitable. Building from a standard foundation will save time and cost by sharing critical information and will avoid the liability of a solely proprietary product. The proposed xRM-framework is based on the cloud-computing framework. A cloud is a powerful combination of cloud computing, networking, storage, management solutions, and business applications that facilitate innovative IT and consumer services. These services are available on demand and are delivered economically without compromising security or functionality. We are moving to an interconnected "world of many clouds". This will allow for an interconnected system giving services, companies, human beings, and intelligent objects access to services any time, on any device, anywhere in the world. To take full advantage of an xRM-based cloud computing solution, enterprises need to evolve their IT strategy.

In order to have a market impact, the xRM-framework must integrate the various components and abstractions that will be needed to enable co-design of software, communications, and interacting subsystems. The above depicted generic system topology of an xRM-framework proposes to have the interconnection between the various stakeholders (human beings, companies, intelligent objects) either on the Infrastructure as a Service level (with distinct IP-addresses once (Internet Protocol version 6) IPv6 is widely deployed) or on the PaaS-level (e.g. web services interacting between the cloud-framework and the intelligent object framework consisting of intelligent objects, embedded systems, CPS, etc.). The user interaction is based on the Software as a Service level allowing also apps to be the user frontend.

5 Conclusion

In this paper, the authors provided an overview of the evolution of the relationship management concept, defined xRM, analyzed the current status of the xRM solution market and proposed an xRM-framework for CNs and CPSs. The key argument was that moving beyond an IoT towards CPSs requires more than simply upgrading micro-electronic objects that communicate with one another. Linking objects to one another, or the internet, requires clear relationship structures, and therefore, an xRM framework. At the heart of this approach is the expansion of web-based services, the IoS, to the IoT. An xRM platform links both real and virtual entities dynamically with respect to the context, and this is done using a variety of applications.

Acknowledgments. The authors would like to thank the European Commission for the financial support of the R&D project GloNet (focusing on glocal CNs) within the FInES cluster.

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Enhancing Collaborative Healthcare Synergy

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Abstract. Worldwide, the constant ageing of the population brings significant challenges to the traditional style of health care systems. Rapidly spreading pandemics triggered by new disease strains, increased population mobility and displacements fuelled by conflict and climate change add another dimension to the health care predicament. In this context, proper cooperation and interoperability of the participants in the healthcare effort becomes paramount. Collaboration is an essential factor but also a major challenge, as typically healthcare institutions are hierarchical and heterogeneous, owing to various administrative, geographical and historical reasons. As the pressure on healthcare availability, quality and cost is constantly increasing, governments can no longer rely on traditional models for managing population wellbeing. Innovative holistic and integrated models and procedures taking into account all essential aspects, elements, participants and their life cycle are necessary if these challenges are to be successfully met. Based on previous research and applications, this paper argues that such necessary artefacts can be built using a life cycle-based whole-system paradigm enabled by advances in Collaborative Networks and Enterprise Architecture. This approach aims to provide a sound platform for efficient response delivered by agile and synergic teams to short and long-term challenges to population health and well-being.

Keywords: Health Care, Collaborative Networks, Enterprise Architecture.

1 Introduction

Worldwide, healthcare situation is radically changing. Earth's population is constantly ageing as people live longer [1]; while reflecting mankind progress and providing some benefits [2], this state of affairs also brings significant challenges to the human society - especially in social security and healthcare [3]. Thus, the pressure on healthcare services availability and cost is increasing worldwide, with governments no longer being able to manage population health using 'legacy' models. Another major healthcare concern is the growing risk of pandemics, owing to drug-resistant diseases and increased population mobility facilitated by modern means of transportation and fuelled by regional conflicts, economic crises and climate change.

Due to a number of regional, historical, organisational and political reasons, there are significant challenges in managing both internal and external collaboration and interoperation of the typically heterogeneous set of participants involved in the healthcare endeavour. This constitutes a critical issue in handling epidemic and

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 459–467, 2013.

pandemic events that require prompt response and typically claim resources and capabilities beyond those of any particular individual healthcare organisation. New innovative and especially integrated models, methods and tools are required in order to enable proper inter-professional and inter-organisational cooperation so as to cope with the new issues brought by the changing healthcare environment.

Previous research [4, 5] has investigated the use of Collaborative Networks (CN) [6] and Enterprise Architecture (EA) [7] concepts and methodologies in tackling generic disaster management efforts. This paper aims to build on the previous results by focusing the application of CN and EA artefacts to the healthcare area. It is hypothesised that this approach will allow addressing the above-mentioned issues in a life cycle-based, holistic and integrated manner; this should enable a prompt and efficient response by agile and synergic teams to both acute and long-term challenges to population health and well-being.

2 Challenges in Healthcare Management Collaboration

Healthcare has made significant advances in the last century, such as the development and wide use of vaccines, eradication of serious diseases and large reductions in communicable disease epidemics and chronic diseases [1, 8].

While solving some very important problems, some of these advances have unfortunately also contributed to a new set of challenges faced by the public and private healthcare infrastructure and organisations. Thus, nowadays we are confronted with population growth and ageing triggered by increased longevity and health hazards owing to causes such as climate change [9] and new strains of diseases [10].

While healthcare as a system has become somewhat more organised, it has also become more expensive, complex and difficult to manage. New technologies hold the promise of remote medical assistance and automated care at home; however, the main problems remain human-related, namely overcoming the organisational and cultural barriers to collaboration and synergy of the healthcare professionals and organisations. Although collaborative healthcare is argued for and encouraged in various medical and other emergency response reports, conferences and journals (e.g. [11-17]), unfortunately the extent of actual collaboration is still limited.

The relevant literature also argues that effective collaborative healthcare could be enhanced by modelling and participatory design [18] aimed at integrating scientific but also administrative and political aspects into a whole-system approach [12, 19, 20]. For example, the long term healthcare issues may be alleviated by the vision and strategic research espoused by Matos et al. [21] and the BRAID project [22] who advocate the necessity for integrated assistive services and infrastructure supporting collaborative healthcare ecosystems [23] as a component of a healthy living and ageing support paradigm [17]. Psychological disaster effects such as uncertainty, anguish, confusion, panic etc are significantly augmented in pandemic-type situations and must be properly dealt with by building appropriate and *specific* preparedness of the organisations involved [19, 24], with ethics playing a prominent role [25, 26].

Owing to the urgency involved, often there is a tendency of the higher ranking and more powerful organisation(s) to override or exclude some participants, adopting a ‘central command’ approach in preference to a cooperative one [27]. This is not desirable as successful disaster management (including healthcare crises) relies on a wide range of community economic, social-psychological, and political resources. This cooperation brings communities together, gives them a sense of usefulness (ibid.) and thus also alleviates the negative psychological effects.

Collaboration between participants in the healthcare effort does not automatically occur. It must be "constructed, learned, and once established, protected" [28]. Like most human-related processes, collaboration can neither be successfully forced on the participants nor achieved in a short time. The divergent perceptions and expectations of the parties involved [29], owing to a traditionally strong hierarchy and marked difference in status between partners [30], can be best dealt with by the higher ranking participants. They can promote collaboration and trust by employing a participatory and inclusive approach [31] which will also build a beneficial sense of security [32].

To conclude, efficient healthcare collaboration requires that organisational cultures, processes and resources of the participants acquire suitable preparedness [11]. This requires access to a plethora of interdisciplinary information and knowledge not always obvious or easily accessible to planners and disaster managers.

3 A Combined Collaborative Network / Enterprise Architecture Approach for Healthcare

The concept of networks in disaster management and recovery as an alternative to a centralised command and control approach has been advocated, studied and applied to some extent for a number of years with mixed results (e.g. [27, 33-35]). While providing valuable data, such attempts appear to have two main shortcomings. Firstly, they propose previously untested models focusing on a specific aspect in isolation, rather than employing a proven set of integrated models in a whole-system approach. Secondly, the life cycle aspect of the participant organisations, networks and other relevant entities (including the disaster event/s) appears to be less addressed. As all participating entities are evolving, it is essential that the interactions required for collaboration and interoperation be considered in an integrated life cycle context.

In attempting to address these issues, it has been observed that the healthcare challenges identified in the critical literature review describe a situation similar to that of commercial enterprises who, owing to a global business environment, find themselves compelled to tackle projects requiring resources beyond their own staff, knowledge and time capabilities. Their usual reaction to this problem is to set up or join so-called Collaborative Networks (CNs) that act as breeding environments for Virtual Organisations (VOs) who are promptly created in order to bid for and (if successful) complete projects requiring combined resources and know-how. The view of CNs as social systems composed of commitments, who absorb uncertainty and reduce complexity [36] also supports their use towards large inter-disciplinary tasks.

Integrated modelling in a life cycle context can be further facilitated by artefacts provided by Enterprise Architecture (EA) research and practice. Thus, EA as a change management paradigm that bridges management and engineering best-practice [7] is capable of providing a framework integrating all necessary aspects in a life cycle-based set of models ensuring the consistency and sustainability of complex projects.

Furthermore, the fact that large scale medical emergencies such as pandemics are particular types of disaster events justifies and facilitates the use of previous research results in applying CN concepts in disaster management, supplemented with an EA perspective providing the essential integration and life cycle perspectives [4, 5]. Figure 1 presents the main issues identified in collaborative healthcare and the potential solution and benefits brought by a CN approach enhanced with EA concepts.

Healthcare Issue	Applicability	Help from EA and CN
Divergent perceptions of the participants' roles	Long / Short Term	Clear, agreed roles for network and task force participants
Lack of trust between partiticipants	Long / Short Term	Trust building in time, within the network
Poor life cycle management of task forces / collaborative healthcare	Long / Short Term	Intrinsic life cycle context to the creation and operation of network and task forces
Difficulties setting up and operating Collaborative Healthcare (e.g. unclear rules, disagreement on the present and future situations)	Long / Short Term	Participatory design, inclusive approach by lead network partner. Agreed upon models of Networks as Collaborative Healthcare Ecosystems.
Focus on a limited set of interoperability aspects	Long / Short Term	A whole system approach integrating all relevant aspects
Information sharing and cooperation impeded by traditional hierarchy	Long / Short Term	Information and process interoperability achieved at network level and carried on in task forces created
Tendency to overrule rather than cooperate in task forces	Short Term	Cooperation previously agree dupon and built in the task forces created by the network
Lack of preparedness to participate in a task force on short notice	Short Term	Participant preparedness built in advance within the network, ready for fast taskforce / VO creation
Difficult discovery and assessment of suitable participants for an effective and agile task force	Short Term	Task forces created promptly using pre-qualified network partners implementing agreed upon processes. Interoperation and agility built in.

Fig. 1. Main collaborative healthcare barriers and solutions offered by EA and CN

Adopting a CN approach for health disaster management provides benefits going beyond mere technical and syntactic-type interoperability. Thus, the participants in a ‘healthcare management’ CN (HMCN) have the time and suitable environment to overcome hierarchical, organisational and typically troublesome cultural interoperability [37] barriers and achieve suitable *preparedness*. This is essential in the prompt and successful setup of ‘health management task forces’ (HMTF) for disasters but also for the creation and operation of continuing VOs (e.g. as described in [38]) for long term collaborative healthcare challenges such as population ageing.

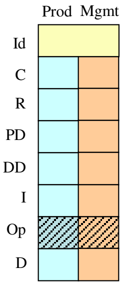
The CNs and VOs set up for the healthcare domain would have specific features. For example, the competitive motivations of commercial CN participants who guide their decisions to create / join / remain / leave the network would transform into the stringent need to cope with increasingly complex health challenges and healthcare systems. The use of reference models, customary in commercial CNs, is feasible here but may be limited due to the diversity in scale and type of healthcare incidents [39].

Importantly, for the health management CN to function, the typical CN ‘lead’ partner/s (here, government emergency management / healthcare agencies) need to take a participatory and inclusive approach. Thus, scientific, faith and community representatives and all relevant non-governmental and volunteer organisations should also be included in the setup and operation of the HMCN, in addition to the typical participants such as hospitals, allied healthcare [40], fire and rescue services, etc.

4 Life Cycle Integration Modelling for Collaborative Healthcare

Successful integration modelling of the CN approach must be done collaboratively with all the network participants [20]. The proposed method and artefacts support this audience variety by using suggestive graphical models and complexity management.

While several EA frameworks would have been suitable, we have selected the modelling framework (MF) provided by GERAM (Generalised Enterprise Reference Architecture and Methodology), described in ISO 15704:2005 [41]. This MF provides a large set of aspects, importantly including life cycle, management, organisation, human and decision. In this paper we will use a subset of the GERA MF containing the life cycle and the management / services viewpoints (see Fig. 2, left). Figure 2 right shows a sample use of the GERA MF life cycle viewpoint to define and map life cycle phases of a health incident on typical health disaster management activities [42].



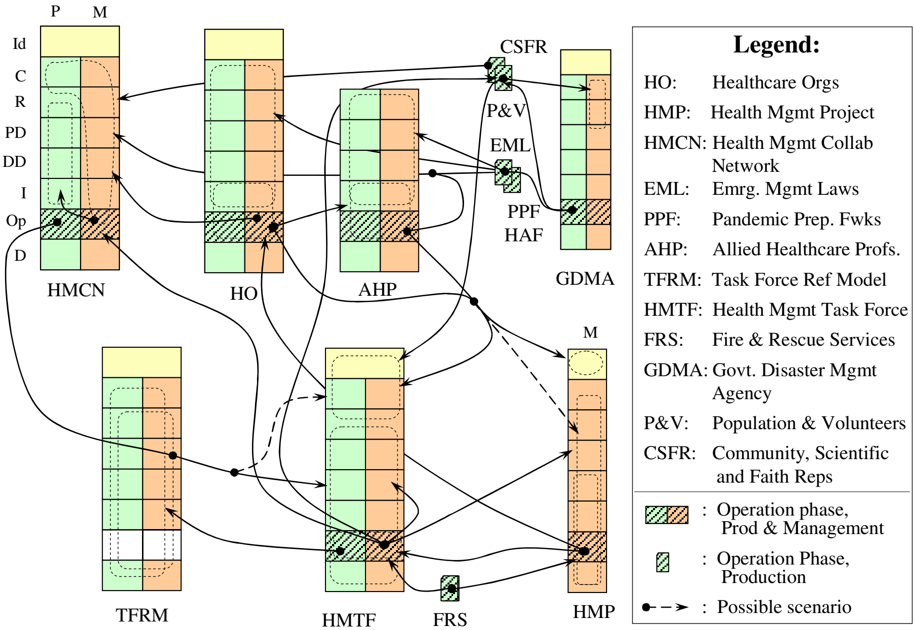
Health Incident Life Cycle Phase (GERA MF)	Health Disaster Management Phase	Comment
Identification	Prevention	Identification of the Health Hazard
Concept	Prevention	Response Required? Why / why not?
Requirements	Preparation	Response Requirements
Preliminary Design	Preparation	Response Solution (Principles, Policies)
Detailed Design	Preparation	Detailed Response Solution; Prepare Partners for fast Task Force Implementation
Implementation	Response	Create Health Disaster Management Task Force
Operation	Response	Deploy, Respond
Decommisssioning	Recovery	Decommissison the Disaster Management Task Force or reconfigure it for Recovery

Fig. 2. Mapping a health incident on disaster management using GERA MF phases

Figure 3 shows a sample model of HMCN and HMTF creation and operation that integrates the life cycle and management aspects. Note that a complete modelling exercise (not possible here due to space limitations) should contain diagrams covering all the *required* aspects. The use of viewpoint combinations based on the same MF will facilitate producing and maintaining a coherent set of models.

The arrows in Fig. 3 show influences and contributions among the stakeholders previously identified to be of interest to the long and short term healthcare concerns. Thus, healthcare organisations HO (e.g. hospitals), allied health professionals (AHP) and scientific, faith and other communities representatives all contribute to the design and operation of a HMCN in its various life cycle phases. These contributions may also extend directly to the design and operation of the HMTFs created by the HMCN, and even to the health management projects (HMPs) created by the HMTF. Influences and contributions also come from 'non-physical' artefacts such as emergency management laws (EML), pandemic preparedness (PPF), or healthcare assessment frameworks (HAF)[17]. Feedback from population, organisations and community representatives is used to improve Government agencies (GDMAs) and the HMTFs.

The arrow from HMTF's Management side of the Operation life cycle phase to some of its upper phases represents a very important 'self partial redesign' capability, showing a need for the HMTF to be *agile* and adapt in real time in the face of rapidly changing conditions on the ground that are typical of some disaster events. Any major HTMF reconfiguration will however need to involve the HMCN participants.



Life cycle phases: Id: Identification; C=concept; R=requirements, PD=preliminary design, DD=detailed design, I=implementation, Op=operation, D=decommissioning. *Other aspects:* P=Production / Service, M=management

Fig. 3. Possible life cycle model of collaborative health system setup and operation

Note that a high-level model such as shown in Fig. 3 does not aim to provide all the details necessary for actual implementation upfront. Rather, its main purpose is to facilitate stakeholder consensus on the problems of the present state and support the selection of the optimal future state. Such models can provide checklists of the entities that need to be considered in the collaborative healthcare endeavour and spell out the interactions between them, in the context of their life cycles. They can also represent organisational autonomy and agility and thus help reveal hidden problems. Once consensus has been achieved, the models can be decomposed and evolved into detailed design and implementation blueprints.

5 Conclusions and Further Work

Collaboration and interoperation are paramount in healthcare in order to meet major contemporary challenges. Politics, hierarchy, lack of trust, dissimilar organisational cultures and limited or missing integration and life cycle-based perspective of the participants' roles are decisive factors that can be addressed by prior preparation in a suitable environment. This paper has argued that the healthcare endeavour could significantly benefit from adopting a CN paradigm applied from an EA perspective and has attempted to exemplify a high-level integration modelling example involving CN and EA artefacts. The paper makes a theoretical contribution by emphasizing the connection between CN, EA and healthcare research and a practical contribution by providing an example of how CN concepts can be employed from an EA perspective in order to model a collaborative healthcare solution to health and well-being challenges. The proposed approach will be further developed and applied to several healthcare management case studies in order to verify, validate and refine it.

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Strategies I

The “Enterprises’ Network Agreement”: The Italian Way to Stimulate Reindustrialization for Entrepreneurial and Economic Development of SMEs

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Abstract. Moving from the key features of knowledge economy and taking into consideration the new paradigms emerged in economic and managerial studies, in many countries several institutions have promoted the formation of strategic alliances to stimulate the reindustrialization and promote the national and regional development. The Italian government has recently defined a new legal framework (law n. 122/2010) to implement collaborative strategic networks through the “enterprises’ network agreement”. The latest data about the implementation of the new form of collaborative networks show a rapid spread of the agreement and represent an important result to read in the light of economic, managerial and industrial literature. In the paper the main characteristics of the agreement are described and discussed, and an analysis based on historical data, since two years from its introduction, is presented. The aim is to evaluate how this kind of tool can have an impact on the reindustrialization of the Country and the emergence of second generation VBE on this process.

Keywords: institutional support, enterprises’ network agreement, collaborative and strategic networks, reindustrialization.

1 Introduction

The creation and development of collaborative networks and alliances is thought to be the best strategy to adapt the business structure to the main features of the knowledge economy, especially in the economic contexts characterized by the presence of SMEs [1, 2] and entrepreneurial business [3]. Moving from the key features of knowledge economy and taking into consideration the new paradigms emerged in economic and managerial studies [4, 5], European countries are promoting the formation of strategic alliances to stimulate the national and regional development [6, 7], providing institutional and financial support to companies willing to cooperate and set up a network. In the last few years, there is in Italy an increasing demand in the industrial world for concretely implement this new forms of collaborations. For example,

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demand often comes from pre-existent form of clusters or consortiums, which want to evolve to more efficient forms of collaboration [8-10]. The latest initiative of the Italian government is based on the definition of a new legal framework (law n. 122/2010) to formalize the implementation of cooperation strategies: the “enterprises’ network agreement” [11].

Following the most important streams of literature on strategic alliances [12-15] it is expected that this tool can generate a strong spread of CNOs strategic purposes, and can have a strong impact on the processes of economic development. The present study therefore considers all network contracts entered into since the start of the law (2010) until December 2012, analyzes their characteristics in terms of size, spatial localization and sectorial distribution and assesses the impact that this tool can have on the process of re-industrialization.

The paper is organized as follows: in section 2, a synthetic summary of the institutional and theoretical framework is reported; in section 3, the data and the methodology of the analysis is described; in section 4 we report the results of the study and discuss about the main implications; in section 5 conclusions are drawn.

2 Institutional and Theoretical Framework

The small size of Italian firms is a relevant limit to the achievement of greater efficiency: it often reduces the ability to change strategies, to internationalize, innovate and in general to cope with competitive pressures.

This circumstances threaten the strategic development and the performance of the Italian industrial system, still characterized by an important role played by the manufacturing business that however need to implement a process of re-industrialization based on innovation and higher critical mass, reaching only through network collaboration (Industry 2015). According to the Italian authorities all companies in Italy, but especially SME, are reluctant to cooperate, given that there were in Italy, until 2010, no effective and simple legal form of cooperation, allowing carrying out common activities (or other forms of cooperation) within a pre-defined legal framework. In this context there were spaces for public intervention in order to stimulate the creation of formal networks between undertakings as an alternative or preliminary to the growth in size. Already in 2000 the "Bologna Charter" adopted by OECD countries [7] recognized networks as an important driver of competitiveness of small enterprises and in 2008 the Small Business Act, the European Union defined lines of action to promote the development of small and medium-sized enterprises, encouraging the involvement of national governments in this area [6].

While other existing forms of legally structured cooperation, such as temporary associations of enterprises, are temporary aggregations of companies to undertake a specific operation, the contract would therefore provide the most flexible and general form of association among companies, with limited rules to ensure only transparency and stability of contractual relationships. According to Italian authorities [16] this measure was strongly demanded by Italian companies and their associations and responded to the specific structure of the Italian industry, characterized by the existence of numerous and small individually-owned companies, willing to cooperate while maintaining their independence.

The law n.122/2010 defined the "enterprises' network agreement" as the legal tool needed to formalize strategic alliances among entrepreneurs whose "aim is to enhance, on an individual or collective basis, their innovation capabilities and their competitiveness on the market" undertaking the commitment to: i) "cooperate in different ways on a specific business related to the management of their own enterprises (or); ii) sharing information and services of an industrial, commercial, technical or technological kind (or); ii) managing in a collaborative way one or more activity included on the mission statement of the companies".

From an organizational perspective the contract can be implemented for a wide variety of collaborations, both in terms of vertical alliance, f.e. in the form of supply chain among companies that operate in the same sector at different stages of production, and horizontal alliance, f.e. among competitors sharing some special projects of innovation and strategic development. The last strategic option can be useful especially for SMEs that, though competing in their local markets, may form special alliances to reach wider markets or implement internationalization project. However, even on the structural perspective, the contract does not provide size limits and can be signed by SME's or large companies and be utilized to set up collaboration among partners with homogeneous or heterogeneous dimensions. The supporting measure consists in a tax deferral: a part of taxable revenue, targeted by participating companies for achieving the purpose of the contract and put in a specific reserve, will be excluded from the calculation of taxable income, for the duration of the contract. Such benefit is temporary, given that the money put aside for the participation to the network will be included in the tax base once the contract is fulfilled.

The contract has to be drawn according to a formal procedure with a notary, requiring an official registration with the competent Chamber of Commerce where the companies reside, and it must indicate (law n. 122/2010): i) references of partners; ii) strategic objectives; iii) performance measurement criteria to assess the progress toward strategic goals achievement; iv) network action plan; v) duration of the agreement ; v) specific endowment to manage cooperation activity.

Assessing this regulatory discipline in the light of the theoretical framework, the definition of network agreement by law n. 122/2010 is consistent with the concept of strategic network [12, 13, 17], considered as an intentional, long-term alliance enabling different companies to acquire or defend the competitive advantage against competitors outside the network. However, on the basis of an exploratory study performed on the first 50 network agreements formalized in Italy [18], it is possible to assume that the strategic objectives tend to be generic and the agreement could be better interpreted as a goal-oriented Collaborative Networked Organizations (CNOs) defined as alliance "driven by continuous production/service provision activities, characterized by a long-term duration and remaining relatively stable during that duration, with a clear definition of members' roles along the value chain". More particularly the "strategic" focus and the need to indicate the strategic goals of the alliance allow to frame the network agreement in a VBE perspective [19] defined as "strategic alliance of organizations and related supporting institutions adhering to a base long term cooperation agreement, and adopting common operating principles and infrastructures, with the main goal of increasing both their chances and their preparedness towards collaboration in potential VOs", enabling the new model to play a crucial role on manufacturing re-industrialization [20]. In this framework the 2nd generation VBEs that are not bound to geographical regions or specific activities and integrate their process through innovative ICT approach shall play an active role in the society/market as competitive entities [21].

3 Data and Methodology

The paper considers the entire population of all network agreements signed under the new legislation framework defined by the Italian government with law n. 122/2010. At December 2012 this population includes 647 agreements recorded in the official Chamber of Commerce registers, at provincial and national level (Unioncamere), characterized by the following dimensions (Tab. 1). We can note that over 20% business entities present the typical organizational structure of entrepreneurial and small enterprises (individual businesses and partnership). In addition some recent studies [22] performed on the agreements formalized until December 2011 confirmed the small and medium size of the companies involved in the contracts, employing less than 10 people on 39.2% of the cases, from 10 to 19 employees on 19.4%, from 20 to 49 on 14.4% and over 50 for 12.0% of the total. Financial indicators of these companies complete the analysis and highlight the high presence of SME's, presenting the following median values: 2,708,000 € of total asset, 2,275,000 € of turnover and EBITDA margin at 7.9%.

The data base reported for each contract the following records: name of the network, strategic goals identified, date of set-up, names of the partners involved, VAT number and the statistic code identifying the sectors and sub-sectors where the members operate.

Table 1. Population of "enterpirses' network agreements"

	N.	%
- "Enterprises network agreements"	647	
Involving:		
- Regions	20	
- Provinces	99	
- Entities	3.360	100.0%
of which:		
- limited companies	2.275	67.7%
- partnership	437	13.0%
- individual business	350	10.4%
- mutual entities	228	6.8%
- foundations and association	10	0.3%
- others	60	1.8%

Source: Chamber of Commerce – Unioncamere

Considering the classification codes according to ISTAT, macro-sector categories identified by capital letters (ex. A – Agriculture, forestry and fishing, B – Mineral mining from cave, C – manufacturing, etc.) and sub-sectors identified by the first two numbers of the code (ex. the breakdown of C is: 10 – food; 11 – beverage;…15 – leather; etc.) the research has provided the following steps.

Firstly we adopted a single entity perspective to understand how the different sectors are represented on the population of 3,360 businesses involved in a network agreement. We compared these data with the incidence of the sectors in the population of total 5,275,515 operating businesses in Italy in order to asses if the collaborative strategy under the new legal framework is affecting the different sectors in the same proportion of the whole production system.

Secondly we moved to a networking perspective focusing on the main characteristics of the 647 CNOs resulting from the data-base in terms of dimension (number of partners) and localization (number of provinces involved). Then we analyzed the sector or the combination of sectors involved in each CNOs, focusing on those agreements that included among the partners at least one company operating in manufacturing. Indeed the literature [23] shows that the process of re-industrialization goes through a reconfiguration of the operations so that any manufacturing company that contributes to the achievement of common business objectives realizes somehow an innovative process of re-industrialization. Given the characteristics of the knowledge economy and the strategic importance of ICT we then identified those CNOs where a combination of manufacturing and ICT sectors is present. Within this group, finally, it is intended to highlight how many contracts have a geographical distribution of partners in at least at two provinces and therefore can be considered second generation VBE.

4 Results and Discussion

Highlighting the operating sectors of the over three thousand entities that have formalized a collaboration through the network agreement and comparing them with the distribution by sectors of the population of enterprises in Italy we get the following results (Tab. 2).

The table shows that almost half of the companies involved in networking agreement (42.4%) operate in the manufacturing sector; at lower percentages we find the professional services (11.0%), constructions (9.7%) and wholesale and retail trade (6.4%). It is worthy to note that the business entities in Italy are distributed according to different percentages, presenting an incidence of manufacturing companies involved in networks much higher than their incidence in the whole production system. This results can demonstrate a strong propensity of manufacturing SME’s to collaborate, being motivated by the loss of their competitiveness and the need to identify new business opportunities through innovation.

Using the second level of ISTAT classification (sub-sectors) we elaborate a breakdown of manufacturing codes identifying the incidence of the first ten specialization inside the sector (Tab.3). The data shows an homogeneous distribution of the different manufacturing specializations between the business entities involved in network agreement and the whole population of manufacturing entities operating in Italy. This fact can demonstrate a good attitude of the new formal setting based on collaborative strategy to reflect the traditional vocation of Italian specializations reinforcing the strengths and safeguarding the values of entrepreneurial SME's operating in manufacturing industries.

Table 2. Breakdown of sectors – incidence comparison

	Business entities	
	involved in network agreement	in Italy
Manufacturing	42.4%	10.2%
Professional. scientific and technical activities	11.0%	3.3%
Constructions	9.7%	15.7%
Wholesale and retail trade	7.4%	27.0%
Information and communication services	6.4%	2.1%
Agriculture. forestry and fishing	4.8%	15.7%
Arts. sports. entertainment and recreation	3.6%	1.1%
Rental. travel agencies. business support services	2.9%	2.7%
Health 'and social work	2.5%	0.6%
Transportation and storage	2.0%	3.1%
Others	6.2%	18.5%

Table 3. Breakdown of manufacturing sub-sectors – incidence comparison

	Business entities	
	involved in "network agreement"	in Italy
Metal product (except mach. and equip.)	17.4%	20.0%
Machinery and equipment	11.8%	6.0%
Food industries	8.4%	10.5%
Leather and related	7.6%	4.1%
Computer products and electr. And optics	4.8%	2.2%
Electrical and equipment for household	4.7%	2.7%
Other manufacturing	4.4%	7.9%
Other products	4.3%	5.2%
Furniture manufacture	3.8%	4.8%
Rubber and plastic	3.8%	2.3%

Moving to analyze the data-base of agreements adopting a networking perspective we studied the main features of CNOs formalized under the legislative framework defined be Law n. 122/2010, focusing on the dimension (number of partners involved per CNOs) and localization (number of provinces involved per network) as resulting in the following table (Tab. 4). Most of the networks (over 70%) includes from two to five members, representing therefore a form of alliance where the coordination and trust mechanisms tend to affect few partners and the strategic focus can benefit of a concentrated collaborative framework. In terms of localization over 30% of the networks are very geographically characterized, involving only one province and probably reflecting the model of the old industrial districts. However, a significant proportion of network includes members that are localized in two or more provinces, meaning a tendency to build network relations not characterized by territorial proximity that are able to create new space of collaboration over geographically diversified areas.

Table 4. Dimension and localization of CNOs formalized with the network agreement

Dimension of CNOs		Localization of CNOs	
N. of partners involved per “network agreement”	%	N. of provinces involved per “network agreement”	%
/	/	1	36.1%
2	15.5%	2	29.3%
3	25.7%	3	17.1%
4	19.2%	4	8.2%
5	11.6%	5	3.6%
6	3.8%	6	2.6%
>= 7	24.2%	> =7	3.3%

Moving to analyze the industrial features of CNOs formalized through the “network agreement” we considered the combination of different sectors of the partners, focusing on those networks operating in manufacturing (Tab.5). It is worthy to observe that almost two-thirds of the contractual CNOs (69%) includes at least one company that operates in manufacturing; inside this sample approximately the 40% presents over a half of industrial incidence on the alliance.

Focusing on the forms of networking that may have greater potential to successfully start the process of re-industrialization, we search for those networks including the joint presence of companies operating in manufacturing and ICT and we obtained n. 83 CNOs (12.8% on the total). Combining these dimension with the localization perspective we found out n. 71 CNOs Manufacturing & ICT involving more than one provinces that can be considered as second generation of VBE.

Table 5. CNOs for reindustrialization

	N.	%
- CNOs involving Manufacturing partners	446	69.0%
of which:		
- Manufacturing (Man) companies 100%	55	12.3%
- 100% > Man >=50%	127	28.4%
- Man < 50%	264	59.1%
- CNOs involving Man & ICT partners	83	12.8%
- CNOs involving Man & ICT & whose partners are dislocated in more than 2 Provinces	71	8.7%

By analyzing the sectors involved in this set of CNOs (Tab. 6) it is possible to note a high degree of sectors diversification, higher than to the totality of the networks involved in the agreement. This confirms that particularly this type of CNOs can assume a strategic role in the innovative recombination of operations and in the reindustrialization of the Italian economy.

Table 6. Sectors differentiation

Number of different sectors per network	Incidence on second generation VBEs	Incidence on the total
2	21.13%	32.2%
3	25.35%	31.6%
4	33.80%	19.2%
5	7.04%	9.6%
>= 6	12,7%	4.3%

5 Summary

In the paper a new legal framework named “enterprises’ networks agreement”, introduced in 2010 by the Italian Government, has been described, and the latest data about the implementation of the new form of collaborative network have been presented. Based on the institutional and theoretical perspective it is possible to argue that the network agreement has been implemented as a strategic tool of industrial policy, able to facilitate the contractual arrangement of the alliances and considered as a vehicle of institutional support to develop the managerial innovations for a new culture of collaboration.

Analyzing the empirical data it can be observed that, since its introduction, the network agreement shows an interesting spread, reaching to December 2012 a total of 647 contracts that involve more than three thousand businesses. This result has already triggered an important innovation process involving all major stakeholders of the Italian economic system (national and regional institutions, business associations, banks, professionals, managers) that are now defining specific measures to stimulate institutional, financial and managerial schemes and tools to support network formation. For this reason, the introduction of the network agreement has certainly achieved the result to define an institutional framework capable of triggering the "leverage" of cultural innovation.

In terms of business performance it is still too early to evaluate the ability of the new formal arrangement to remove the limits of the small size developing the potential benefits of partnerships on liabilities, IP protection and industrial development strategy. Instead, studying the characteristics of the network in terms of sectorial composition, size and geographical location, the paper demonstrates that the contract has the potential to really stimulate re-industrialization and innovation.

Results show that manufacturing companies are particularly involved in the formation of the new type of CNO, being the entire sector well represented in each of its specialization (sub-sector). With respect to earlier collaborative forms developed in

Italy, like Industrial Districts and Consortia, the new form shows a much higher degree of sectors diversification, and is much less characterized by the geographical concentration, being relevant the number of networks involving different provinces spread over the Italian territory. There are also a number of networks that add to these two characteristics (diversification and de-localization) the joint presence of manufacturing and ICT sectors. The networks of this type are candidates to become the so called ‘2nd generation VBE’, and seem to have the characteristics to play a relevant role in the reindustrialization of the Italian economy.

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Opportunities for Collaboration in the 'Asian Century'

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Abstract. The migration of manufacturing into Asia, notably China and India, has been accompanied by varying degrees of concern by western (traditional) businesses. Initially the use of *offshoring* by high volume/low value manufacturers was seen as a means by which they could remain price competitive; however the more recent moves by Asian manufacturers into the high value/low volume markets has become both an economic and a political issue in what currently is shaping up to be a more serious economic downturn than the "2008/9 GFC". The move towards *reshoring* has been driven by the equalisation of wage rates in Asia and the softening of labour attitudes in western manufacturing countries, specifically in North America: where recently some runaway plants returned home, and there are some positive economic incentives to encourage more domestic sourcing. The paper discusses the current and future opportunities for Western companies in this scenario and suggests there is scope for collaboration between Asian and Western organisations.

Keywords: network business models, global value chains, collaboration, Asian business models, producibility.

1 Introduction

In recent years the trend in the global economy has been the "so-called rise" of the economies of many developing countries that were rapidly converging with those of the more developed countries: "The drive behind this phenomenon was the four major emerging-market countries, known as the BRICs: Brazil, Russia, India, and China. The world was witnessing a once-in-a-lifetime shift, the argument went, in which the major players in the developing world were catching up to or even surpassing their counterparts in the developed world" [1]. Forecasts of BRICs growth (based upon their growth rates during the middle of the last decade and extended straight into the future) suggested the *developing world's* high growth rates from the middle of the last decade and extended them straight into the future, juxtaposing them against predicted sluggish growth in the United States and other advanced industrial countries. They suggested the Chinese economy was on the verge of overtaking the United States as the world's largest economy. "Chinese growth is slowing sharply, from double digits down to seven percent or even less. And the rest of the BRICs are tumbling, too: since 2008, Brazil's annual growth has dropped from 4.5 percent to two percent; Russia's, from seven percent to 3.5 percent; and India's, from nine percent to

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 481–488, 2013.

six percent" [1]. Sharma [1] cites work by Rodrik [2] who has shown that before 2000, the performance of the emerging markets as a whole did not converge with that of the developed world the per capita income gap between the advanced and the developing economies steadily widened from 1950 until 2000. Rodrik suggests that except for the few small countries that benefited from natural-resource bonanzas (notably Brazil and Russia), all of the successful economies of the last six decades owe their growth to rapid industrialization. One thing that is agreed is that Japan, South Korea, Singapore, Taiwan, and China all were efficient at moving their labor from the countryside (or informal activities) to organized manufacturing; but this has changed. Roubini [3], in an international survey of the 'health' of leading economic blocs and countries reaches similar conclusions reporting; "In China – and in Russia (and partly in Brazil and India) – state capitalism has become more entrenched, which does not bode well for growth. Overall, these four countries (the BRICs) have been over-hyped, and other emerging economies may do better in the next decade: Malaysia, the Philippines, and Indonesia in Asia; Chile, Colombia, and Peru in Latin America; and Kazakhstan, Azerbaijan, and Poland in Eastern Europe and Central Asia".

2 The Asian Business Model

The Economist identified a number of significant differences between the Asian and Western business models. India's *diversified conglomerates* have a major impact on industrial activity; for example the *Tata Group*, with wide spread industrial activities is responsible for some six per cent of the National GDP. Diversified conglomerates widen market base and enhance market power using economies of scale and scope. They offer profit stability by their improving financial performance. Growth counters competitive threats and the access to latest technology is improving quality as well as productivity. The structure of these organisations has facilitated access to funds for growth but this is seen to be becoming problematic and they are looking overseas for acquisitions and funding. [4]

China's *State Owned Enterprises (SOEs)* dominate major industries. SOE's have a distinct legal form and they are established to operate in commercial affairs. They may also have public policy objectives. Ideally they are differentiated from other forms of government agencies or other state entities that are established to pursue purely non-financial objectives that have no need or goal of satisfying shareholders with a return on their investment through share price increase or dividends. A number of commentators make the point that the influence of the SOE is declining as policy favours a shift towards the Western stakeholder model. Since the 1980s, the Chinese government and the ruling party have followed a policy of *zhengqi fenkai*, which formally separates government functions from business operations. The policy has been applied gradually, first to the consumer goods industry, then to high tech and heavy manufacturing, and, more recently, to banking, as officials have attempted to strengthen domestic businesses and the economy to prepare them for unfettered global competition.

3 East Is East and West Is West – ne'er the Twain Shall Meet?

Wooldridge [5] in a detailed review of Asian management developments identified the emerging differences in Indian and Chinese approaches to business and business models. Successful Indian businesses are predominantly led by entrepreneurial individuals and families; whereas in China Central Government's involvement can be seen. The Wooldridge contribution identifies operational differences between East and West. He identifies *Open Innovation;* as a contributor to their success; here the emphasis is not on innovation in a western context (new product-services) but more on identifying unfulfilled necessities among the less well off. For example, ***Tata Consultancy Services*** (TCS), has produced a water filter that uses rice husks (which are among the country's most common waste products) to purify water. It is robust, portable and cheap, providing an abundant supply of bacteria-free water for an initial investment of about $24 and a recurring expense of about $4 for a new filter every few months. Tata Chemicals, which is making the devices, is planning to produce one million over the next year and hopes for an eventual market of 100million people. *Frugal/Reverse innovation:* ***General Electric's*** a hand-held electrocardiogram is small enough to fit into a small backpack and can run on batteries as well as on the mains sells for $800, instead of $2,000.

The Asian business model has identified opportunities to *apply mass production to sophisticated services;* at 1,000-bed ***Narayana Hrudayalaya Hospital***, ***Dr Devi Shetty's*** surgeons operate at a capacity virtually unheard of in the U.S. The approach has transformed health care in India through a simple premise that works in other industries: economies of scale. The application of *dispersed manufacturing* is well established; geographically dispersed customers in both emerging and established global markets now demand higher quality products in a greater variety and at lower cost in a shorter time. Furthermore, also as product profit margins continue to shrink, organisations reorganize their activities and realign their strategies to provide the speed and flexibility necessary to respond to windows of market opportunity; moving from centralised, vertically integrated, single-site manufacturing facilities to geographically dispersed networks of resources. The more recent moves by Asian manufacturers into the high value/low volume markets has become both an economic and a political issue in what currently is shaping up to be a more serious economic downturn than the "2008/9 GFC. *Hybrid manufacturing models* (a combination of advanced manufacturing technology with traditional production processes) are being introduced by large manufacturing organisations, this development changes the competitive environment between East and West, and however, the impact is unlikely to be seen for some time.

Government activity has had a strong influence. For example China uses *selective interest rates* for loans to industries it selects for growth together with *industry subsidy support strategies*. *Managed exchange rate flexibility* has provided an export advantage for manufactured products and *inter-government currency exchanges* create favourable trade terms on a selected basis.

3.1 Or Can They?

The recent move towards *reshoring* has increased a number of reasons suggesting this is a strategic response not a short-term operational reaction aimed at cost containment.

Prominent among these are the increasing wage rates in Asian manufacturing together with increasing energy costs, particularly oil prices with a huge impact on transportation costs. To these should be added the advances in robotics specifically the impact of the increased flexibility of robotics; robot technology has resulted in "multi-skilled' robots now capable of being multi-tasked resulting in flexible manufacturing techniques offering lower operating costs *and* the ability to reduce the response time to customer demand.

Organisational structures have also moved on. Industries and organisations have also undergone significant changes. McKinsey [6] highlighted recently in *"Manufacturing the Future"*. While the developed countries will continue to increase their share of global production, the impact of Asian manufacturing will be significant. Although some manufacturing is returning to America and Europe from locations where it had been offshored, such as China, this trend will not recreate all the factory jobs that once existed. Two reasons support this claim: one is the application of robotics (becoming increasingly flexible *and* less expensive) and secondly the lack of skilled labour in the developed economies will be an increasing problem. There is potential here for competition in the high value/low volume sector markets to intensify; however ideally both Western and Asian interests should be seeking solutions that involve collaboration rather competition.

There are a number of reasons to suggest a structured network organisation could work. The synergy that would result from the product and process innovation that an 'East-meets-West' business model could increase the value returned to all stakeholders. Furthermore, an increased emphasis on *producibility* a measure of the combined outputs of profitability, productivity and resources mix management using *total cost analysis* (TCA) is currently being used by a number of large organisations is resulting in optimised decisions; these typically involve a mixture of offshore and onshore activities. TCA is being increasingly applied to evaluate the 'total cost' implications of manufacturing options; such as all of the associated logistics and supply chain management costs, including qualitative 'what if' scenarios concerning control off offshore operations; these decisions often resulting in decisions favouring *re-investment in domestic production.* An example of TCA at work is provided by ***Cue*** a medium size ladies wear retailer in Australia. Cue has analysed its value proposition and 'manufactures' its core range of products (60/70 per cent) in Australia; the remaining merchandise is sourced from Asia. This is because Cue requires short lead times (3/4 weeks) to maintain customer interest and to avoid excess inventory levels and a high quality, complex, product to meet customer expectations; Asian manufacturers cannot meet these requirements. However the remaining 40/30 per cent are sourced from Asia.

4 Facilitators: The Value Chain Network Model

Marsh [7] and others (e.g., [8], [9], [10]) have commented upon the flexibility of the value chain network. Marsh qualifies the value chain network as innovative with; "… in the early years of the twenty-first century, the realization grew that making products is just one part of the 'value chain' of company operations. Others include design and development, and the way products are maintained or 'serviced' after installation. To be considered a great manufacturer, companies do not need to make anything, even though they will almost certainly know a lot about what this entails. Increasingly, elements of the value chain are being left to a variety of businesses in different countries. The management of this mix is becoming a highly prized skill. Marsh predicts that; " as the new industrial revolution proceeds, the connections will become denser, more complex and more susceptible to sudden shifts in technology or market forces … The fragmentation of activities will become greater as more businesses in different countries find they can participate".

Production processes of technology are undergoing dynamic change and can meet this challenge (for example; the digitisation of manufacturing, continuous manufacturing, additive manufacturing, and flexible manufacturing) offering opportunities for global partnerships to western countries from designing and manufacturing innovative components (and introducing innovative processes) across a number of industries. The value chain network model is sufficiently robust to undertake this task. Currently the focus of value chain management is on coordinated value adding activities based upon *consumer centricity*. However there is evidence to suggest a new generation of value chain thinking that is becoming based upon *market-centric networks*; large organisations such as General Electric, ABB, Millenium (a Bio Tech/Pharmaceutical organisation), and Siemens are pursuing strategies of entering new growth markets (such as renewable energy, life sciences/ biotechnology and medical devices) and are being innovative in how they compete by collaborating with local organisations using local resources creating networks structured around mergers, acquisitions, and strategic alliances. These organisations been active in the M&A sector building global networks of RD&D, manufacturing and marketing capabilities that are typically local-market based, that are able to be product-service specific, manufacture locally (avoiding foreign exchange problems) and use local distribution networks. For example, General Electric has established RD&D Centres in a number of Asian countries and is pursuing opportunities in these and global emerging markets and is using innovative process management as its strategy of "frugal" innovation suggests.

The expansion of global value chains has changed some views on how productivity should be measured. This is because a product may not only be worked upon across a range of organisations, each adding value as it leaves their premises; but it may cross a number of international borders where there may or may not be taxation payments that distorts the vendor/purchaser price and therefore the added value. The McKinsey Report [6] segmented global industries by identifying value adding intensities by manufacturing components. It demonstrates that the industries*: global innovation for local markets* (34 per cent of global manufacturing added value); *regional processing* (28 per cent of global manufacturing added value); regional processing) *energy/resource intensive commodities* (22 per cent of global manufacturing added value); *global technologies/innovators* (9 per cent of global manufacturing added value); and *labour intensive tradeables* (7 per cent of global manufacturing added value), each require varying levels of input expertise. It follows that any organisation or perhaps country would identify where, in this context, its capabilities and expertise can best be utilised and in this way plan around these to enhance productivity across the network of a global value chain.

4.1 Facilitator: The Factory of the Future

The forgoing suggests some major structural changes in the notion of what manufacturing is, what it is, and how it operates. Barkai and Manenti [11] argue that current market trends require the future production environment to be highly adaptable and reconfigurable to respond to rapid changes in market demand, technology innovation and changing regulations. Flexible manufacturing technologies employed by most automakers are a critical ability in this process and the foundation for profitable growth, but these alone will not suffice in a long term strategy to fend off the competition. The authors suggest a practical "design anywhere, make anywhere, sell anywhere" strategy is needed, and propose, arguing that: "Factories of the future will be a global network of production facilities managed as single virtual factory. This type of manufacturing network consolidates multiple resources and capabilities to form an end-to-end fulfillment network that we call fulfillment execution system (FES)."

Barkai and Manenti [11] argue that current market trends require the future production environment to be highly adaptable and reconfigurable to respond to rapid changes in market demand, technology innovation and changing regulations. Flexible manufacturing technologies employed by most automakers are a critical ability in creating *collaborative competitive advantage* and the foundation for profitable growth and can be designed with resources management as an objective. The authors suggest a practical "design anywhere, make anywhere, sell anywhere" strategy is needed, and propose, arguing that the FES (fulfillment execution system) is an approach to a *coordinated management* of demand, capacity and resources, and outbound order fulfillment across the entire network of manufacturing plants and along the value creation chain. Data gathered will be connected to corporate-level intelligent decision support tools, creating visibility and intelligence on operational data. It enables manufacturers identify problems, isolate root causes, understand the state of execution processes, and adopt corrective actions quickly across multiple plants.

IDC Manufacturing Insights Predictions [12] introduced *Global Plant Floor* model following much the same approach: a network of factories, managed as a unique virtual factory that consolidates the number of different manufacturing plants in terms of resources, processes, and products with the ability to harmonize, supervise and coordinate execution activities across company's and suppliers' manufacturing operations, with greater level of real-time visibility; and, with Centres of Operational Excellence and plant-floor IT seen as essential to this transformation. Together these concepts propose a coordinated international multi-plant operation that may located anywhere by using ICT facilities.

4.2 "Producibility" and the Global Value Chain: Opportunities for Collaboration

Producibility is a total design activity that includes all relevant activities within the value chain network and creates intra and inter-organisational partnerships by applying *total cost analysis* to evaluate an optimal structure to achieve end-user satisfaction. It is a management process whereby the product-service design process is integrated with the manufacturing process in an attempt building *strategic* *effectiveness* into the value proposition by integrating both design and manufacturing processes to achieve *production efficiency* (i. e; manufacturing business model, quality specifications, volume and delivery targets at target costs and commercial prices), (Boothroyd et al [13]). However to be an effective network model the concept requires expansion:

> *Producibility* is the *total design* activity that includes all relevant activities within the value chain network and creates intra and inter-organisational partnerships to achieve *stakeholder* satisfaction. It is a management process whereby the *product-service-design* process is integrated with the design of manufacturing processes and the subsequent the operational processes of physical distribution and service support management.

Clearly not all of the activities need to be performed by any one organisation; but given the assets, capabilities and capacities of current and potential network members, together with the end-user expectations, it is now possible to design the product-service, the manufacturing processes, the physical distribution processes, and the maintenance service activities concurrently. By identifying the 'value-added intensity profiles' within each network member it is possible to construct *industry value-adding chains* [6]. A producibility-approach makes a structured -value - adding chain possible. This is becoming economically viable with the contributions of Barkai and Manenti [11], the *Fulfilment Execution System* (FES) and IDC Manufacturing Insights' *Global Plant Floor* model introduced in 2012 [12]. Together these concepts propose a coordinated international multi-plant operation that may located anywhere by using ICT facilities.

5 Concluding Comments

Producibility is not new it has a number of precedents; value engineering, value analysis, and design for manufacturing assembly, to name a few. Examples can be found, the four lane strategy of Caterpillar embraces producibility principles as do the frugal/constrained innovation strategies of General Electric [14] and of Panasonic [15]. However this paper suggests an extension of Boothroyd et al.'s original model to include distribution and service activities within the concept. Adopting producibility introduces: operational processes that participate in building strategic effectiveness into the value proposition; integrated design, manufacturing and distribution processes to achieve operational efficiency (i.e., the manufacturing business model, quality specifications, volume and delivery targets at target costs) and; the inclusion of the commercial business model (physical distribution, resale (end-user access) availability and 'serviceability') designed into the total product-service package. The developments of ICT (information communications technologies) are now able to combine the innovative expertise and operational efficiencies of both East and Western business models provided the political will is applied to make it happen.

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The Potential of Agritourism in Revitalizing Rural Communities: Some Empirical Results

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Abstract. Modern patterns of rural development propose a rational and respectful exploitation of agricultural resources together with the rediscovery of historical and naturalistic heritage as means to reach sustainable development. In this sense, Agritourism represents the contact point between the tourists' request of wellbeing, genuineness and rediscovery of nature, and the offer of typical agricultural products and touristic services of a network of rural organizations. The aim of this study is to improve our understanding of how agritourism activities can contribute to revitalize rural communities; the study assumes particular importance in a period of economic crisis characterized by the failure of the traditional patterns of rural development. We present key findings of an explorative survey carried out in the Calabria region, Italy, during 2012 on a sample of 52 farms offering agritourism activities. The study deploys an original methodology aimed to highlight the extent of the agritourism phenomena in the selected region and to evaluate how agritourism can support sustainable development of a rural community becoming the hub of an "agritourism rural network".

Keywords: Agritourism, rural network, agritourism rural network, rural community, sustainability, Calabria.

1 Introduction

The question of rural development has been long addressed by the scientific community [1][2]. Rural development can be defined in general terms as "an overall increase in the welfare of the residents of rural areas and, more generally, as the contribution that rural resources offer to the welfare of the entire rural population" [3]. The concept of rural development is becoming increasingly complex, going beyond the boundaries of the economic sphere and leading to a growing emphasis on the not overexploitation of natural resources and landscape, as well as on the rediscovery and valorization of existing tangible (infrastructure, monuments, typical foods, etc…) and intangible assets (culture heritage, traditions, history). Scholars group such patterns into the concept of "sustainable development", asserting the importance to involve local actors in common development pathways [4] [5].

In the effort to gain sustainable development, farmers and other organizations have started organizing themselves spontaneously in rural networks in order to solve their

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 489–497, 2013.

problems and those of rural communities. New and alternative business models have developed with the aim to guarantee competitive advantages, to improve farm revenue streams, to return in taking an active role in the agrifood system, and to develop new consumer market niches [6]. Such models are known as *Alternative AgriFood Networks*, AAFNs [7], which are collaborative networks in the agrifood sector characterized by a re-connection among producers and consumers with these explicit ethical and political goals: "re-vitalisation of territory identity and rural community relations to local food and agriculture, linking with sustainable agriculture, economically viable and socially responsible practices" [8].

In this work we aim to deepen the understanding of the Agritourism phenomenon and evaluate its potential as a model for the sustainable development of rural communities. In details, the paper is organized as follows. In section 2 the theoretical background of the study is summarized in order to have a fully understanding of the survey whose methodology is reported in section 3. Survey results and discussion are present in section 4 followed by conclusion in section 5.

2 Theoretical Background

In the last decades, rural communities have been invested from deep changes consisting mainly in the shift of economic activities and population to urban areas and in the loss of significance of the agricultural sector as the most important sector in terms of production, wealth and number of employees. These phenomena brought a crisis in traditional structure and organization of rural areas, exposing them to the risk of a economic, social and environmental decline, that involved agricultural sector as well as the entire local economy and rural communities as a whole [9] [10]. From the producers side, farmers are continuously looking for "new ways" of doing business, exploring the viability of alternative economic strategies [11]. According to [12], the main questions for farmers still remains "How, why, to what extent and under what conditions can the combination of activities within a rural enterprise positively affect costs, benefits, risks and prospects?".

From the consumers side, the increasing demands for quality safe, healthy and ethically correct food, led to a widening consensus that conventional agriculture is no more sustainable and radical changes are needed [13]. New organizational networks, based on processes of synergic collaboration, between farmers, consumers and other rural actors emerged in recent years in order to propose solutions for the rural community question [5][8][14][15]. Problems are better understood when analysed from different perspectives, thus a collection of differently skilled actors can, in principle, go beyond individual knowledge and reach new solutions for the whole community's questions [16][17][18][19]. Various studies [20][21], state that farmers might be able to realize their expectations by shortening long and complex agrifood supply chains and by embedding high "typical and quality" features, strictly linked to *local* agrifood products, within their production processes. AAFNs give farmers a direct means to increase their revenues by reducing intermediaries along the supply chain as well as the opportunity to strengthen relationship with consumers, by offering "personal" quality guarantees on products [11] [20]. AAFN paradigm is strictly interconnected with *relocalization* principles which are seen as a way to reinvigorate rural communities, reducing producers' dependence on subsidies and increase agricultural competitiveness [22]. Relocalization is characterized by the rediscovery of local traditions and environmental and cultural heritage as means of improving well-being, authenticity, and, in a more general sense, quality of life. Rural communities development concept goes beyond the boundaries of the economic sphere and leads to a growing emphasis on the exploitation of natural resources and landscape, as well as a rediscovery of tangible and intangible resources. In this sense, rural communities can look at "tourism" as an opportunity to diversify the economy and revitalize rural areas [23] [24].

2.1 Agritourism and Rural Networks

From an organizational point of view, a rural community is characterized by different autonomous entities (people and organization) that live and operate in a rural area, i.e. areas with poor infrastructure, far from major urban areas, and characterized by economic and cultural backwardness [10]. These entities aim to achieve the common goal of sustainable local development in order to increase their general competitiveness in a larger area. A rural community can be viewed as a *Breeding Environment*, *BE* [25], characterized by shared principles, infrastructures and culture, where networking and cooperation is practiced among their members. Within a rural community it is possible to identify particular kinds of *Collaborative Networks* [26], the *Rural Networks*, which are particular AAFNs whose members are not only agrifood producers, but also suppliers of touristic service, craftsmen, artists, local public administrations, etc. who want exploit advantages of AAFNs and relocalization offering tourists to experience rural tourism while tasting/buying local agrifood products. Members of a rural network are a subset of the rural community actors that establish long term and structured collaboration relationships and align their actions, interests, resources and goals, in order exploit business opportunities arising from direct and not-mediated connections with customers. In this paper we introduce the concept of *Agritourism Rural Network* considering agritourism as a farm activity able to give sustainable development to rural communities. Agritourism farm represents the hub of a rural network, the place where agrifood products and tourism services meet consumers demand for relocalization, the trigger to motivate further direct business opportunities between tourists and other rural community actors.

Agritourism is a widely debated topic in the scientific literature. According to the Italian legislative system, which acknowledges the European Union directives, the agritourism is exclusively defined as "tourism activities exercised by farmers through the exploitation of their own farm according to a logic of "connection", "complementarity" and "non-prevalence"[27]. In the scientific literature the term "agritourism" is often understood in a wide sense as a synonym for "farm tourism", "farm-based tourism", and "rural tourism. All these definitions present a common point in the rural/agricultural context in which services are provided [28] [29]. Many authors utilize the term "working farm" where tourism services are provided besides traditional agricultural activities. In our intent, rural tourism refers simply to tourism services provided in a rural context, while agritourism refers to "tourism services provided by agricultural entrepreneurs within their own farm, allowing also visitors to take part, directly or indirectly, in agricultural activities" [30]. In particular, agritourism farm may offer services as hospitality, meal provision, farm tour, on-site processing of agricultural goods, pick-your-own activities and so on. In [31] authors emphasize the dual role of agritourism for both individual "actors" (rural tourism operators, intermediaries in the tourism sector and visitors) and rural community as a whole. In fact, agritourism farms serve as a stimulus for other local activities (agrifood producers, crafts, restaurants, shops), as well as contributing to the preservation of customs and the local culture [32]. In those rural communities where members actively collaborate with farmers in their arrangement of agritourism services provision, we can observe the rise of an agritourism rural network.

3 The Survey

In this section we propose some results of an exploratory survey conducted among farms of a rural region with the aim to understand if and how farmers and rural actors, exploit agritourism potentials as a means to revitalize the rural community. Moreover, we aim to highlight the presence of agritourism rural networks in the surveyed region where rural actors operate together with agritourism farms for the sustainable development of the rural community.

3.1 Research Questions

The research questions can be defined as follow:

RQ1: Do farmers understand the importance of setting agritourism activities within their farm?

RQ2: Can the agritourism farm be a direct contact point between the rural community offer of products/services and the tourist request for relocalization?

- Do farmers offer tourists possibilities to enjoy the cultural and/or naturalistic heritage of the region? When such possibilities are offered, do tourists enjoy them?
- Do farmers offer tourists possibilities to taste and buy typical local agrifood products of the region? When such possibilities are offered, do tourists enjoy them?

RQ3: Is it possible to highlight the presence of an agritourism rural network in supporting the activities of the agritourism farm?

- In their products and services offer, do farmers act in formal cooperation with other suppliers of the rural networks?
- Which is the percentage of products or services sold through the agritourism farm that is supplied by local firms/associations?
- Are there any long-term supply contracts with such firms/associations?
- How many local workers are engaged by the farm exclusively to carry out the agritourism activities?

3.2 Methodology

The methodology is designed to address the research questions and can be applied to all regions being studied. The methodology is made up of the following steps:

step 1: determine the overall number of agribusiness in the region, and how many of them are officially authorized to offer an agritourism experience and are currently active. The set of such agritourism farms constitutes the population of interest for our analysis.

step 2: Definition of a questionnaire to be delivered to the managers of the agritourism farms within the population of interest. Responses to the questionnaire will be analyzed to answer the research questions.

step 3: Delivery of the questionnaire to the farms' managers and gathering of their filled forms. The set of agritourism farms whose managers filled the questionnaire constitutes the sample of the analysis.

step 4: Analysis of the managers' responses of the sample in order to answer the research questions and discussion.

4 Survey Results and Discussion

The proposed methodology has been applied to the agritourism farms located in the Calabria region (Italy) and has been carried out from 01 October 2012 to 31 December 2012. Calabria is a "lagging behind region" (i.e., a European Union region with per capita GDP, measured in purchasing power parties, less than 75% of the Community average [10]) with a population density of less than 150 inhabitants per square kilometers and whose endemic problems are broadly characterized by geographical remoteness, low population density, low income levels, limited employment opportunities, dependency on agriculture, poor service provision, and poor development capacities [33].

In line with step 1 of the methodology, the population of interest, *P*, of our analysis was selected using an official agritourism database directly purchased from the Italian Chambers of Commerce. The "Regional agritourism farms registry" at the office of the Regional Department of Agriculture was used as a cross reference to validate the selections. We surveyed that the number of Calabrian farms offering some forms of agritourism experience is rapidly increasing in few years; the number of new authorized agritourism activities in the period 2005–2010 presented a grow rate of 56% (from 313 to 488) while the Italian national rate was 26% in the same period (from 15.327 to 19.304) [31]. In particular, at the end of 2010, on 137.790 agribusinesses present in Calabria, only 488 (0.35%) (0.26 % in 2005) were authorized and active in agritourism; so *P* is made up of 488 agritourism farms [31].

According to step 2, a questionnaire was set up containing 10 questions, all designed to answer the research questions. For each farms belonging to P, we tried to have a phone meeting with the managers in order to deliver the questionnaire. On 488 agritourism farms in P, 52 of them , the 10.6%, agreed to answer the questionnaire. After a telephonic interview with the farm managers, we gathered their responses; at the end of step 3 the final sample was made up of 52 farms. According to step 4, for each of the farms in the sample, we analyzed the gathered responses and statistical results of the analysis are reported in the next section.

To answer RQ1, we can put in contrast quantitative results from official statistical data and qualitative results from our survey. First data point out that few are the

Agritourism farms in Calabria (488), especially in relative terms on the overall number of agribusiness activities in the region (0.35%) and to analogous rates in other Italian regions (4.2% of Tuscany's farms and 11.27% of Trentino Alto Adige's farms) [31]. Looking at the statistical analysis of questionnaires in the sample, 38% of respondents affirmed that over half of the overall farm's yearly turnover come from the agritourism activities, while 29% declared that the rate of turnover coming from agritourism activities is between 20% and 50%. Overall, 67% of respondents declared that more than 20% of the farm's yearly turnover come from agritourism activities. Looking at the costs side, 21% of respondents declared that more than 50% of the farm's costs come from the agritourism activities, while 23% declared that the rate of costs ascribed to the agritourism activities is between 20% and 50%. Overall, 44% of respondents stated that the rate of total agribusiness costs ascribed to the agritourism activities is more than 20%. Moreover, 51% of respondents affirm the will to increase the investments in the agritourism activities in the following year, with respect to the previous year, while only 8% of them want to reduce the investments.

The small number of agritourism farms present in Calabria, suggests that we cannot positively answer to RQ1. Anyway, the rapid increase of the new authorized agritourism activities in the last few years (+56% in the period 2005-2010) point out that the awareness about the importance of setting an agritourism activity within the farm is spreading among farmers of the regions. Such awareness is strengthened by statistical data from the survey which highlight the economical positive results reported by agribusiness where agritourism activities are present and the generalized will of sampled agribusiness to continue invest and, in many cases, to increase the investments. Positive feedback stated from the surveyed farms can be an important reason to motivate other farmers in doing the same and it can help to explain the rapid growth rate of new authorized activities in Calabria.

To answer RQ2, we identify some activities that let tourists enjoy the cultural and/or naturalistic heritage of the region as well as taste and/or buy typical agrifood products of the region. For each activity, we asked respondents to state if such activity was present in their agritourism offer and, in case of positive answer, to indicate the percentage of their customers who purchased /enjoyed it in the previous year. Results from the statistical analysis point out that surveyed farms intend agritourism mainly as a means to:

- let tourists enjoy services within the property of the farm (overnight accommodation offered by 84,62% of respondents and purchased by 34,58% of their customers, and educational farm, offered by 44,23% of respondents and purchased by 19% of their customers) or, at the most, visits to touristic places at free entrance (offered by 51,92% of respondents and enjoyed by 45,28% of their customers);
- taste/buy/cook self-produced food (offered by 65,38% / 71,15% / 94,23% of respondents, enjoyed by, respectively, 55% / 17% / 84,63% of their customers).

So we cannot give positive answer to RQ2, highlighting that agritourism is still intended by farmers only as a means to sell products/services self-produced. At the same time, the rural community is not able to exploit the presence of agritourism farms as direct contacts point with the tourists intended as potential customers.

To answer RQ3, is important to note that statistical analysis of responses in the sample point out that:

- 40% of respondents declared they have some kinds of formal cooperation with other actors of the rural network
- 12% of respondents declared that more than 20% of the agrifood products utilized in their agritourism activities come from other actors of the rural network; 61% stated that less than 20% of the agrifood products they utilized in their agritourism farms come from other local actors. Only 27% stated they utilized only agrifood products self-produced. Overall, 71% of respondents utilize products supplied from the rural network.
- 67% of respondents who utilize products supplied from the rural network, affirmed to have long-term and stable supply contracts with the other actors of the rural networks;
- on average, almost 5 local workers are engaged by the farm exclusively to carry out the agritourism activities.

Data show the emergence of real agritourism rural networks in Calabria. Rural community benefits from the agritourism presence mainly for agrifood producers, which receive direct benefits from long-term contract, and local workers, who are directly engaged for the agritourism services offered to tourists. Less diffused are connections with non-food producers local partners.

5 Conclusions

Agritourism activities, even if not so diffused among Calabrian farms, give farmers important revenues being an alternative way for selling farms' products and services. The reason because rural community does not fully exploit benefits from direct connections with agritourism customers remains unclear: is the community that cannot understand potentials of this connection or is it a lack of entrepreneurial farsightedness among agritourism farmers? Yet, direct contacts between agritourists and rural community actors can benefit both the agritourism farm and the rural community.

Anyway, stable rural networks exist within the orbit of the Calabrian agritourism farms. Data analysis picture the most diffused agritourism rural network model in Calabria as so characterized:

- the agritourism farm represents the rural network hub, the contact point between rural network offer and tourists/customers demand.
- Local suppliers, through their long-term contracts with the farm, offer agritourists their goods and services having an indirect contact with them (mediated by the farm). Such provisions contributes to enrich and complete the basket of rural offer to the tourists.
- Local workers benefit from employment opportunities at the farm site.

Even if this survey is the first of its kind, results are encouraging in supporting our hunches about the importance of setting agritourism activities, both for farms and for the rural community, as a means to revitalize the rural communities.

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Strategies II

Practicing Public Intervention in Collaborative Projects: Generalisation of Findings from an Empirical Study in Government-Owned R&D

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Abstract. Public interventions of government-owned research and development organisations present a number of challenges exacerbated by continuous changes of industries' expectations in a turbulent economic climate. There is a need for overcoming the barriers of practicing collaborative projects in government-owned research and development organisations. Conducting a combined Delphi and Analytic Hierarchy Process approach in a case study reveals that the 'commercial value' orientation plan yields the highest impact score on innovation factors. Societal value, such as supporting collaborative projects, is ranked in the second place. This leads to a suggestion to increase the organisational responsibility in promoting public-private collaborative projects. Thus, the paper provides an illustrative generic model for deploying the combined Delphi and Analytic Hierarchy Process approach in other government-owned research and development organisations to further improve public interventions for sustainable innovation development.

Keywords: AHP, collaboration, Delphi, government-owned R&D, innovation.

1 Introduction

The current economic climate has had a substantial impact on organisations worldwide. A risk-averse company concentrates on short-term benefits, and opposes to long-term high risk innovation projects. Some studies suggest that smart anti-crisis strategies should balance between shot-term and long-term investments; innovation will be the key for managing the economic downturn and providing long-term sustainable economic growth in both micro and macro economic environments. Furthermore, public intervention focusing on innovation at the governmental level is essential for fostering long-term growth [1], [2]. The role of government stimulates considerably innovation, for instance, establishing national innovation system (NIS) which states policy of governmental involvements in subsidising and encouraging collaborative projects, or even conducting government-owned research and development (R&D) in organisations [3], [4]. However, the questions of how and to what extent government-owned R&D organisations may contribute to national innovation need to be answered; for instance, how well does government-owned

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 501–508, 2013.

R&D practice collaborative projects? There has been a growing awareness in a crucial role of collaborative networks in innovation performance. It is thus essential to reconsider the full spectrum of collaborative activities starting from planning, implementing, to assessing collaborative performance [5], [6]. However, a harmonised system of performance measurement for research activity is still being a controversial subject in both private and public R&D [7], [8]. Whatever the performance criteria for R&D, conceptual frameworks or models for managing R&D are essential for improving overall performance including research collaboration [9].

The purpose of the paper is two-fold: to provide a practical model for public intervention in research collaboration, and to provide an illustrative model for generic deploying the practical model in other government-owned R&D organisations. Thus, the paper first reviews public intervention in science and technology. A practical model for planning research collaboration designed for a national microelectronics centre is then presented. This is followed by generalisation of the practical model in other contexts. The final section draws out the contribution of the paper.

2 Public Intervention in Science and Technology (S&T)

Research collaboration has long been acknowledged by academics and policy makers as the key factor influencing innovation capability. Practicing collaboration could deliver several benefits: (a) economic benefits e.g. reducing cost, reducing time and reducing risk; (b) knowledge benefits e.g. academic excellence; (c) societal benefits e.g. satisfying collaborating stakeholders [6], [10]. Although private R&D could collaborate amongst its stakeholders, governmental intervention is needed. For instance, policies may be launched to stimulate public-private collaboration to share high risk of long-term innovation. However, many countries are facing barriers of transforming intervention policies into practices. Only increasing R&D expenditure is not sufficient to overcome the barriers; it is essential to reconsider all collaborative activities starting from policy formulation [2], [5], [11].

Barriers to research collaboration may occur at the phase of formulating collaborative networks, who is responsible for the leading role to ensure the momentum of collaborative projects? Should public sector such as government-owned R&D organisations play a leading role? Government-owned R&D could intervene in collaborative projects in different forms, such as technical consultant, marketing consultant, exchanging staff, joint research and funding. Thus, it has to select potential projects and make decisions over levels of involvement [5], [8], [12]. In addition, collaboration barriers could happen within organisations. Government-owned R&D carried out by public employees within governmental institutions, the organisational characteristic combines the culture of public organisations and the nature of employees in research organisations together. Thus, the organisation needs collaborative strategies that promote collaboration. Unclear strategies are obstacles to collaborative processes; for example, time-limited policies may constrain consulting activities which are time consuming work. The goals of collaboration should be stated in project selection criteria and evaluation systems [6], [13]. Furthermore, some government-owned R&D organisations may be confronted to human-related barriers; researchers may not perceive organisational goals and fail to realise the necessity of public-private collaborations. Individual and organisational benefits form collaboration should be stated in performance evaluation system to shift the culture of pursuing self-interested research to collaborative research [11], [13].

3 Practicing Public Intervention in Government-Owned R&D

Most of existing studies involving collaborative research have been devoted to assessing performance of collaborative projects [14], [15]. However, a performance evaluation system measuring outputs at the end of a collaborative process may be not flexible enough to manage future innovation. Collaborative research should be managed at the first stage of planning policies and strategies. In addition, planning stage should take multiple dimensions of government-owned R&D into account to better overcome collaboration barriers [2], [9], [16]. Thus, the study of practicing public intervention in government-owned R&D was motivated by the lack of an integrative framework for managing research collaboration. However, managing R&D is a part-dependent process; it cannot be separated from local societies and national contexts within which the R&D is operated. Thus, there is a need for country-specific studies which allow for deep exploration of a particular phenomenon. Furthermore, practicing public intervention in developing countries, where technological innovation relies on government-owned R&D organisations, may present a clear perception of governments' roles in innovation systems.

The combined use of Delphi and Analytic Hierarchy Process (AHP) has been reported in existing literature to establish a practical model that can assist in innovation management planning [17]. Thus, the authors employed the approach to establish a practical model for planning research collaboration in government-owned R&D. The methodological framework is shown in Fig. 1. The first empirical study to refine gathered factors and to investigate other factors resulting from the expert panel's opinion was based on the Delphi method. A Delphi panel was assembled in a particular country to limit the effect of diverse panel implications across countries [18]. Thailand was selected because the country is an example of a developing country where major R&D is performed in universities and government-owned R&D organisation. Thailand is an interesting developing country; although the governmental funding has been assigned to government-owned R&D than private organisations, the contributions of government-owned R&D in driving the national competitiveness remain ambiguous. Practicing public intervention involving innovation policies of Thailand is considered weak [19], [20]. The multi-round questionnaires were distributed to experts working in different government-owned R&D organisations in Thailand such as electronics and computer technology, metal and materials technology, and genetic engineering and biotechnology centres. The Delphi consultation was concluded at the third round. A set of factors classified into four main dimensions – mission, internal R&D, collaboration and management – were accepted by thirty-three experts from Thailand as the influencing factors for managing Thai government-owned R&D organisations.

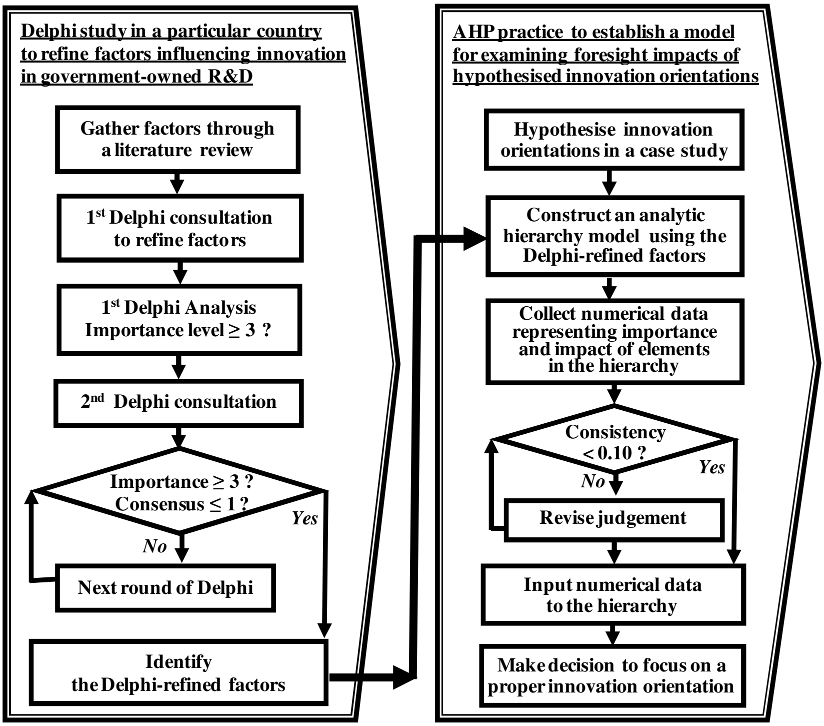

Fig. 1. A combined Delphi and AHP methodological framework

The second empirical study to establish a model was based on the AHP approach; at least one case study with specific circumstances is required to provide good insight into prioritising the factors. Additionally, a case study of which the organisational characteristic could represent the public intervention in collaboration research should be drawn from the country where the Delphi consultation was employed. The selected AHP case study (i.e. MEC) is the first and only microelectronics research centre in designing and fabricating integrated circuits in Thailand. MEC is fully sponsored by the Thai government to develop microelectronics prototypes that can be commercialised in the semiconductor world. It also collaborates with microelectronics industries by providing high investment infrastructures, technological consultations and research funds to promote research activities in all fields of microelectronics including nanotechnology. With noticeable infrastructures and human capital, MEC has the capability to practice public intervention involving the national innovation. However, MEC tends to conduct research projects without scoping innovation orientation; the top management approves projects which concern to any one of the missions. Under such circumstances, the decisions seem to be intuitions by nature; prioritising criteria still is quite vague. The AHP is thus conducted in MEC at the planning stage of innovation to examine sensible foresight impacts of different innovation orientations. To orientate the innovation plan of MEC, a pre-determined model was then constructed and discussed with top management resulting in a five-level hierarchy the first level (H1) of which is the goal to examine foresight impacts of future innovation orientations (Fig. 2). The three lower levels (H2, H3 and H4) consist of the factors and sub-factors verified by the Delphi consultation and re-arranged by the top management to fit to the goal. The fifth level (H5) of the hierarchy is arranged for alternative orientations which are hypothesised orientations that are conceived by making assumptions about current and future trends of MEC. There are 3 orientations: (a) a knowledge orientation focusing on academic excellence; (b) a societal orientation focusing on collaboration and societal values; (c) a commercial orientation focusing on commercial values of research products. The importance priorities of factors and impact weights of alternatives obtained from the AHP study is shown in Fig. 2. Amongst three alternatives, the 'commercial orientation' has the highest score at 0.4871, while the score of 'societal orientation' and 'knowledge orientation' are 0.3369 and 0.1760, respectively. In addition, a sensitivity analysis of orientations was carried out to investigate whether any change in priority of any factor could make the societal orientation the most impact creating orientation on innovation. The societal orientation becomes the one with the most impact creating orientation on innovation when the priority of collaboration is more than 43%, whereas the original value is 9.42%. This leads to a suggestion to increase the organisational responsibility in promoting public-private collaborative projects [21].

4 Generalisation of the Findings from an Empirical Study

The findings from the empirical study in MEC can be generalised by replicating the study in multiple-case studies, or it can be applied to other situations. Even though the analytic hierarchy model is specifically designed for the selected case study, i.e. MEC, other government-owned R&D organisations can reap benefits from the Delphi-refined factors and the structure of MEC hierarchy model as illustrated in Fig. 3. For instance, other government-owned R&D organisations in Thailand, somehow share the similar culture and political environment. Thus, they can shorten the process of combining Delphi and AHP for innovation management by skipping the Delphi study. This is enabled by the set of innovation influencing factors by judgements of the experts from a broad research area of S&T in Thailand.

Although the results from this study are not directly usable in other countries, the factors gathered from research of government-owned R&D in developed and developing countries (the highlighted factors in the Fig. 2) can be used as candidate factors to be refined and validated by a Delphi and AHP study in the new selected country. The verified factors suitable to a particular country can be further applied to establish an analytic hierarchy model for innovation planning as described in the methodological framework of this paper. It may be argued that comparing influencing innovation factors across countries may add value to the current study. Nonetheless, the difference of culture and political environment (represented as the root of the AHP tree in Fig. 3) leads to the difficulty in comparing different (context specific) hierarchy models. The comparison across countries could be carried out by comparing the innovation competitiveness (represented as 'fruits' in the Fig. 3).

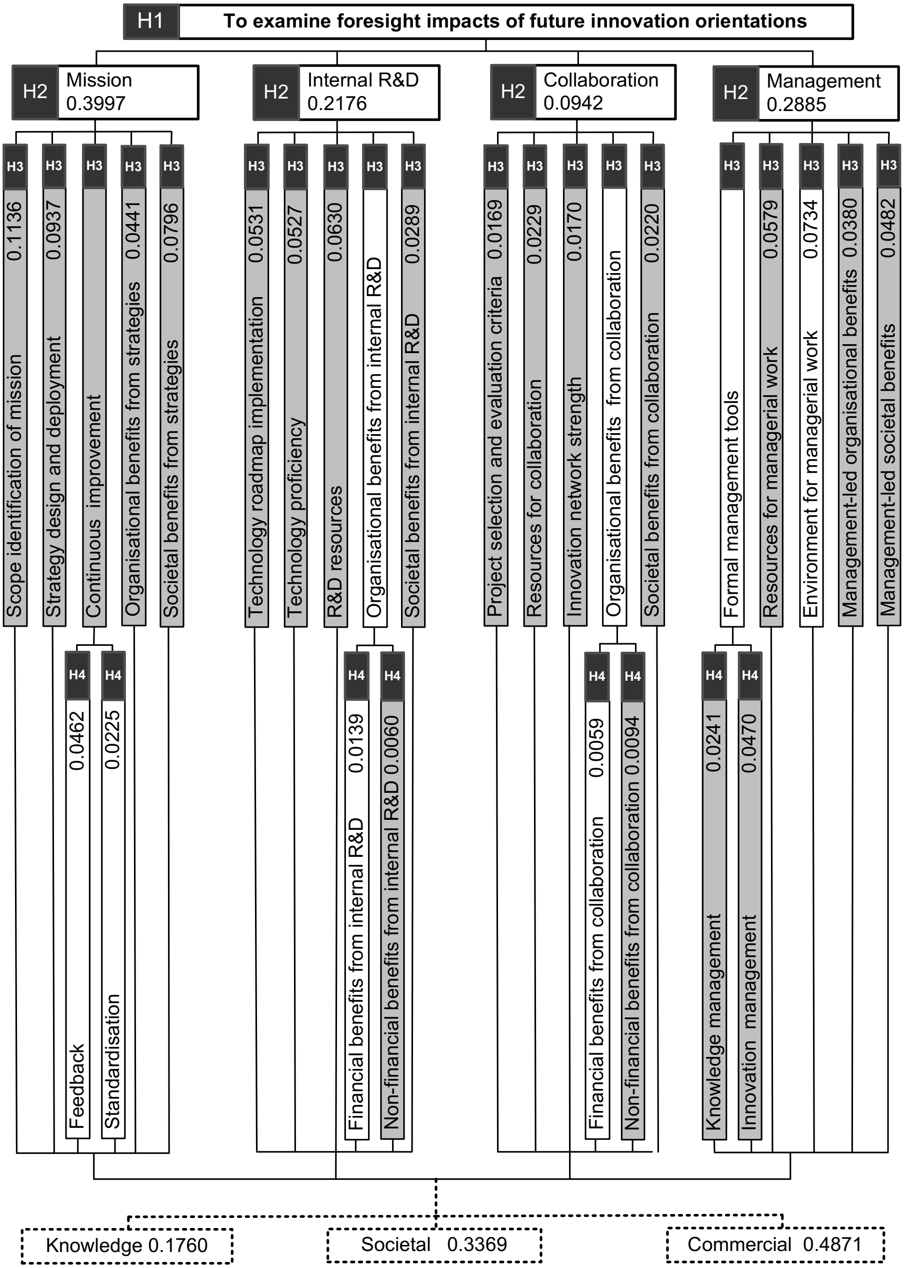

Fig. 2. An analytic hierarchy model for planning innovation orientation in MEC

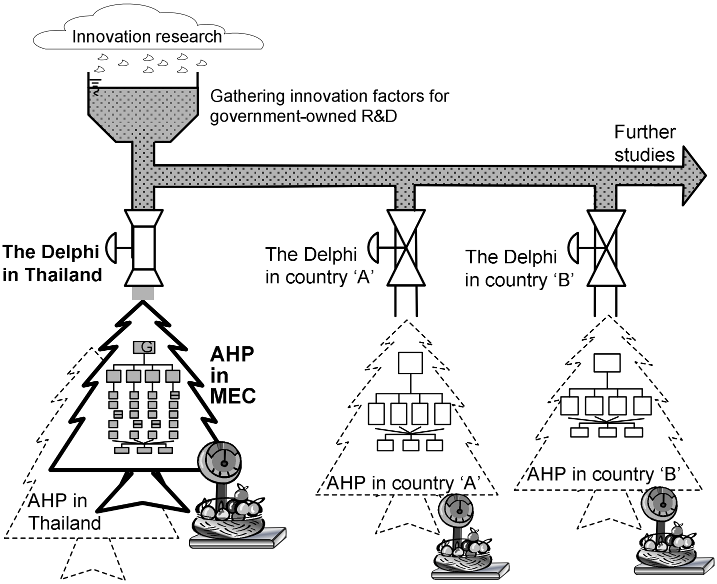

Fig. 3. An illustrative model for generic deploying a combined Delphi and AHP

5 Conclusions

The paper provides an analytic hierarchy model to assist a government-owned R&D organisation to plan national innovation by practicing collaborative projects. The model which considers not only factors in the collaboration but also the other dimensions of government-owned R&D, was designed for innovation planning in the early phase of formulating an organisational orientation. The model was established by conducting two empirical studies: the Delphi consultation using Thai experts from different government-owned R&D organisations, and the AHP applied in a Thai case study (i.e. MEC) which delivers public intervention in supporting long-term high risk innovation and involving the full spectrum of the innovation process. The study resulted in an authoritative model for examining foresight impacts of hypothesised innovation orientations in MEC: knowledge, societal, and commercial plans. Moreover, the paper provides an illustrative model to generalise the findings from the conducted empirical studies. The illustrative model suggests that adopting the Delphi-refined factors to construct new hierarchy models to select adapted innovation orientations in Thai public R&D organisations could help better develop a cohesive and strong national innovation system in Thailand. The illustrative model also guides government-owned R&D in other countries in adopting the methodological framework proposed in the paper to establish an analytic hierarchy model to better manage collaboration in R&D organisations. The authors hope that the present paper will contribute to the ongoing research aimed at managing government-owned R&D.

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The Evolution of Business Models within a Business Ecosystem for Cooperative Logistic

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Abstract. The aim of this paper consists in presenting a new approach in studying the evolution of the business models of the categories of business actors belonging to a business Ecosystem focused on co-modal logistics networks. Each type of actors is pursuing its own value system on the basis of the key elements that identify and characterize the nature of its activities and business. The focus of the business models is on the key elements that characterize the value-creation links between the involved actors in the Value Chain. The paper focuses on broadening and exploring the traditional concepts of business models showing their evolution when considering the future business environment. To perform this analysis, a template, recalling the well-known approach by Osterwalder, is proposed, discussed and applied to systematically consider alternative approaches to value creation in terms of reference business models.

Keywords: value creation, business models, ecosystem, value chain, logistics networks.

1 Introduction

The analysis and the study of issues related to business models is widely addressed in literature, [3], [6], [13], [14], [15], but it is always a very up-to-date topic, since, even if it is extensively investigated in the past and recent years and several definitions are available in literature, the application of business models as a conceptual tool was not as clearly defined in practice as might have been hoped.

In such context, this paper aims at presenting an innovative approach to study the evolution of the business models of the categories of business actors belonging to a business ecosystem focused on co-modal logistics networks. Each type of actors, being part of a business ecosystem as an intentional community of economic actors whose individual business activities share to a large extent the fate of the whole community, [10], [11], [12], is pursuing its own value system on the basis of the key elements that identify and characterize the nature of its activities and business.

The use of the concept of business model increased dramatically during the rise of the so-called ‘digital economy’ period in the 1990s when companies were actively seeking new ways of doing business. The business model concept offers managers a

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 509–516, 2013.

coherent way to consider their options in uncertain and fast-moving environments [9]. A business model of a company can be seen as an essential locus of innovation, and has the potential to disrupt existing industry structures, [1], [19], [8]. Business models can also be used as an analytical tool for the description of business activities of a company, [18]. Business models help in getting everyone in the organization aligned in producing the kind of value the company wants to create. Therefore, the concept has an enormous practical value, [7]. A business model is a holistic concept, which embraces elements such as pricing mechanisms, customer relationships, partnering and revenue sharing [13], [14]. Business models can be seen as focusing on the activity-system side of how a firm creates economic value, [16].

The focus of the business models is on the key elements that characterize the value-creation links between the involved actors in the value chain. Hence, these elements are identified, explored and structured to find out the business model the fit at best the needs of the three main categories of actors. At a conceptual level, a business model includes all aspects of a company's approach to developing a profitable offering and delivering it to its target customers. Research conducted in the last ten years, [17], has established a link between business model innovation and value creation. This research points to the need for organizations to build a competency in business model innovation exploring possible business model alternatives.

Starting from this assumption, the goal of the analysis is to present a new approach that treats business models as a variable and not a constant element. For this purpose, we explore the concept of a business model by addressing the several core questions that the majority of business model researchers deal within their models, but we do not consider that, as it is done usually, [17], the answers to these questions are fixed, and we investigate the new opportunities can be captured by taking into account variable answers to these questions that form the essence of business model evolution.

This work contributes to the project iCargo, [5], Intelligent Cargo in Efficient and Sustainable Global Logistics Operations, sponsored by the European Commission under the 7th Framework Program and aiming at advancing and extending the use of Information and Communication Technology, ICT, to support cooperation between specialized business actors to offer competitive and efficient door-to-door logistic solutions. The paper applies this novel methodology to find out how the iCargo ecosystem modifies the current business scenario and market. In this way we will be able to highlight the impact of iCargo not just as an enabler of operational improvements on the current business, but as a support infrastructure for new value proposition and new ways of cooperation in the logistics market. The iCargo Project is founded on the assumption that interoperable supply chains, including connected intelligent cargo and vehicles, cannot materialize as a result of incremental innovations in individual functional areas or single technology components. Instead, a comprehensive and coordinated stakeholder driven approach is needed, involving multidisciplinary research and development in ICT, co-modal transport networks and strategic management.

The paper is organized as follows: Chapter 2 introduces and defines the core concepts related to the iCargo ecosystem and Reference Value Chain; Chapter 3 describes the proposed approach, Chapter 4 presents the main results obtained by applying the proposed methodology in the iCargo ecosystem and finally Chapter 6 concludes the paper and presents the next steps.

2 The iCargo Reference Value Chain

The iCargo Integrated Project aims at advancing and extending the use of ICT to support new logistics services, [5], that: (i) synchronize vehicle movements and logistics operations across various modes and actors to lower CO_2 emissions, (ii) adapt to changing conditions through dynamic planning methods involving intelligent cargo, vehicle and infrastructure systems and (iii) combine services, resources and information from different stakeholders, taking part in an open freight management ecosystem. In the iCargo vision the logistic industry will evolve into a business ecosystem [4], [10], where specialized actors obtain environmental and economic benefits by combining their resources and capabilities.

The iCargo ecosystem is constituted of business communities sharing a common framework, and a semantic enhanced ICT infrastructure supporting interoperability and cooperation between software services, company systems and intelligent objects. The iCargo ecosystem encompasses existing business communities, allowing them to keep their standards at the same time enlarging the scope of their interactions. These aspects trigger modifications in the current business scenarios by introducing new and value-added elements that heavily influence the business models of the involved companies.

The categories of companies that will be considered are the Logistic Service Client (LSC) as the user purchasing the door-to-door service solution, the Freight Service Integrator (FSI) as the user providing the combined door-to-door service to the LSC, the Logistic Service Provider (LSP) as the user providing transport and logistic services contributing to the door-to-door solution like, and the Information Services Integrator (ISI) as the organization providing the information infrastructure of the iCargo ecosystem. The other two roles in the iCargo Value Chain are only marginally addressed, as they are not directly involved as services providers, and this are not expected to develop Business Models for iCargo. These are the Transportation Network Manager (TNM) as the organization in charge of managing of the transportation infrastructure sustaining the door-to-door flow like, the Transport Regulator (TR) as the organization receiving all mandatory reporting and checking if reporting has been carried out, in order to ensure that all services are completed according to existing rules and regulations.

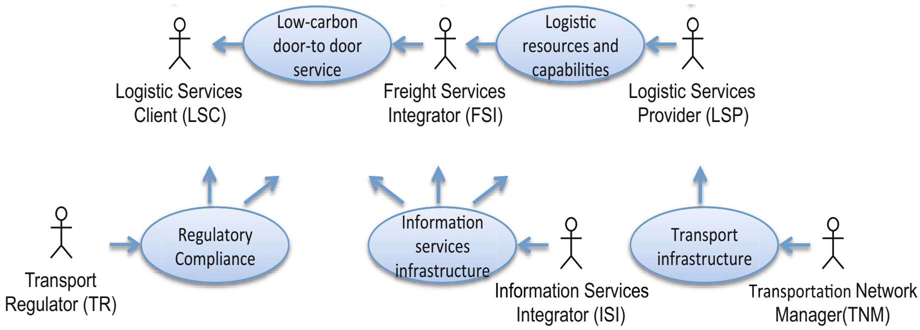

Fig. 1. iCargo Reference Value Chain

3 The Proposed Methodology

We propose the following innovative methodology to find out the evolution of the market due to the iCargo innovations:

1. Collection of data about the current business models in the market, on the basis of the Osterwalder Canvas, implemented by the companies belonging to the LSC, FSI, LSP, and ISI categories. The canvas is derived from the business model ontology by Osterwalder, [13], [14], in which nine building blocks are the core of the business model are proposed. These building blocks are customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.
2. Mapping the current implemented business models by the different involved actors and the business and technical innovations introduced by iCargo to show the advantages conveyed by the iCargo new low carbon door-to-door services in the current business scenarios. In the proposed approach, we link the iCargo business and technical innovations to the dimensions of the Canvas to find out the effect of these benefits on the business models and, in particular, how the elements that characterize the business models of each category of actors are influenced by these new solutions.
3. Creating a template that allows to examine the new business models to systematically consider alternative approaches to value creation in terms of reference business models. The questions that help to shape a business model represent a series of decisions, each of which has a set of possible outcomes: (i) *no change* on current dimension of the business model, either because it is outside the company's business or because the company already provides a suitable solution; (ii) *change* in terms of not a new solution but an adaptation of the current model, for the company to stay competitive in the iCargo ecosystem. The change is not so relevant as to require a significantly different business model, but some aspects still need to be changed; (iii) *disruption* in terms of a solution that does not fit the company's current model. Moreover, the iCargo solution will be implemented in an entirely different way that, if successful, will put the company current solution out of the market as obsolete or no longer needed; (iv) *opportunity* in terms of a new solution, not fitting the company's current offer, but the company is in the position to provide it by evolving its business model. Hence, the company has the strategic opportunity to provide the new solution by leveraging its current assets and expertise. The "opportunity" case indicates a challenge, too, since if the opportunity is missed it may actually become a disruption, [2].

   Selecting one possibility from each category and then linking them together forms one potential new way to proceed. And, of course, selecting different combinations creates other possible outcomes. Fig. 2 below depicts an extract from an example of possible evolution of the current business model into different new business models, indicated as BM.
4. Definition of the iCargo ecosystem and description of the evolution of the current market to the future iCargo ecosystem, see Chapter 4.

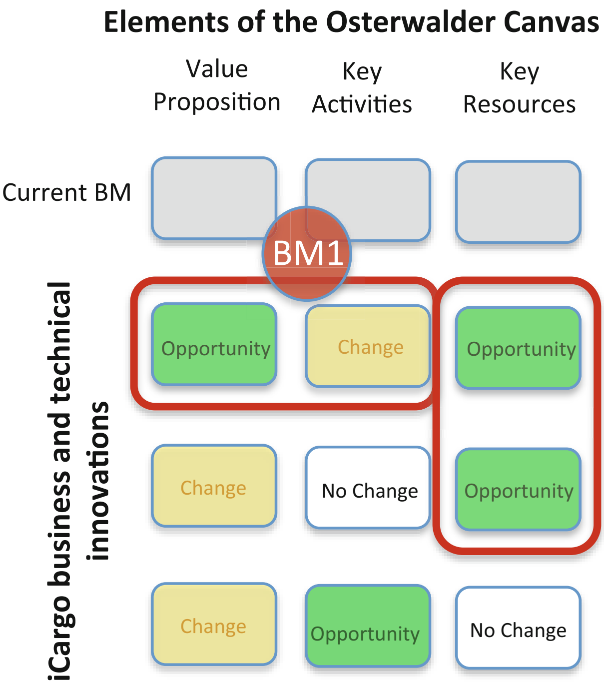

Fig. 2. Proposed approach to analyse the evolution of the business models

4 The Main Results

From the general theory of business ecosystems, [4], [10], [11], [12], there are two foundational components in a business ecosystem: (i) first, it is a necessary to create value within the ecosystem in order to attract and retain clients and providers, thus providing growth potential for the ecosystem. In the case of iCargo, this means delivering better, less expensive and less pollutant logistic services, based on the foreseen business and technical innovations; (ii) second, an appropriate ecosystem structure is needed to share the value within the ecosystem. The different species of business actors must find their own well-defined and relatively secure value propositions, relying on other actors for complementary products and services.

The complete iCargo Business Ecosystem in its mature stage is represented in Fig. 3 below: there are the six roles in the iCargo Reference Value Chain, represented by rounded rectangles. For each role, the corresponding reference Business Model is identified, represented by circles of different colors showing the different types of evolution in the iCargo ecosystem: (i) blue: pre-existing models that may grow or shrink in the iCargo ecosystem, (ii) green: new models, made possible by iCargo, (iii) red: models that will be disrupted because of iCargo. Solid arrows represent provision of products or services from one role to the other, whereas dashed arrows represent evolution from one Business Model (one circle) to the other.

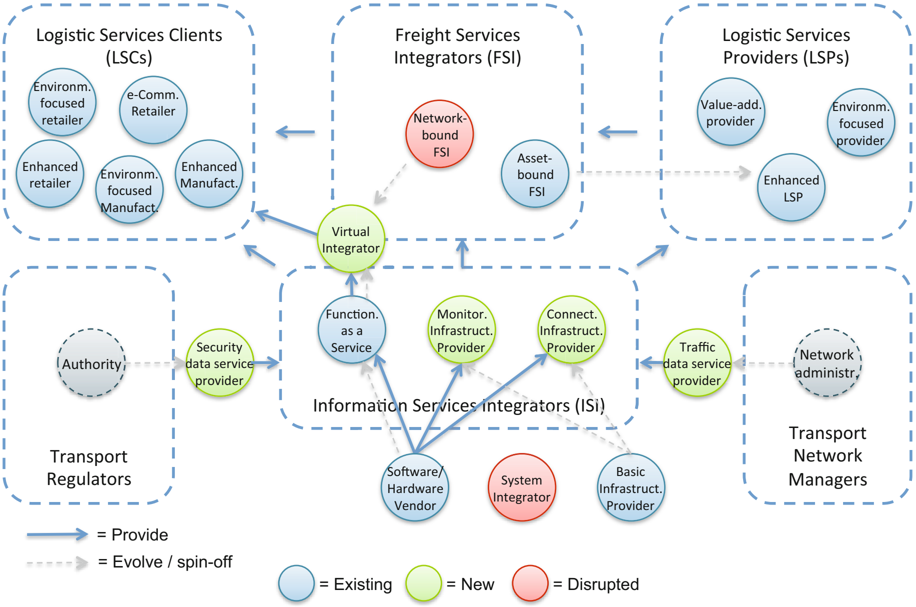

Fig. 3. iCargo Business Ecosystem evolution

The overall iCargo ecosystem picture results from the following considerations. The Logistic Service Client role will see no disruption of current business models, all companies will have the opportunity to enhance their business through iCargo, by becoming environment-focused retailers and manufacturers, and/or e-commerce based retailers. Logistic Services Providers will have a similar evolution, being pushed by their clients and by the iCargo opportunity to evolve towards environment-focused business models. Traditional asset-bound integrators, such as warehousing companies or terminal operators, will re-focus their value proposition on their core services rather than on the integration, thus going back to the LSP role. The business model of network-bound integrators, such as supply-chain outsourcers or closed marketplaces, will be disrupted. Instead, Virtual Integrators will emerge as providers of pure information services and competencies for better composing, planning and monitoring logistic chains in iCargo. The traditional system integrator model, developing ad-hoc platforms and services for interoperability, will disappear. Interoperability on the business level will be provided as a service from Connectivity Infrastructure Providers. These will likely evolve into Monitoring Infrastructure Providers, offering logistics monitoring as a combination of hardware/infrastructure rental and services. Software and hardware vendors will remain as providers of specialized functionality to the other information services providers in iCargo. Transport Regulators, like custom authorities, and Transport Network Managers, like road administrators are expected to make available relevant information that they handle acquiring distribution rights for these types of information services.

5 Conclusions

The main results of the presented work deal with the study of the evolution of the business models of the main category of actors involved in the iCargo Reference Value Chain. The impact of iCargo in the current business models has been detailed and specified in relation to the influence of its business and technical innovations on the nine dimensions of the Osterwalder business model Canvas.

These results are particularly important in the iCargo project and represent a common basis for the exploitation planning phase. The next steps will focus on the validation of the results with the iCargo involved actors in order to increase the understanding of using business models in the development of possible future business options.

The innovation of the proposed approach is related to the exploration of the business model concept as an evolution and not only as a static analysis in order to capture systematically new opportunities that are not currently addressed.

By analyzing the value creation and business logic of companies by using the business model framework, it is possible to develop a solid understanding about the principles and dynamics of a specific industry. The business model also highlights the critical service related issues like relationships with customers needing special attention in the industry's development, and it can be utilized in designing new services, too. The proposed approach could be also generalized to other applications and domains in which the key issues concern the investigation of the value creations and the effect of innovative strategies on the current business models.

Acknowledgments. The paper presents the work carried on within the Intelligent Cargo in Efficient and Sustainable Global Logistics Operations, iCargo, project.

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Tourism Breeding Environment: Forms and Levels of Collaboration in the Tourism Sector

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Abstract. Tourism, one of the largest industries in the world, has been subject to strong innovation in the last years. Main changes are due to the availability of new Information and Communication Technologies, which directly connect tourists among them and with service providers, and to the always more personalized supply of tourism experience. Such evolution may represent a driver of development for local communities if they are able to reorganize the territorial tourism offer around different pattern of collaboration. In this paper we propose an organizational model for a Tourism Breeding Environment, TBE, whose members are tourism operators of a regional area with tourist vocation. After discussing about which forms of collaborative networked organizations can rise from the TBE, we present a classification of the different levels of collaboration emerging in those forms.

Keywords: Tourism Breeding Environment, Collaborative Networked Organizations, Tourism Extended Enterprise, Tourism Virtual Organization.

1 Introduction

Tourism made a significant contribution to the economies of many nations around the world because of its ability to create income, taxes, and employment [1]. T provides a strong impact on the global economic development, employing more than 210 million people worldwide (7.6% of global employment) and generating an estimated US$ 5,474 billion of economic activity (9.4% of global GDP) [2]. Impressive changes in the ICTs and the Internet caused an extensive transformation of the industry. Demand and supply of ICT have innovated considerably Tourism Sector in operational workflows, management and marketing of tourism packages and new paradigms in tourism experiences [3]. ICTs provide significant opportunities for internal business process re-engineering and e-business, at the company level, while, at the industry level, ICTs allow communication and information exchange with partners, integration of information flows from a wide spectrum of suppliers, and new patterns for the customer care [4].

Changes are evident from the industry side. The Internet is changing the industry structure by altering barriers to entry, revolutionizing distribution channels, facilitating price transparency and competition, as well as enhancing production efficiency [5]. As tourism companies become a part of the global economy, local collaborative actions that

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 517–524, 2013.

generate externalities for the companies increased in importance. Engaging in new forms of collaboration and maintaining relationships within business networks have become a natural way for organizations to meet performance requirements in competitive markets [6][7]. Since nineties, several case studies and models highlight the increasing importance of tourism partnerships, assessing new organizational forms and identifying key factors in successfully initiating and sustaining tourism development [8][9]. Many case studies in literature agree that a high integration level among partners results in terms of internal efficiency and resource saving of partners in collaboration. Furthermore, problems are better understood when analysed from different perspectives, thus a collection of differently skilled partners can, in principle, go beyond individual knowledge and reach new solutions for the whole business network's questions [10][11][12][13].

From tourist side, the breakdown of geographical and cultural barriers is a result of international cooperation/exchange agreements and fast advances in transportation, communication and electronic communication. New and cheap means of transport, reductions in custom duties and on limitations to cross-countries tourism, allow people easy consuming of tourism products. E-commerce developments enable tourist to interact directly with tourism service providers, allowing travelers to retrieve reliable and accurate information in a fraction of the time, cost and inconvenience required by conventional methods, often disintermediating traditional players of tourism market such as travel agencies and tour operators [14]. Furthermore, new forms of tourism experiences are emerging related to the rediscovery of rural places as a way to gain wellbeing and relaxed life by enjoying the benefits of *relocalisation* [15]. From these changes, main consequences for tourists are:

- from an operational viewpoint, the ever more diffused self-creations of tourism packages, often comprising online reservations and payments [16].
- From a decisional point of view, the increasing request for personalized forms of tourism experience sometimes based on the rediscovery of cultural heritage, folklore, traditions, as well as on the direct contact with the nature [17] [18] .

In many regions with tourism vocation, local entrepreneurs have started organizing themselves in tourism networks in order to create aggregate tourism offers able to compete with big players. New business models have developed with the aim to reach competitive advantages, to improve revenue streams, to return in taking an active role in the tourism system, and to develop new consumer market niches [19]. Such models of *collaborative networks* in the tourism sector are characterized by a direct connection among local service providers and tourists with these explicit ethical and political goals: re-vitalisation of territory identity and local community relations to local natural, cultural and historical heritage, linking with sustainable agriculture and handicraft, economically viable and socially responsible practices [20].

In this paper we propose an organizational model of *breeding environment* for the tourism sector where regional tourism operators can operate in order to timely exploit opportunities coming from the tourism industry evolution while gaining sustainable development for the whole regional area. The paper is organized as follows. After summarizing latest trends in tourism market in section 2, a characterization of the organizational forms of collaborative networked organizations proper of the tourism sector is proposed in section 3. Section 4 discusses the possible levels of collaboration that can be observed during collaboration while section 5 contains conclusions.

2 Tourism Breeding Environment and Forms of Collaboration

In a territory with a touristic vocation, live and operate autonomous entities whose business is related to the sector. While these entities can be heterogeneous in terms of their operating environment, culture and goals, they all aim to achieve the common goal of local tourism development and to increase the general competitiveness respect to other geographical areas and global competition. These entities constitute the reference universe of this study and we define them as *Regional tourism operators*.

The regional tourism operators can be grouped into the following categories:

- *Hospitality Services Enterprises*: companies that offer overnight accommodation (e.g. hotels, B&B) and meal provision (e.g. restaurant).
- *Transportation Services providers*: public and private companies that provide services of people transportation (i.e. buses, taxies, airplanes, trains, etc).
- *Event Management Services*: public and private companies dealing with the organization of events (e.g.: conferences, concerts, exhibitions, sport events).
- *Tourism complementary goods and services providers*: e.g. local shops, museums, excursion services, sport & leisure facilities, handicrafts.
- *Destination Marketing Organizations*: that promote incoming tourism and Tour operators that purchase/book services to combine and resell them.

When some of the regional tourism operators decide to reinforce collaboration, they can set stable agreements in the forms of Touristic Associations or Touristic Districts, adhering to a base long term cooperation agreement, and adopting common operating principles and infrastructures. Each agreement is characterized by an own organizational form in terms of structure of membership, activities, definition of roles of the participants, governance principles and rules [21]. We name each of such agreements as a ***Tourism Breeding Environment*** (*TBE*) [22] i.e. a Breeding Environment in tourism sector whose members share values, culture and infrastructures and have the potential and the will to cooperate in order to pursue the general long-term objectives of territory development and competitiveness [23]. In a TBE, each member competes with the others and with players outside the TBE in searching for new business opportunities in the global market. When a business opportunity is identified, a subset of the TBE members can be rapidly selected to become part of a short term ***Collaborative Networked Organizations, CNOs,*** oriented to catch the opportunity. Two kinds of short term CNOs are most evident in a TBE:

- ***Tourism Extended Enterprise*** (TEE)**:** it refers to a tourism operator that "extends" its business boundaries by involving all or some of its suppliers in the product packaging and delivery in order to offer customers possibilities to a more complete tourism experience. For example, a TEE can be formed by a hotel that stipulates commercial agreements with restaurants, lidos, amusement parks, cruise ship companies. Tourist perceives the overall TEE offer as a whole and, typically, purchase it directly at the hotel (web)site.
- ***Tourism Virtual Organization*** (TVO)***:*** It represents a temporary alliance of private and public organizations that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose collaboration is supported by computer networks. A TVO is

established in a short time to respond to a competitive market opportunity; it has a short life cycle dissolving when the short-term purpose of the TVO is accomplished [23]. ICT advances enable tourists in customizing services on the basis of their own specific tastes [24]. Availability of systems for tourism packaging enable tourist to (self) compose a personalized tourism product choosing a subset of services provided by TBE members (an example of tourism package can be: 2 nights in the hotel A, 1 night in the hotel B, 2 meals in the restaurants C, 1 ticket for a football match, etc.). The set of all services in its personalized package is, usually, supplied by more than one service provider; tourist, while purchasing the package, is indirectly triggering a TVO responsible to deliver the personalized tourism package.

3 Levels of Collaboration in a Tourism Breeding Environment

Tourism operators may interact in different way in a TBE. Four coalition's types can be recognized within a TBE, each of them represents a different level of integration among considered groups of actors: *networking*, *coordination*, *cooperation*, *collaboration* [25]. According to [25], "as we move along the continuum from networking to collaboration, we increase the amounts of common goal-oriented risk taking, commitment, and resources that participants must invest into the joint endeavor". In what follows we propose the four levels highlighting, for each of them, characteristics of interactions and types of technologies best suited to supporting collaboration among partners.

Level 1 - Networking. It involves communication and information exchange for mutual benefit of TBE. Each TBE actor involved in the relationship can benefit from the information shared but there is not necessarily a common goal influencing individual contributions as well as there is no common generation of value. At this level, it's not possible to highlight the presence of CNOs within the TBE. A TBE offer to each tourism operator a way to grasp opportunities that current demand of tourist flows is producing. In particular, individual actors may benefits from integrate communication and promotion activities performed by the TBE. It represents a local brand that propose a diversified tourism offer, contributing to local tourism development and to increase the local competitiveness respect to other geographical areas. This is the case of a Touristic Associations that aim to promote tourism activities in a specific territory and offer to tourism operator a "showcase" in order to promote their own services. While a TBE promotes a common brand, a slogan, a symbol, etc., individual operators are responsible for the accuracy and the correctness of the information provided about offered services.

At Networking level, it is possible to identify a set of ICT solutions representing a valid support for promoting a tourist destination:

- *Inspiration Portals*: websites promoting the sharing of multimedia content among users by allowing them to get a preview of territories, places, cultures and type of vacation that will inspire potential tourists [26].
- *Tourism Services Comparators*: web portals that allow travelers to compare tourism services offered by different providers. Travelers have the possibility to compare services providers and chose the offer that best suits their needs [27].

- *Tourism Social Networks:* collection of individuals who share information, opinions and contents about tourism in an online setting over the internet [14].
- *Mobile and Immersive Technologies:* technologies that harness the potential of mobile devices to provide information, geolocation, and augmented reality services; information about the surrounding real world becomes interactive and digitally manipulable [28]. Mobile services support users with additional information such as maps, points of interest, tourist guides that overlaid the real world. Tourists interact with the surrounding reality and get information on areas of interest typical of tourist services (hotels, restaurants, etc.) and public utilities services (public transport networks, events, etc..,).

From a functional viewpoint, process automation is low being related to supporting horizontal communication with the aim of developing teamwork, share information and promoting activities' coordination within and among organizations. From a technological point of view, automation technologies are intended to supporting communication technologies between tourism operators and tourists.

Level 2 - Coordination. In addition to communication and information exchange, more organizational commitment is evident at this level. Coordination involves aligning/altering activities so that more efficient results are achieved; nevertheless each networks member might have a different goal and use its own resources. In order to expand its own tourism offer and capture new customers, a tourism operator can tighten *symbiotic* relationship with other tourism operators that complement each other or have reciprocal products. This is the case of an operator which originates a TEE that "extend" business services, proposing to customers complementary tourism services provided by other tourism operators.

At the coordination level, ICTs are intended to support automation of inter-organizational business process. In addition to the tools typical of the networking level, at this level technologies need to support tourist to take advantage of integrated offerings. Examples of such technologies are the *Destination Management Systems (DMSs), i.e.* systems that gather into a single portal a variety of tourism services provided by heterogeneous tourism operators and related to a specific geographical area. DMS attempt to utilize a customer centric approach in order to manage and market the destination as a holistic entity, typically providing strong destination related information, real-time reservations, destination management tools and paying particular attention to supporting small and independent tourism suppliers [29].

Level 3 - Cooperation. In addition to level 2, it involves knowledge and resources' sharing for achieving compatible goals of TBE. In this case the aggregated value is the result of the addition of individual "components" of value generated by the various participants in a quasi-independent manner. A common plan exists which in most cases is not defined jointly but rather designed by a single entity. Participants' goals are compatible in the sense that their results can be added or composed in a value chain leading to the end-product or service. Trust plays a key role in the willingness of network members to cooperate in tourism services provision. The risk of opportunism is crucial at this level and it is mainly based on partners' behavior manifested during group's interaction. A partner needs to signify its trustworthiness through the way it be haves in the alliance. This is the case of a TBE that allows tourist to compose a customized tourism package (whether by means of an automated tourism packaging system or supported by a travel agency operator) combining and organizing services provided by multiple tourism actors members of the TBE. The composition of a such tourism package indirectly determine the creation of a TVO among the providers of each service in the package. In the TVO, each tourism services provider is responsible for the correct provision of its part of the service.

At this level it is desirable to use web and mobile based systems which enable consumers to build their own tourism package made of flights, accommodation, and other tourism services instead of purchasing a predefined package from a catalogue. This kind of technologies are known as *Tourism Dynamic Packaging Systems, TDPS,* whose characteristics are: full automation through online applications; real-time update of travel product information; single price for an entire tourism package. From a process automation point of view, distributed business processes management tools are required in order to allow integration and communication processes between individual information systems adopted by tourism each operator [30].

Level 4 - Collaboration. At this level, all entities share information, knowledge, resources and responsibilities to jointly plan, implement and evaluate a program of activities to achieve a common goal. It implies sharing risks, resources, responsibilities, and rewards. Tourist operators committed in collective decision process have common values and visions. The TVO becomes a self-organizing system with global properties that cannot be predicted from the properties of the economic actors who are directly involved in it. This is the case of a TBE that allows the composition of a customized tourism package in a seamless and transparent way to the customer. Partners of the resulting TVO have joint identity, goals and responsibility; the TBE constitutes the unique interface for the customer and it's responsible for the correct provision of the tourism package.

At this level the inter-organization process planning and management regards many operative and supporting processes which are managed in a common way. The CNOs can be supported by a form of *Enterprise Resource Planning* technologies for tourism networked organizations also known as a *Cloud-Based Business Network* that connects and coordinates the ERP of each networked tourism operator on a common platform. "Business networks supplement ERP systems, rather than replacing them. The ERP system remains the system of record and the guardian of the internal processes of the enterprise, while the business network provides the system of process, the platform for working with trading partners to meet customer needs profitably and expeditiously" [31].

4 Conclusions

The importance of setting a TBE is related both to the necessity to answer to the request of personalized tourism offer, in line with the new demand trends, and to the possibility to give sustainable development to local tourism players in the effort to overcome limits of touristic organization's size and reach economy of scale and competitiveness in contrast to big players. The availability of organizational models and ICT supporting solutions make possible the operationalization of the collaboration concept in the tourism sector and the setting up of CNOs in a TBE at different level of collaboration, in line with the territorial development strategies and tourism operators' propensity to risk taking. In this paper we proposed a characterization of the organizational forms of collaborative organizations proper of the tourism sector and discussed the possible levels of collaboration that can be observed in those forms. Further studies are undergoing in order to provide a mechanism to identify and assemble competencies in a TBE in order to determine the source and type of competencies needed to efficiently and timely catch opportunities and to individuate the best TBE partners to involve to carry out a specific business.

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Risks and Trust

A Risk Analysis Method for Selecting Logistic Partners to Compose Virtual Organizations

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Abstract. Virtual Organizations (VO) have complex interactions between their members, both industrial and logistics. Once industrial partners are selected, the VO should be complemented with the logistics partners that will deliver the produced goods between those partners. This paper presents a supporting decision method for selecting the most suitable logistics partners that consider not only capabilities, historical performance and availability, but also risks. In general, a risk is characterized by the potential of each logistic partner to do not fulfill VO's business requirements and that can jeopardize its accomplishment. The method firstly evaluate and measure risks per partner, and collectively afterwards. Its formalization and examples are provided along the paper. Discussions are presented in the end.

Keywords: virtual organization, logistics partners' selection, KPI, risk analysis.

1 Introduction

Companies have increasingly been immersed in more dynamic and adaptive value chain networks so favoring the expansion of logistic partners. New markets and new products have been increasingly created all over the world and proper logistic partners should be hired in order to cope with this need. The cleverer the hiring activity is done, the greater visibility, improved customer service, better planning and cost savings can be supported [1]. This cleverness can also be crucial for companies as a support for reindustrialization and for facing current economic challenges. However, when companies get involved in more volatile strategic networks, the difficulty of selecting the most appropriate logistic partners is much higher.

This work focuses on the Virtual Organization (VO) type of strategic network. A VO is a temporary and dynamic alliance of autonomous, heterogeneous and usually geographically dispersed companies (often SMEs) created to attend to certain demands [2], sharing costs, benefits and risks, acting as they were one single enterprise [3]. A VO dismisses itself after ending all its legal obligations. Therefore, part of that difficulty in terms of logistics is due to the VO intrinsic nature, that industrial partners are only known after an analysis of the demand's requirements.

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Once industrial partners are selected and hence the VO is formed, it should then be *complemented* with logistics partners (LP). By LP it is considered in this work the logistics providers (of types *2LP* and *3PL*) which act at the ‘arc’ part of the network (*outbound*) and that are totally responsible for delivering the produced goods between VO’s industrial partners.

In a previous work authors conceived a model to select LPs [4]. It applied fifteen key performance indicators (KPI) over the set of possible LPs to further select the most adequate ones for each logistic leg considering the VO’s industrial partners and the whole logistics path. This selection was based on the LPs’ historical performance in past VOs, on their technical competence and temporal availability, and on the demand’s requirements.

The problem is that, even considering such elements, there is a risk of failure. Faults in some LP can affect other partners and lead the given VO to fail in its goals [6]. Therefore, it is very important to measure them for further decision-making.

In this sense, this paper presents a complementary work to also take risks into account. Considering a sort of potential sources of risks, the VO risk of each possible composition of LPs is calculated so that the responsible stakeholders can select the most qualified and less risky list of LPs for a given VO before it goes for operation. Besides that, they can further act towards mitigating risks if it was the case.

This work presents results of an ongoing, applied and qualitative research which basically look for answering how LPs for a given VO can be more properly measured when considering risks. It is represented by a novel method for risk analysis in the formation of VOs called *MRALP* (*Multi criteria Risk Analysis method applied to Logistic Partner*). ETA and FTA risk analysis methods [7, 8] are the essential theoretical basis for the proposed method.

In this work the current focus is only on LPs, not covering yet the VO as a whole, i.e. the industrial partners as well. Besides that, it assumes that LPs are be members of long-term alliances (like VBE [3]) so sharing some minimum and common collaboration, working, quality and performance principles.

This paper is organized as follow: Section 1 has introduced the general problem and paper’s goal. Section 2 addresses the problem of selection of LPs for VO and contextualizes it within the risk analysis area. Section 3 presents the proposed method. Section 4 shows an example of the method. Finally, Section 5 provides preliminary conclusions about this research.

2 Risk Analysis in Virtual Organizations

There are many definitions of what risk means in the literature. In resume, risk can be defined as the probability of an event to can occur and that causes a negative or positive impact on the organization’s goals when it takes place. A risk can be viewed as a composition of three basic elements: the general environment within it can happen; its probability of occurrence; and the scope of its impact in the case of its occurrence [7]. In the context of this research, a risk is characterized by the potential of each LP does not cope with the given demand / collaboration opportunity’s (CO) requirements and hence can jeopardize the VO accomplishment. Thus, it is necessary to comprehensively identify and quantify the VO risks associated to the selected LPs.

In the research review a number of risk analysis methods has been identified as potentially suitable for VOs, namely FMEA (Failure mode and effects analysis), FTA (Fault Tree Analysis), ETA (Event Tree Analysis), Bayesian Networks, CNEA (Causal Network Event Analysis) and Ishikawa Diagram [7,8,9,10,11,12]. Some requirements can be pointed out for the tackled problem [5]: events can be treated as independent from each other; the deterministic relation between events can be known; events analysis can be both qualitative and quantitative; a risk can be globally quantified after a succession of events. Regarding these requirements, ETA and FTA techniques were selected to be used and combined in the proposed method.

In a review of the state-of-the-art some works related to risk analysis for VOs failures have been identified. In [13,14] thirteen KPIs were identified as general risk sources in VOs, further identifying the importance of each one. In [15] two sources of risks were specified (external and internal) and risk occurrence likelihood in the life span of a VO was calculated based on them. In [6] the problem of risk mitigation in VO was discussed and four processes were identified to improve the level of VO performance reliability. In spite of the value of their results and that some insights have been taken from them to this work, none of them has neither somehow formalized how the proposed KPIs should be used nor provided means to quantity VO partners' risks, both individually and collectively. Actually, it was not found out any work in the literature that has tackled logistics issues and measured VO risks.

Considering the classical main phases of a VO life cycle (*creation, operation, evolution* and *dissolution* phases) [3], risk analysis should ideally be done along the entire process. The scope of this research is however focused on the creation phase, i.e. to provide means to managers to evaluate the VO before its operation.

Within the *creation* phase, and respecting the reference framework for the VO creation [3], it seems more natural that risk analysis be carried out in the *Partners' Search and Selection* step, i.e. after the VO topology are defined and before selected partners starting eventual negotiations. In [16] authors expanded this step to introduce a process of selecting the proper performance indicators that should be applied over candidate *industrial* partners' (IP) for a VO regarding the CO. In [4] this same framework was complemented and expanded again to comprise the selection of *logistics* partners (Figure 1). The work presented in this paper introduces an additional sub-step within this part in order to embrace risk analysis (circle in Figure 1).

When related to VOs, risks can be identified and measured considering the equivalent factors that determine the risk probability in traditional organizations [6]. As such, they should consider the organization's goals so that the most important ones can be determined for more proper management. Identifying risk sources is the first and crucial step in risk management [7].

Although risk analysis is performed in the Creation phase, sources of risks should be identified and risks measured having in mind the whole VO life cycle [15]. There are four main sources of risks regarding VOs: *trust, communication, collaboration* and *commitment* [13,14]. In this work they are modeled as KPIs and their values are calculated and provided by the previous method phase, developed in [4].

- **Trust:** Logistic partners who are going to compose a VO do not necessarily have prior knowledge about each other before starting collaborating. Thus trust is crucial to bear in mind, which in turn involves commitment in doing the planned tasks. When trust among partners is not enough established there is a hesitation to share risks and so the VO can be jeopardized.

- **Communication:** Communication among VO's LPs is a key factor for its proper operation. They should provide correct information about parts, products and services, collaborating in solving conflicts, sharing practices, etc. However, this can be complicated by the fact that LPs are heterogeneous, independent, geographically dispersed and usually have distinct working cultures. The insufficient communication can put a VO on risk.
- **Collaboration:** Collaboration is characterized when the sharing of risks, costs and benefits of doing business are agreed and fairly distributed among partners. However, when a collaboration agreement is not clearly defined, i.e., when there is no clear definition of its main objectives, the risk of a VO increases.
- **Commitment:** Commitment is related to the attitude of VO partners with each other, i.e. it considers the contributions and agreements made by and among them for a business. This is important as partners use to have complementary skills and so it is important they feed the whole environment with the right and timely information. The VO risk gets higher when partners fail in that attitude.

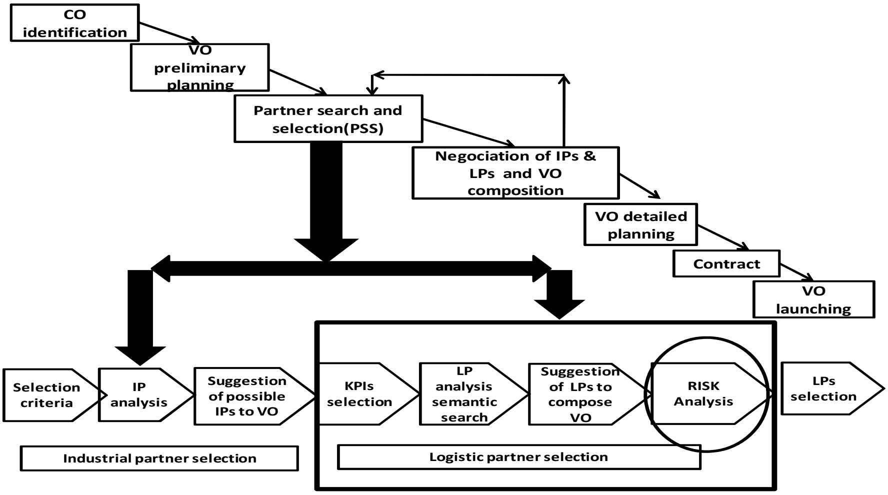


Fig. 1. Extended framework for the VO creation [4]

3 The Proposed Risk Analysis Method

In general, the most important requirement for any method related to VOs is transparency, which is a basis for trust building among partners. In this direction, being a selection (or suggestion) process, this work helps in leaving clear the criteria for that as well as in providing a more systematic process, i.e. a formal method.

The devised model for risk analysis starts having as input a pre-selected and ranked list of most suitable LPs for each itinerary within the given VO. As mentioned in the introduction, this pre-selection is performed by the previous phase of the method [4] involving a set of elements. In this work, considering VO reference foundations [3], the so-called *VO Manager* is seen as the main decision-maker.

The proposed method is generally presented in Figure 2. It splits the problem into two stages. It starts measuring the risks individually, for each of pre-selected LP, and after and based on that, collectively, for the entire LP team for the given VO. In this context, VO manager has a fundamental role, which is to define (with some degree of subjectivity) the *minimal acceptable level* (MAL) of risk for a LP to be member of a VO regarding CO's requirements and the strategic vision upon the VO. There is also a risk specialist, who is in charge of auditing the LPs' historical KPI values at the VBE's data repository.

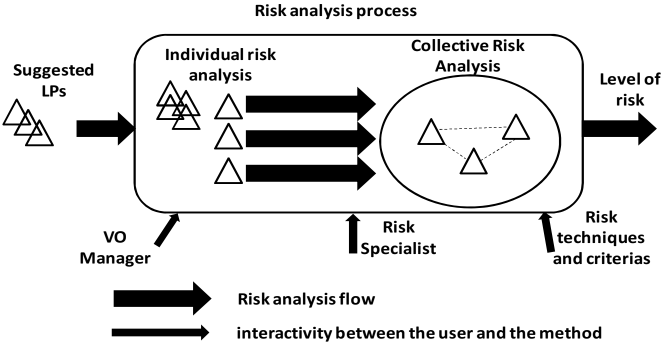


Fig. 2. Risk Analysis model

The MRALP method itself is illustrated in Figure 3. Inspired in [17], it divides the problem into two phases: the first phase does the individual risk analysis and applies ETA method for that. The second phase does the risk analysis taking the group of LPs as a whole into account, applying FTA method.

3.1 Individual Risk Analysis

In the first phase of MRALP an individual risk analysis for pre-selected LPs is performed. ETA is particularly suitable for risk analysis of systems where there are interactions between several types of probabilistic events, whether dependent or independent [8]. It uses a visual representation based on a logical binary tree structure, known as Event Tree (ET), as shown in Figure 3 (Stage 1).

An ET is a probability tree which provides two possible conditions: *success* and *failure*. It also has three basic components: *initiating event*; *intermediary events*; and *outcomes*. The initiating event begins the ET creation process. In this work, the initiating event corresponds to one pre-selected LP, and the assigned probability is always 1 (or 100%) in the beginning [8]. Next step consists in specifying the (four) intermediary events, which are represented by the (four) KPIs: *trust*, *communication*, *collaboration* and *commitment*. These events are used to quantify the effectiveness of a particular LP, i.e. if it is able or not to compose a VO.

These KPIs are used to generate an ET by assigning success and failure probabilities to each of them, as shown in Figure 3 (Stage 1). Inspired in [18], the criterion to assign the KPI success probability to each LP takes the historical values analysis of the KPI that were assigned to it in past VOs. The proposed method gets these KPI values and checks if they are greater than MPS (*Minimum Probability of Success*). MPS is a value that is also set up by the VO manager and represents the minimum probability of a KPI value to be within the considered acceptable range. For instance, in Figure 4, the value of the MPS related to the (intermediate event 'KPI_1') *trust* would have been set up as 0.3 (he also gives MPS values to the other three KPIs). In this figure, the VO manager would be stating that he accepts a global risk of 0,4 (MAL) and that the minimum level (of *fail*) for *trust* is 0,3 and so 0.7 for *success*.

The setting up of MAL and MPS are a bit subjective, and basically tries to make a trade-off between acceptable risk and effective performance situation of existing LPs. In the same line, each VBE can adopt a particular way of calculating every KPI, usually grouping a set of performance indicators at the operational level. In this case, the following understanding would be used by the given VBE´s partners when classifying their KPIs: [0.0 ; 0.2]: *regrettable*; [0.2 ; 0.4]: *bad*; [0.4 ; 0.6]: *regular*; [0.6 ; 0.8]: *good*; [0.8 ; 1.0]: *superior*.

Applying Equation 1 (see below), the KPI success probability is calculated for the current participation.

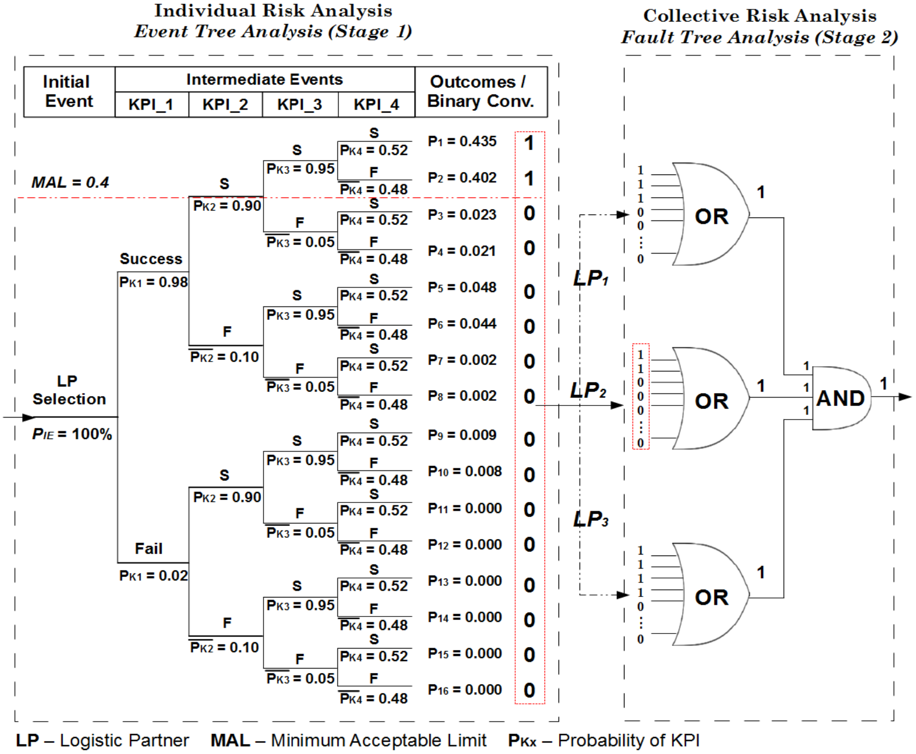


Fig. 3. MRALP method general example

The values assigned to each KPI can vary from 0 to 1 and are associated with a success rate between 0 and 1. Figure 4 shows a graph with hypothetic KPI values about trust associated to a LP, assuming it has participated in n_{pa} past VOs. Since $n_{>mps}$ represents the number of its previous participation in VOs and considering its KPIs values greater than MPS (with an '*'), Equation 1 presents the KPI success rate.

$$\boldsymbol{Pr}(\boldsymbol{K}) = \frac{n_{>mps}}{n_{pa}} \tag{1}$$

The failure rate for a given KPI is represented as $Pr(\overline{K})$ by the following equation:

$$\boldsymbol{Pr}(\overline{\boldsymbol{K}}) = \mathbf{1} - \boldsymbol{Pr}(\boldsymbol{K}) \tag{2}$$

That success and failure calculation procedure is repeated for all KPIs that compose the ET for a LP. A set of probabilities representing the success and failure probability for each KPI is obtained as a result, which are presented in Figure 3 by the four intermediate (and independent from each other) events KPI_1:4 that populate the ET. Event KPI_2, for instance, would be related to KPI *communication*, with *fail* and *success* values of 0,4 and 0,6, respectively.

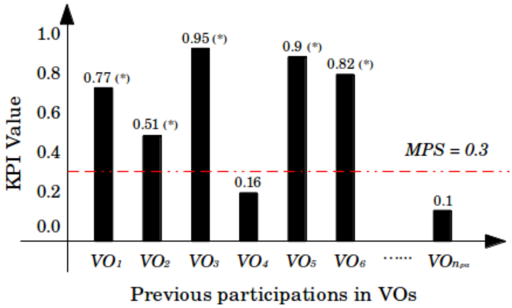


Fig. 4. Trust KPI historic values for a given LP

After assigning all probabilities for all ET branches, it is necessary to identify if the LPs are minimally qualified to compose a VO. For this, a calculation is performed to obtain the final probabilities for all event combinations composing the ET. They are determined for each of the $2^{|K|}$ branches of ET and are got by multiplying the probabilities of events that compose each path. The results greater than MAL are then selected to be part of the Stage 2 of MRALP.

The above concepts can be formalized as follows:

Let $LP = \{LP_1, LP_2, \cdots, LP_p\}$ be a set of p LPs previously selected, where each element in this set is associated with a different type of logistic activity that is being requested in a business. Let $K = \{K_1, K_2, \cdots, K_n\}$ be a set of n KPIs associated to a LP, and $\rho(K)$ the probability function associated with each event in K (as defined in Equation 1). ETA events occur independently, i.e., where the occurrence of an event does not affect the occurrence of other event. This situation can be represented by the equalities defined in Equation (3) and Equation (4):

$$\rho(K_n|\, K_{n-1}\,|\cdots|K_1) = \rho(K_n) \tag{3}$$

$$\rho(K_1 \cap \cdots \cap K_n) = \rho(K_1) * \dots * \rho(K_n) \tag{4}$$

Now consider $P = \{P_1, P_2, \cdots, P_{2^{|K|}}\}$ as a set of all possible outcomes from the $2^{|K|}$ ET events combinations. The procedure for obtaining this set was performed using a binary search tree [7], which travels $2^{|K|}$ different paths and assign a value to each element of P, as shown in Equation (5):

$$P = \bigcup_{k=1}^{2^{|K|}} \left[Initial\ Event * \prod_{l=1}^{|K|} \omega(i,j,k,l) \right] \tag{5}$$

The function ω, as shown in Equation (6), corresponds to a 4-dimensional vector which performs a binary search in the tree, returning a path element of each iteration. Values i and j correspond to the beginning and ending of the search, and have initial values of $i = 0$ and $j = 2^{|K|}$. The value k corresponds to the index of the sought element (an element of P) and l, the current level of the tree. The sequence of events can be viewed in Figure 3 (Stage 1).

$$\omega(i,j,k,l) = \begin{cases} Pr(K_l); j = (i+j)/2,\ k \le (i+j)/2 \\ 1 - Pr(K_l); i = (i+j)/2,\ k > (i+j)/2 \end{cases} \tag{6}$$

After defined all possible outputs P for a LP and calculated their probabilities, the method applies a constraint variable Q, which checks if its value is greater than or equal to MAL for each element of P. Only the results that are greater than MAL are considered, and the other are discarded. Thus, $Q = \{q_1, q_2, \cdots, q_m\}$ is a subset of P:

$$Q = \{q \in P \mid q \ge MAL\} \tag{7}$$

The final probability values obtained through Equation (7) will be used to measure and analyze the LP's risk. Consider the risk level of a LP defined by a pair $\langle R, S \rangle$. R represents a condition of the LP to compose a VO (using boolean logic), while S represents the success probability of the LP associated with the condition R. So $LP_i = \langle R_i, S_i \rangle$ for the i-th selected LP and the i-th is the score S associated with the i-th result R. R is calculated checking if Q set has some element (Equation (8)), i.e. if there is at least one outcome value greater than MAL. A value 1 corresponds to the presence of elements so enabling the LP to compose a VO. S (Equation (9)) is calculated summing all elements of Q, obtaining the success probability rate for a LP.

$$R = \begin{cases} 0, & |Q| = 0 \\ 1, & |Q| \ne 0 \end{cases} \tag{8}$$

$$S = \sum_{i=1}^{|Q|} q_i \tag{9}$$

3.2 Collective Risk Analysis

This second phase of the MRALP method aggregates the results provided by the first phase (i.e. the risk level of each pre-selected LPs) to calculate the VO success probability as a whole, i.e. if the VO formation can succeed or not.

This phase applies FTA (fault tree analysis) method [7]. FTA uses a logical diagram- called Fault Tree (FT) – which is a graphical representation of failure events logic that can occur in a system among all other possible event combinations. The graphical model can be translated into boolean logic using logical gates to calculate failures. Events are associated with input lines from the logic ports (0-failure, 1-success) and must be analyzed to determine the logical connection between underlying failure events that might cause them.

FTA method takes the boolean values from ETA (first phase) as input (see Figure 3). An OR logic gate with $2^{|K|}$ entries is associated to each LP, meaning that the number of OR logic gates changes according to the number of LPs.

Resulting values from OR logic gates are aggregated to an *AND* logic gate, which verifies if all LPs are able to compose the VO. This gate returns 1 on success and 0 on failure, i.e., if at least one LP is not able to compose the VO, the VO formation process is considered unfeasible. On the contrary, if all members are considered able to, the VO as a whole is considered able to go for operation.

For this, it is necessary to perform a calculation with all elements of LP and, after that, to set a R_f, which corresponds to the success/failure value of the association between the LPs (Equation 10).If $R_f = 1$ then the VO formation is considered feasible from the risk analysis point of view. If not, that VO is discarded and the procedure is restarted with other LPs, i.e. with the other (possible) VO compositions.

$$R_f = \bigwedge_{i=1}^{|SP|} SP\ \langle R_i \rangle \tag{10}$$

4 An Illustrative Example

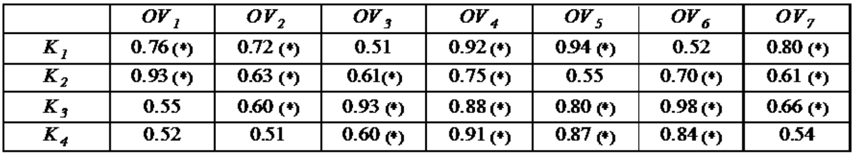
This section presents an illustrative example to better show the proposed method. Suppose that a CO was created and three LPs ($\{LP_1,\ LP_2,\ LP_3\}$) were selected to link four industrial partners (using the method developed in [4]. The goal is to measure the risky of every selected possible LP coalition for the given VO. Following the proposed method, for each LP coalition the individual risk of every LP is firstly measured and the overall VO risk is calculated afterwards.

Considering size restrictions, the risk analysis that will be illustrated will only consider LP_1, with the final values of LP_2 and LP_3arbitrarily defined.

The assessment criteria $K$of each LP are defined by a set of four KPIs: Trust (K_1), Communication (K_2), Collaboration (K_3) and Commitment (K_4). Table 1 shows hypothetical historical values that would be assigned to $LP_1{}'$s KPIs related to its participation in the last seven VOs. Equation (1) calculates the success probability of these KPIs applying a MPS=0.6.

Table 1. Quantitative values of KPIs according historical values of LP_1 in VOs

(*) KPI values greater than MPS = 0.6 are considered in the risk analysis.



	OV_1	OV_2	OV_3	OV_4	OV_5	OV_6	OV_7
K_1	0.76 (*)	0.72 (*)	0.51	0.92 (*)	0.94 (*)	0.52	0.80 (*)
K_2	0.93 (*)	0.63 (*)	0.61(*)	0.75 (*)	0.55	0.70 (*)	0.61 (*)
K_3	0.55	0.60 (*)	0.93 (*)	0.88 (*)	0.80 (*)	0.98 (*)	0.66 (*)
K_4	0.52	0.51	0.60 (*)	0.91 (*)	0.87 (*)	0.84 (*)	0.54

In order to individually measure its risk level, LP_1 is submitted to the first stage of MRALP method, applying ETA method. It should also consider the success and failure probabilities of each KPI that composes the intermediate events and then adding them as parameters in the ET. The ET graphical representation can be viewed in Figure 3 (Stage 1). According to Table 1, using Equations (1) and (2) and considering, for example, MPS = 0.6, the success and failure probabilities associated with each KPI are calculated (Table 2) and the respective ET is formed.

Table 2. Success and failure probabilities to LP1

Success Probabilities	**Failure Probabilities**
$Pr(K_1) = 5/7 = 0.71$	$Pr(\overline{K_1}) = 1 - 0.71 = 0.29$
$Pr(K_2) = 6/7 = 0.86$	$Pr(\overline{K_2}) = 1 - 0.86 = 0.14$
$Pr(K_3) = 6/7 = 0.86$	$Pr(\overline{K_3}) = 1 - 0.86 = 0.14$
$Pr(K_4) = 4/7 = 0.57$	$Pr(\overline{K_4}) = 1 - 0.57 = 0.43$

Let $P = \{P_1, P_2, \cdots, P_{16}\}$ be a set of all combinations among K_1, K_2, K_3,K_4 and, for example, MAL = 0.1. Table 3 presents this result after applying Equation 5. It represents the $2^{|K|}$ combinations of K, corresponding to all the probabilities (sixteen) associated with each event.

Next step consists in assigning a S score and a R boolean result for the LP_1 (Equations (8) and (9)). A constraint Q = {0.3, 0.15, 0.12} is defined (Equation (7)), corresponding to the probabilities of values to be greater than MAL.

$$S = (0.3 + 0.15 + 0.12) = 0.57$$
$$|Q| > 0 \rightarrow R = 1$$

Table 3. Results from the event combinations
(*) values greater than MAL = 0.1

(1) P1 = P(K1) * P(K2) * P(K3) * P(K4) = 0.71 * 0.86 * 0.86 * 0.57 = 0.3 (*)
(2) P2 = P(K1) * P(K2) * P(K3) * P(K'4) = 0.71 * 0.86 * 0.86 * 0.29 = 0.15 (*)
(3) P3 = P(K1) * P(K2) * P(K'3) * P(K4) = 0.71 * 0.86 * 0.14 * 0.57 = 0.05
(4) P4 = P(K1) * P(K2) * P(K'3) * P(K'4) = 0.71 * 0.86 * 0.14 * 0.29 = 0.02
(5) P5 = P(K1) * P(K'2) * P(K3) * P(K4) = 0.71 * 0.14 * 0.86 * 0.57 = 0.05
(6) P6 = P(K1) * P(K'2) * P(K3) * P(K'4) = 0.71 * 0.14 * 0.86 * 0.29 = 0.02
(7) P7 = P(K1) * P(K'2) * P(K'3) * P(K4) = 0.71 * 0.14 * 0.14 * 0.57 = 0.01
(8) P8 = P(K1) * P(K'2) * P(K'3) * P(K'4) = 0.71 * 0.14 * 0.14 * 0.29 = negligible
(9) P9 = P(K'1) * P(K2) * P(K3) * P(K4) = 0.29 * 0.86 * 0.86 * 0.57 = 0.12 (*)
(10) P10 = P(K'1) * P(K2) * P(K3) * P(K'4) = 0.29 * 0.86 * 0.86 * 0.29 = 0.06
(11) P11 = P(K'1) * P(K2) * P(K'3) * P(K4) = 0.29 * 0.86 * 0.14 * 0.57 = 0.02
(12) P12 = P(K'1) * P(K2) * P(K'3) * P(K'4) = 0.29 * 0.86 * 0.14 * 0.29 = 0.01
(13) P13 = P(K'1) * P(K'2) * P(K3) * P(K4) = 0.29 * 0.14 * 0.86 * 0.57 = 0.02
(14) P14 = P(K'1) * P(K'2) * P(K3) * P(K'4) = 0.29 * 0.14 * 0.86 * 0.29 = 0.01
(15) P15 = P(K'1) * P(K'2) * P(K'3) * P(K4) = 0.29 * 0.14 * 0.14 * 0.57 = negligible
(16) P16 = P(K'1) * P(K'2) * P(K'3) * P(K'4) = 0.29 * 0.14 * 0.14 * 0.29 = negligible

It can be seen that logistic partnerLP_1 is able to compose a VO as it has at least one value greater than MAL. Now, (arbitrary) values of R and S are set to LP_2 and LP_3, as shown in Table 4.

Table 4. Values of $\langle R, S\rangle$ associated each logistic partner

	LP_1	LP_2	LP_3
$\langle R_i, S_i\rangle$	$\langle 1, 0.47\rangle$	$\langle 1, 0.54\rangle$	$\langle 1, 0.38\rangle$

The second stage of the method consists in aggregating all the individual results from the LP group and in analyzing them as a whole. This is done using FT results as input to verify if that VO coalition, collectively, is feasible or not. Equation (9) is applied considering the provided values (Table 4) using the $LP_i(R)$:

$$R_f = LP_1(R) \wedge LP_2(R) \wedge LP_3(R) = 1 \wedge 1 \wedge 1 = 1$$

As explained in Section 3, considering that $R_f = 1$, this would mean that the combination of those three logistic partners has an acceptable level of risk. Therefore, they could become members of the VO and hence the VO could be created.

5 Conclusions

This paper has presented a supporting method to perform a risk analysis upon a set of logistic partners (LP) that are going to compose – together with industrial partners – a Virtual Organization (VO). It corresponds to an extension of a previous work, which selected LPs but without considering risks. This method represents the result of an ongoing research which aims at last to develop a comprehensive framework for VO risk analysis.

The presented method, called MRALP, performs the risk analysis along two stages, firstly evaluating risks individually, per partner, and secondly at a global level. Four KPI are used as the essential basis for the selecting criteria, applying ETA (Event Tree Analysis) method in the first stage and FTA (Fault Tree Analysis) method in the second stage.

Although implemented in a controlled computing environment and with hypothetical values, the achieved results seemed promising about the suitability of the method regarding its purpose. Both ETA and FTA could model the required variables as long as it was needed besides being not much complex to use them.

Considering the state-of-the-art, the presented method proposed a concrete way to express to measure risks in a VO scenario when considering logistics. Yet, modeled as a process, it represents a systematic way to analyze risks. This is important once partners are autonomous and are members of long-term alliances so transparency in the involved processes is crucial for trust building. Moreover, being a more organized process, it has the potential to increase the agility in the VO formation process. On the other hand, it is assumed that a VO manager is the one responsible for the decision (i.e. the very final selection of LPs) as well as for actions aiming at mitigating risks, both in the creation and operation phases of the VO life cycle.

The four chosen KPIs (communication, commitment, trust and collaboration) to cope with risks in VO seem appropriate regarding literature. However, it is necessary to assess them in near-real scenarios, not only in terms if they are suitable enough or if more KPIs are required, but also to evaluate the complexity to implement them. Companies are often very much variable and this implementation also depends on the culture and working methods currently applied by the involved organizations.

Considering the combinatorial essence of the method, its computation can become overwhelming when dealing with very large global logistics chains, composed of tens of partners.

Although preliminary devoted to logistics and partners' selection problem, the method can be easily adapted to other application domains, basically changing the group of selected KPIs and the way they are calculated.

Next main steps include testing the method in near real scenarios as well as to extend it towards comprising the VO entirely, involving industrial partners. Besides that, a more detailed categorization of types of LPs (inbound and outbound as well as 4 PL) will help in a more precise definition of the most suitable LPs.

Acknowledgements. This work has been supported by the Brazilian and German research funding agencies Capes and DFG in the scope of the BRAGECRIM Program, project No. 2009/2. Also by the Brazilian research funding agency CNPq.

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Offshoring Decision
Based on a Framework for Risk Identification

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Abstract. Offshoring has been a growing practice in the last decade. This involves transferring or sharing management control of a business process (BP) to a supplier in a different country. Offshoring implicates information exchange, coordination and trust between the overseas supplier and the company that means to assume risk. In this paper categories and types of risk have been hierarchically classified using a new approach with the aim to propose a multilevel reference model for Supply Chain Risk evaluation. This classification has been used to analysis the offshoring decision taking into account not only operational and financial risks but other aspects as strategic, compliance, reputation and environmental. The proper risk identification can help to take the correct decision whether or not to bet on offshoring or maintain all the processes in the country of origin.

Keywords: Offshoring, risk identification, Supply chain.

1 Introduction

The decline in manufacturing jobs in industrialized countries has been stunning since 1998 and this tendency cannot be completely explained in terms of higher productivity of these nations. Likely the main reasons are the offshoring strategies of multinational enterprises as well as the manufacturing output reduction due to the global economic situation.

Nowadays governments are focusing their interests on internal manufacturing sector because it is the source for jobs creation using innovation as key driver. Furthermore, the national production of a country helps reducing the trade deficit.

But additionally to the interest of different governments to attract the production of national enterprise that previously manufactured at home, some enterprises had found that offshoring it is a risky option. For example, Ravi Aron and Jitendra V. Singh explained in detail the case study of Alpha Corp in 2003 [1].

In general, there is a consensus among academics about main causes of offshoring implementation failures:

a. Enterprises did not distinguish between core and non-core business processes.
b. They only took into account saving costs in order to maximize economic benefits.
c. Offshoring strategy is not an all-or-nothing choice. Hybrid strategies are feasible.

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 540–547, 2013.

To evaluate adequately the offshoring decision and to avoid previous mistakes, authors propose to develop a specific framework to manage business risks in the supply chain (SC). It will be crucial to consider a wide risk category and the overall impact in each member of the SC.

2 Value of This Study

Multinational enterprises and SCs must always take strategic decisions to set and place their production processes. The best decision would be to retain "in-house" the core segments of the SC while the others are properly dispersed or disaggregated. This is not an easy decision because although offshoring/outsourcing can capture external talent, at long term can be a risk to the SC. It is fundamental to take into account high-end activities (e.g. product development and R&D) [2].

In addition, an alternative option to outsourcing / offshoring has to be considered. Collaborative network of SME's can also satisfy the random nature of customer behaviour and dynamic changes of demand patterns [3].

Supply Chain Risk Management is based on a "well known" methodology called SAM which consists of three tasks: Specifying sources of risk and vulnerabilities, Assessment, and Mitigation [4]. However it is difficult to apply it in "real life" due to the absence of a complete framework for supply chain risk management. The objective of this paper is to establish a comprehensive risk classification framework to facilitate the search of risk sources [5].

Many papers highlight and detail the implications of each type of risk associated with the different activities of the SC. Among them, Kumar et al. work has to be emphasized because it gives a first approach of all the causes of offshoring risk decisions [6]. Starting from this point, but covering all the possible risks that may affect the SC, in this paper a risk hierarchical classification has been created. This will help enterprises to address the right decision whether or not to bet on offshoring or maintain all the processes in the country of origin. It will also help government to know the risk associated to offshoring and in this way to develop policies in order to mitigate risk in the own country and to retain or attract companies.

3 Methodology

3.1 Literature Review

Literature review has not been centred in a specific topic like "offshoring risk". Using Sciverse Scopus© the search process has been done, starting with general keywords like "supply chain risk" or "business risk" and finishing it with specific keywords like "risk identification" or "offshoring risk".

The initial papers list covered 45 articles from major science-cited journals. Because of multi-disciplinary nature of the SC management, different knowledge areas specified by Kumar have been taken into account. Due to the space constrains the full list of papers is not included, but authors can supply it on demand.

From all these papers 22, are found much more relevant for the intersection mentioned above (see table 1).

Table 1. Distribution of the articles found with respect to journals

Supply Chain Management: An International Journal	5
International Journal of Production Economics	3
International Journal of Physical Distribution & Logistics Management	2
Journal of Manufacturing Technology Management	2
Journal of Operations Management	1
R&D Management	1
MIT Sloan Management Review	1
Production and Operations Management	1
Journal of Risk Research	1
Journal of Purchasing & Supply Management	1
Journal of Management Information Systems	1
Information Systems Management	1
International Journal of Operations & Production Management	1
Harvard Business Review	1
Total	22

3.2 Proposed Framework for Risk Classification

Considering the literature review, it has been found that the issue of risk identification has been a matter of interest to many authors for a long time, and of which even there are some specific papers.

Although some authors have classified these risks according to existing frameworks or creating a new one, authors have not found a generic framework to evaluate the overall SC risks. For instance, a simple way to classify risks was introduced by P.R. Kleindorfer and G.H. Saad [4], in this case authors classified risks in three categories: operational contingencies, natural hazards and political instability. D. Bandaly et al.[7] as well as Klimov et al.[8] included a distinction between risk that are internal or external to the supply chain. Chopra et al.[9] and Blackhurst et al.[10] preferred to disaggregate risks in specific categories such as disruptions, delays, inventory, information systems etc. Probably, an excellent generalisation of all the previous classifications for operational risk management is the work of O. Tang and S.N. Musa [11]. Operational contingencies were classified by the authors attending to the three types of flow in SC: material, information and financial. Furthermore these authors subdivided these categories using SCOR basic processes as drivers for a second level of classification. The limitation of this work is that management and relationship aspects are out of scope. In the case of Global Sourcing, Christopher et al. [12] divided the risks in process, control, demand, supply and environment. Focusing on offshoring Olson et al [13] used a similar classification to the one done by Chopra et al [9], but in the case of Kumar et al. [6], the authors introduced cause-effect fishbone diagram to map offshoring risks.

In our proposed Framework for Risk Identification (FRC), Kumar specific map was the starting point to determine and to prioritize main risk categories. Then, SC reference models were used to disintegrate them into types of risk. For instance, SCOR [14] was an excellent option to subdivide process risk categories whereas GSCF [15] was a standard to create technology and people risk elements.

Table 2 represents author's proposal Framework for Risk Classification, an extra column has been added to clarify the number of citations. This column indicates the number of papers in which this risk appears in order to show the importance given by other authors for each specific risk element.

4 A First Approach about Offshoring vs Reindustrialization Decision Using Author's Framework

Strategic decisions like offshoring, outsourcing or alliances with other enterprises to establish a collaborative network can have a huge impact on Supply Chain. Therefore all the supply chain members must agree it. As mentioned before, it is crucial to apply SAM methodology in order to mitigate consequences [4, 16].

A framework such as the proposed in table 2 facilitates to specify the sources of risk, which is the first phase of SAM methodology. Second stage of SAM methodology is assessment; authors propose to use a questionnaire in order to evaluate different scenarios (current situation vs offshoring, reindustrialization…). Its first column gathers all the elements of risk extracted from table 2. Alternative scenarios will be represented in different columns, each of them will include four elements: subjective priority (S-priority), probability (P), impact (I) and Value at Risk (VAR). Questionnaire processing will be divided in two stages:

- First, S-priority is fulfilled by SC managers and their feedback will be weighted according with its authority level. Due to complexity of SC networks, only risk elements which have a relevant averaged variation for the whole SC between different scenarios will be deeply investigated. At this point, it is important to remark that exist several alternatives to assess risks. Authors have decided to use an alternative based on subjective priority, although other structured techniques like Analytic Hierarchy Process (AHP) or Analytic Network Process (ANP) are feasible for multi-criteria decisions [17].

- Second, the probability and economic impact of each relevant element will be calculated. Although probability determination is out of scope, a Bayesian networks can be a properly approach [18]. Total cost determines the economic impact value. Finally authors have decided to use SCOR strategy for risk evaluation based on VAR metric, which is calculated as $VAR=P\cdot I$ [14].

Table 2. Proposed framework for risk classification

1. STRATEGIC RISK	**Cited by**	**2.OPERATIONAL RISK**	**Cited by**
1A. Adverse business decisions risk	18	2A. Structural risk	2
Misunderstanding what product to transfer	4	Inappropriate storage/warehouse for incoming product/part from suppliers	2
Opportunism risk	3	Inappropriate final product warehouse before deliver	1
Price volatility of commodity/alternative energy	3	2B. External SC processes risk	20
Alliances, joint-ventures, acquisitions	1	Delay at ports due to port capacity or congestion	2
Partner become a competitor	1	Augment in transport capacity required	2
Risk of particular segment of supply chain being crippled	1	Port strike	1
Partner business continuity	1	Transportation breakdowns	1
SC Sustainability risk	1	Higher costs of transportation	1
Loss of synergy across firm activities	1	Custom clearances at ports	1
Not finding qualified personnel	1	Uncertainty about transit time	1
Loss of internal capabilities/process knowledge	1	2C. Source process risk	17
Loss of managerial control	1	Supply product monitoring/quality	8
Loss of core group	1	Supplier inability to conform to specification	4
1B. Improper SC implementation risk	6	Supplier selection	4
Poor partner collaboration	3	Inflexibility of supply source	4
Lack of SC visibility	2	High percentage of key component or raw material procured by single source	4
The difficulty of cross-functional and cross-locational coordination	1	Supplier deliver discontinuity or low reliability	4
1C. Information system risk	8	High dependence on supplier	3
Information infrastructure breakdown	3	High capacity utilization supply source	3
Lack of effective system integration	3	Low supplier capacity to absorb a higher demand	3
Information accuracy	2	Quality of service	3
Vertical integration of SC	2	Supplier bankruptcy	3
Very complex IS due to global outsourcing/offshoring	2	Poor supplier collaboration	2
1D. Competitor risks	4	Poor quality or yield at supply source	2
Competitors actions	3	Supplier financial instability	2
Product does not provide competitive advantages	2	Supplier fulfilment errors	2
Low impact of the introduction of new product on market	1	Supplier low readiness to accept modifications if required	2
Competitive product being launched before launch of new product	1	Non-standardized workflow, in communication with supplier	1
Response actions towards public and media expected from competitors	1	Sudden demise of supplier	1
Not foreseeing future competitor's challenges	1		

Table 2. (*continued*)

2.OPERATIONAL RISK (cont)	**Cited by**
2D. Make process risk	8
Rate of product obsolescence	5
Operational disruption/Manufacturing breakdown	4
Production capacity risk	3
Inventory risk	3
Product and process design risk	2
Poor production quality	2
Inventory holding cost	2
Fluctuations on product value	2
Demand and supply uncertainty	2
Lower process yields	2
Higher product cost	1
Products causing safety hazards	1
Processing delays	1
2E. Deliver process risk	12
Demand volatility/seasonability	3
Late deliveries	3
Balance of unmet demand and excess inventory	1
Paperwork and scheduling	1
Shipment disruptions	1
Packing requirements and parts size	1
Poor customer collaboration	1
Dependence on customer	1
2F. Return Process risk	2
High volume of product return from customers	2
2G. Plan process risk	8
Inaccurate forecasts due to longer lead times, excess of variety, swing demand or life cycle	5
Uncertain supply lead time	4
Fluctuation in raw materials, finished product, labour prices	3
Contract type and compliance	3
Uncertain customer demand	2
Uncertain supply yield	2
Uncertain costs	1
Order fulfilment errors	1
Information distortion due to sales promotions	1
Exaggeration of demand during product shortage	1
Inappropriate inventory plan	1
Inappropriate warehouse/storage plan	1
Uncertainty over long-term impact on supply and demand	1

3.COMPLIANCE RISK	**Cited by**
3A. Law and regulations risk	7
Governments regulations and laws	7
3B. Contracts risk	1
Long term versus short term contracts	1
4.FINANCIAL RISK	
Capital cost for product's life cycle based on convincing data	3
Product Price uncertainty	2
Financial strength of customers	1
Sales perspectives not being realistic	1
Not knowledge of pricing sensitivity	1
Non adequate investments to secure safety in production	1
Cash-to-cash cycle time Exposure	1
Decrease in net earnings from global sourcing due to the hidden costs	1
High switching cost	1
Accounting risk measures	1
Asset impairment risk	1
Downside risk associated with negative outcomes	1
5.COUNTRY RISK	
Economic crises, strikes	7
Regional instability	5
Political risk	5
Exchange rate risk	5
Cultural and ethics	4
Communication difficulties	1
6.REPUTATION RISK	
Public perception of the enterprise	4
New products don't fit with existing brand	1
Product don’t contribute to brand name position	1
7.ENVIRONMENT RISK	
Natural disaster	9
Terrorist attack	7
Environment degradation and awareness	5
Accidents and safety issues	3
Theft	1
Diseases	1
High levels of CO_2 carbon emissions during the global sourcing activity	1

Table 3. Example of questionnaires for supply chain risk management

Risk Element	Present situation				…	Scenario n			
	S priority	P probab	I impact (M€)	VAR (M€)		S priority	P probab	I impact (M€)	VAR (M€)
Rate of product obsolescence	3	0.34	1.27	0,43		9	0.61	1.11	0,67
Operational disruption	2	0.46	1.67	0,76		8	0.12	2.12	0,25
Product and process design risk	3	-	-	-		3	-	-	-
…									

It is important to remark that this methodology is useful not only to decide to disaggregate the SC, it can help the enterprise to decide if reindustrialization would be a best choice and also to the government to a clear idea about the drivers that enterprises use to take this decision. In this way, Governments could act adequately to try to reduce risk in the country.

During risk assessment phase, VAR metric of each main source of risk will be calculated in order to facilitate the decision to managers. Thus, following this approach, all the costs that can appear after a strategic decision will be explicated and the overall impact on all the SC members will be taken into account.

5 Conclusions

This paper was intended to provide an overview of risks classification associated with Supply Chain strategic decisions and possible strategies that could be implemented by corporations to help managers take the best decision.

Authors argue that offshoring/outsourcing/reindustrialization decisions should not only be based upon the direct effect that these decisions have on an organization's profits. It is necessary to apply a Supply Chain Risk Management approach to take into account all risk components (strategic, operational, compliance, country…) because an indirect impact on other SC members can be as important as the direct one.

Authors FRC can be transformed into questionnaires to facilitate source risk identification phase of the SAM methodology. Thus, better understanding of different risk scenarios is possible. Assessment strategies were also discussed in this paper. It is proposed to use "Value At risk" (VAR) metric to calculate risk starting from probability and economic impact measurements of each element of risk. Decision costs are the best drivers to help managers to decide among reindustrialization, outsourcing or offshoring.

This theoretical proposal will be contrasted and extended in future investigations applying it to real supply chains.

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Modeling of Evolution and Sustainability of Rational Trust in Dynamic VOs

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Abstract. Modeling of trust sustainability and evolution among partners of a dynamic Virtual Organizations (VO) whose collaboration is already established, poses high challenge to such virtual co-working environment. Research in VOs has not established suitable modeling approaches for analyzing evolution and sustainability of rational trust and related assessment mechanisms for the collaboration which is already in progress. This is very necessary as it has now been proved that the base trust level acquired by VO partners during the VO formation is not static and cannot to remain constant over entire period of collaborative business execution. Thus proper modeling and analysis approaches for measuring the continuous changing of trustworthiness of organization need to be developed. This paper proposes approaches and mechanisms for modeling and assessment mechanism for supporting inter-organizational trust sustainability and evolution.

Keywords: trust evolution, trust sustainability, VO, trust modeling.

1 Introduction

In traditional business undertakings, organizations tend to struggle and win business opportunity individually. Nowadays, SME organizations in particular are less and less capable to afford acquiring and executing business opportunities individually, and now a new form of working in cooperation networks is being adopted (Msanjila and Afsarmanesh, 2007). The emerging approach which is now being adopted by collaborating organizations is Virtual Organizations (VO) which are configured constituting organization that are members of a long-term strategic alliance. Dynamic VOs which are mostly preferred are those temporary consortiums whose structure and particularly partners may change during the collaboration. The VOs characteristics include tendency of organizations to create "virtual size" by becoming partners but at the same time trying to preserve the flexibility of small companies (Riemer et al., 2001); and there is no leading or subordinate" (Appel & Behr, 1996).

Smooth operation of the VO needs to be supported with *rational trust* among the partners to provide a bonding factor and a glue to stick these partners together. Established inter-organizational trust through rational mechanisms is used to enhance partner's confidence that a specific member of the VO can execute its assigned roles appropriately to collaboratively achieve the common goal(s). Despite the different and opposing perception of trust, we perceive trust in VO, which only rational trust is

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 548–555, 2013.

suitable to apply, as the objective-specific confidence of a trustor in a trustee, based on the results of rational (fact-based) assessment of trust level of the trustee (Msanjila, 2009). The main input into trust analysis is measurable organization's performance.

Organizations collaborate in the VO for a number of reasons including saving time and decreasing development process, sharing costs and risks with partners, improving resource utilization, and gain access to new markets through partnership (Nami and Malekpour, 2008). Although, it is clear regarding its urgency, trust of the VO partner does not remain static, but varies depending on many influencing factors including comparative nature. Since the level of trust for an organization is dynamic and evolves over time, then comprehensive approaches for managing rational trust in VOs whose collaboration is already in progress is important. It is because, with a rising number of relationships and especially short-time relationships, as needed in VOs, conventional approach to build trust among business partners has proven to be inefficient (Wehmeyer and Riemer, 2007). Scientific mechanisms for modeling trust sustainability and supporting for a VO evolution are needed so that VOs remain bonded to achieve their goals and undergo evolution when required.

This paper describes classification of trust (section 2), presents approaches and mechanisms for modeling and assessment of rational trust (section 3), suitable for analysis of inter-organizational trust sustainability and evolution.

2 Classification of Trust

Trust can be classified in two aspects, namely; (1) Subjective trust, and (2) Objective trust. In the past, trust used to be perceived as subjective (opinion-based); posing difficulties in its evaluation and formal reasoning on analysis of its results, due to the use of opinion-based data, thus being risky as it is biased (Msanjila 2012). In subjective trust, a trustee is evaluated based on opinions, suggestions, and recommendations and sometimes polling. It is a biased trust and very difficult to reason about its results. Measurement and assessment of the subjective trust provides questionable results for a VBE/VO member to be trusted, because data sources are not properly characterized and are difficult to factually measure.

Objective trust is the results of the rational (fact-based) assessment of the trust level (Msanjila and Afsarmanesh, 2007). It is the trust whose assessment is based on organizational performance data (fact-based), and provides results which an individual can reason about. Trust in the past was measured statically and did not consider the variation of trustworthiness with time. Such dynamic behavior of trust level accounts for existence of *Trust Sustainability and Trust Evolution.* Trust sustainability is the process whereby a VO partner maintains their trustworthiness to the specific trust level to enable it remains acceptable in the VO during execution of the activities that lead into achieving the common goal of their collaboration (Msanjila, 2012). Each VO partner has to maintain its trust level above the acceptable value, namely the required specific trust level for the VO. If the trust level falls below the specific trust level of the VO then the said VO partner cannot be trusted and its capacity to execute its assigned roles shall be doubtable. When such an organization fails to sustain its level of trust, the VO undergoes evolution from which new VO partners are selected from VBE to fill the gap of departing partner with poor trust.

When new partners are added in the VO naturally trust level of others will change because of the comparative analysis and measurement applied. This process is referred to as trust evolution. When new member(s) are added in a VO, there will be a change on an average trust level of the VO, which implies trust evolution.

3 Trust Evolution Assessment Mechanism

In research there is still lack of suitable mechanisms for the assessment of rational trust of collaborating VO partners. Mechanisms for assessing rational trust during the selection of VO partners measure the basic trust level. These mechanisms cannot be applied to assess trust in already existing consortiums, because trust level is not static but changes with time. Current mechanisms for assessing rational trust consider trust level at a specific point in time (static assessment). These mechanisms do not address the evolution of trust with time and thus assumes trustworthiness of organizations is static once measured. This has proven to be not the case and therefore mechanism for assessing evolving trust level of organizations are required as proposed in this paper.

The assessment mechanisms that can support trust sustainability and evolution among partners collaborating in VO over entire period of business execution as proposed in this paper are modeled based on performance acquired or achieved by the partners in the specific VO. The proposed models are developed applying statistics concepts that can capture variation measures with time. The statistics concepts, namely: (1) measure of central tendency (mean) and (2) dispersion (mean deviation and standard deviation) are applied to develop mechanisms to capture the evolution of trust in VO partners. In the subsequent subsection three (3) rational trust assessment mechanisms discussed in detail, and finally a best-to-fit model is proposed. In each presented model, the following assumptions are made: *Base period*: Is a specific interval time (monthly, quarterly, semi-annually, and annually) which is considered to be a period for assessment base trust level of VO partner. *Base trust level*: The trust level acquired by a VO partner at specific point in time.

3.1 First-Level Model: Mean Estimation

This approach considers mean estimation for trust level of VO partners in a given period (1). The mean trust level estimated at current period becomes the target score for which every member's trust level should not fall below the threshold in the next period. For example if the base period is assumed to be quarterly, then mean trust level is computed using trust level of individual partner. After a lapse of three (3) months, the new acquired trust level for each VO partner is compared against that mean trust level to find if it is less than, equal to or greater than mean trust level at such current period (refer figure 1 and figure 2). Mean trust level is calculated as

$$\text{Estimated } Mean\ Trust\ Value(Xmean) = \sum_{i=1}^{n} \frac{Xi}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots. eqn\ 1$$

Where Xi is a trust level and n is the number of VO partners participating in the VO. In figure 1, M stands for a VO partner while TL stands for Trust Level of the partner.

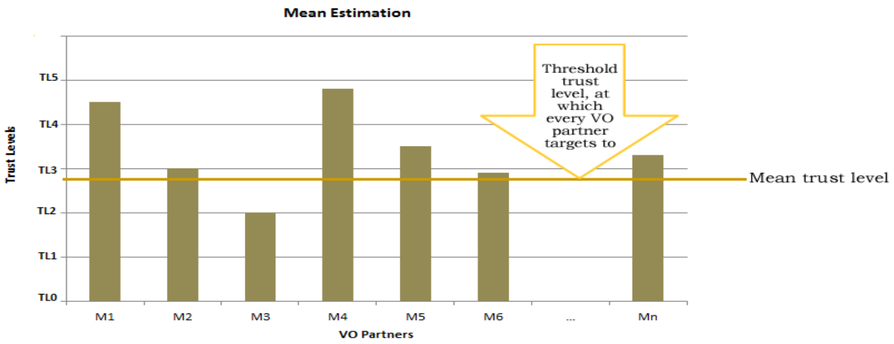

Fig. 1. Trust assessment by mean estimation method

It may happen that the mean trust level be above of some levels of trust of some VO partners at a given period (figure 1). In such situation: (1) Fair play to some of the partners (M_3) is ignored, but favoring partners whose trust values were high (M_1, M_2, M_4, M_5, M_6) during the base assessment period and (2) Assessment does not provide a target point for a particular partner, looks at a single point for all member to achieve.

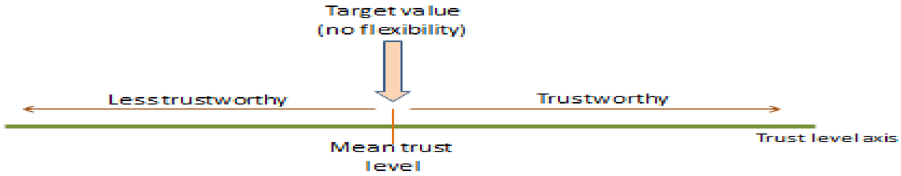

Fig. 2. Linear presentation of cut-off point in the statistical mean estimation method

The impact of this assessment includes: (1) Partners whose trust levels are below mean estimated trust value are deprived of a fair chance to build trust over others; (2) Partners whose trust level scores are above mean estimated level have greater confidence to build trust over others; (3) The model does not give a range for variation in trust level, rather aims at single point and (4) The mechanism has a narrow space for trust variation limits. This model is suitable for discovering partners whose levels of trust have fallen below specific VO's mean trust level for removing underperforming partners and replace them with other new partners (figure 2).

3.2 Second-Level Model: Mean Deviation

The mean deviation (average deviation) is the mean of the absolute deviations of observations from some suitable average which may be the arithmetic mean, the median or the mode. The difference (how far is each data from the average) between a specific data and the average itself, is called deviation. Considering arithmetic mean for this model, mean deviation is the average of how far is each individual data element from the mean. This difference is given by the following formula.

Mean= (X - Average) ……………………………………eqn 2

If the negative sign is ignored, the deviation is written as

$$Mean=|X - Average| \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eqn\ 3$$

and is read as mod deviation. For ungrouped data, mean deviation is given by

$$Mean\ Deviation\ (M.D) = \sum_{i=0}^{n} \frac{|Xi-Xmean|}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eqn\ 4$$

where X_i is a VO partner's trust level, X_{mean} is a mean trust level and n is the number of VO partners participating. This model considers trust level for each partner as data sets for computing mean trust level for VO, which is denoted as X_{mean}. Then individual deviation for each VO partner is computed as illustrated in equation 2 and further in equation 3. The mean trust level for all VO partners is computed during the base period.

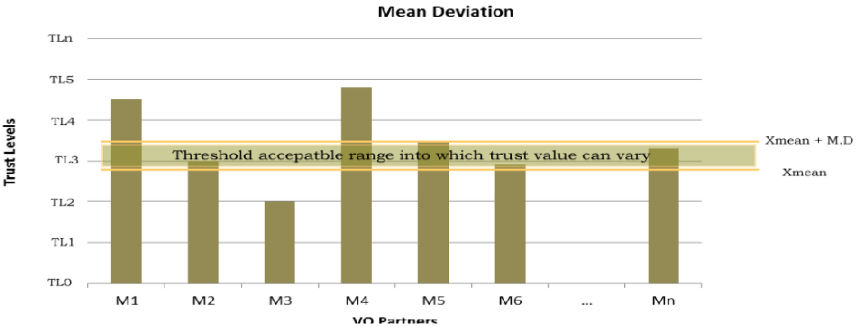

Fig. 3. Trust assessment by mean deviation method

Then VO's mean deviation (M.D) is calculated as illustrated in equation 4. The range $Xmean + M.D$ becomes the acceptable range over which individual VO partner's trust level can oscillate or vary and still that specific partner remain trustworthy (refer figure 4). After a lapse of agreed period (say, semi-annual), each individual VO partner's trust level is assessed and compared to see if it range between and above $Xmean + M.D$ or has fallen below $Xmean$. If the trust level of a particular VO partner is found to range below X_{mean}, then such specific partner is said to fail to sustain its trust level and therefore it is less trustworthy.

This is a better model as compared to mean estimation one, because it targets to a range of values (refer figure 3 and figure 4) which is somehow easy to achieve than targeting to a single value which is obviously hard to make. Since deviation is given as absolute value, it is always positive. It does not reflect whether such deviation in trust level was of decrease or increase (figure 3). Though the model creates a customized space for interval limit in trust value for each individual VO partner; the space appears to be biased in one direction. The deviation is an absolute value which is always positive, so that space for interval limit is given by $Xmean + MD$. Its limitations include providing space for trust level limits only in one direction but also it is not standard for all VO partners participating. This approach is very suitable when there is a large set of organizations from which a few need to remain in a VO and thus all those organizations whose trust level has fallen will be first dropped.

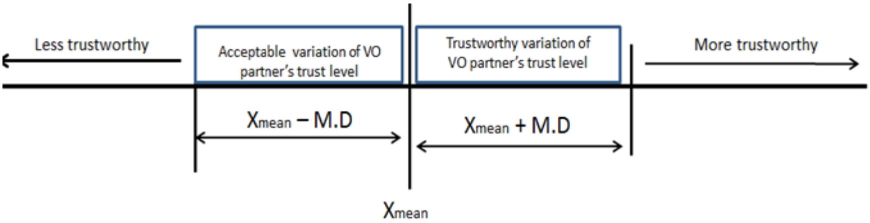

Fig. 4. Linear presentation of VO member's trustworthiness by mean deviation method

3.3 Third-Level Model: Standard Deviation

Standard deviation model is a statistical method useful in determining how far is the data spread out in a particular sample or population, and how individual data are close to the mean. This value gives information on how the values of the data set are varying, or deviating, from the mean of the data set. The statistical assessment mechanism which is standard and able to cater for overall weaknesses of both, mean estimation and mean deviation models is a standard deviation model. It requires calculation of trust variation range (Figure 5) based on standard deviation of trust level given by

$$Standard\ Deviation\ (Vsd) = \pm\sqrt[2]{\frac{\Sigma(square(Xi-Xmean))}{N}} \ldots\ldots\ldots\ldots\ldots\ldots eqn\ 4$$

Since standard deviation may be positive or negative, then the range for trust value becomes acceptable within the range V_{mean} - V_{SD} to V_{mean} + V_{SD}. With this model, space interval limits in both directions exists, with their width twice the standard deviation. Since the width is standard, a VO partner becomes equipped with wide space to allow variation in trust level. Such VO partner's individual trust level can vary within its customized acceptable limits evaluated based on its own capacity determined by its current period's trust level to be assessed in the next period. This means, if the VO partner's trust level is within the range, such VO partner has succeeded to strive for its existence and maintained its trust level. If the trust level shoots down below the acceptable minimum trust level, it is said to fail to comply with agreed trust range. The model works by calculating first the mean trust value for all the available VO partners, as

$$Mean\ Trust\ value\ (Vmean) = \sum_{i=1}^{n} \frac{Vi}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eqn\ 5$$

Then, it calculates population variance of the trust values based on mean trust value denoted by $V_{variance}$, as

$$Population\ variance\ (Vvariance) = \sum_{i=1}^{n} \frac{Square(Vi-Vmean)}{N} \ldots\ldots\ldots\ldots.\ldots eqn\ 6$$

Finally, the model calculates standard deviation for trust level denoted by VSD, as

$$Standard\ Deviation\ in\ Trust\ Values\ (SD) = \pm\sqrt{Vvariance} \ldots\ldots.\ldots eqn\ 7$$

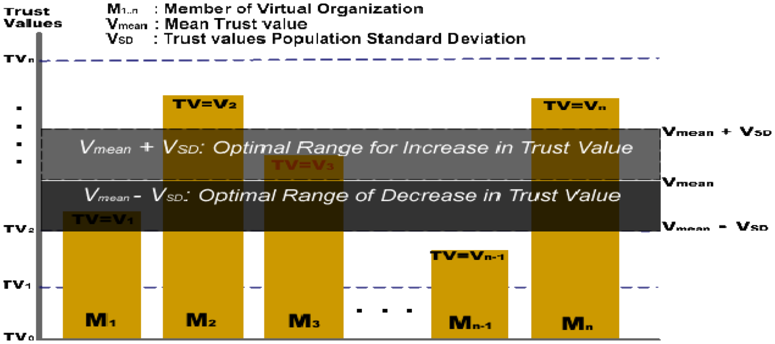

Fig. 5. Model for Trust Sustainability and Evolution Support

Since the standard deviation for trust values may be positive or negative, this implies that it provides an interval of twice standard deviation for which the trust levels variation is allowed. Mathematically, standard deviation measures how widely spread data points are from the mean (refer Figure 6). If more proportion of trust level for the individual VO partners are very close or near to the mean, standard deviation becomes very small number. Since an experiment that yields data with a low standard deviation is said to have high precision, this implies **strong bonding** among VO partners and VO collaboration is assured. On the other hand, if a high proportion of trust levels lay far from the mean trust level, then the standard deviation is large, and as such the experiment that yields data with a high standard deviation is said to have low precision. This implies creation of gaps in levels of trust, and consequently weakens collaborative bonds. A score below minimum acceptable range signifies that such particular VO partner threatens and weakens bonding factor and hence affects collaboration. Thus, the partner cannot be trusted any more by other partners in achieving common and shared goals. It is important to think about replacing a failed partner by selecting another member from VBE to join the VO. In such environment, the VO is said to evolve.

Fig. 6. Range of Trust Values Variation

The implementation of the standard deviation model, employing real case example with real indicators, was done in Trust Sustainability and Evolution (TrustSEv) system; which is not part of this paper.

4 Conclusion

This paper has presented models that can be applied to develop approaches for rational trust assessment in VO whose collaboration is already in progress. The VO partners need to sustain their levels of trust and undergo evolution if need arises. Since the assessment model for trust assessment during VO formation is insufficient to address trust evolution during VO operations, then devising new approach is promising. The paper has compared three statistical models namely; mean estimation, mean deviation and standard deviation that each is suitable for different cases. The mean estimation is suitable for dropping partners whose performance in terms of trust level is below the mean.

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Sustainability Issues

A Model to Realise Sustainability in Networked Production and Transportation

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Abstract. Cost optimisation in decentralised, make-to-order production systems requires tight integration with suppliers and transport operations as well as flexible network connections. Additionally, minimisation of environmental impacts of freight flows must be included in the industrial practice to realise sustainable growth. To these aims, the paper presents a model integrating production networks and sustainable freight transportation. The model includes Bill-of-Material constraints with alternative sources having different production and distribution costs. The objective function considers sourcing, production and transportation costs as well as environmental impacts of transport over a multimodal network. Due dates and time windows constraints for production and transportation management are included. Computational experiments are based on a real multimodal network. The optimisation model solved the case study instance. A sensitivity analysis proved the model robustness. The results demonstrate that the model can be effectively used in order to analyse cost-emissions trade-offs and the influence of links' capacity on emissions.

Keywords: Production Network, Transportation, Sustainability, Optimisation.

1 Introduction and Background

Competitiveness and sustainability are key drivers for designing and managing global production networks. Current challenges for networked production are then to stay competitive by optimising system-wide costs and service levels as well as to minimise negative impacts of freight transport on environment and society. These objectives are often separately pursued or only partially integrated in research approaches as well as in planning tools used by industry. It becomes imperative to completely include and widely spread in the industrial practice effective methods and tools dedicated to the simultaneous fulfilment of both business and sustainable growth targets. The

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 559–568, 2013.

aforementioned objectives should be pursued not only at strategic level (network design) but also in the management of day-to-day operations.

To these aims, the article presents a model integrating production networks and sustainable freight transportation. The optimisation model includes Bill-of-Material (BOM) constraints with alternative supply sources having different production and distribution costs. The objective function concurrently considers sourcing, production and transportation costs as well as the environmental impact of transport over a multimodal network. Multimodality is represented through a specific graph model. Due dates and time windows constraints for production and transportation management are considered. Computational experiments are based on a real multimodal network.

The integration of production and transportation networks has been tackled in several optimisation problems for the minimisation of supply, production, inventory, facility, and transportation costs by using formulations based on multi-commodity production-distribution [1]. Reviews and classifications cover the design process of production-distribution networks [2], as well as models and algorithms for production and outbound distribution scheduling in make-to-order production systems [3] and the integration of production and distribution problems in global supply chains [4]. Only a few research works include the freight flow constraints related to the BOM in the Mixed Integer Linear Programming (MILP) formulations that have been used [4], [5]. Only a few works attempted to simultaneously pursue routing and scheduling material flows while minimizing the environmental impacts [6], [7]. In these networked production scenarios little evidence has been identified about the sourcing options from alternative suppliers. Environmental sustainability has been generally addressed in terms of CO_2 emissions as well as other impact parameters encompassed in the objective functions [6], [7], [8], [9].

MILP, multi-objective programming and other analytical models have been used for designing sustainable logistic networks considering, respectively, uncertainty factors [10], environmental performance and cost efficiency of the logistics networks [11] as well as carbon footprints in supply chains [12]. In these works, BOM constraints, sourcing options as well as transportation planning are not included.

In general, a multimodal transportation problem can be modelled through a multi-commodity capacitated network design problem [13]. Nonetheless, another fundamental formulation is the multimodal, multiple capacity constraints, and multiple time windows transportation problem (M++P) [14]. This model constitutes the foundation of other research works that integrate short haul and long haul freight transportation problems [15].

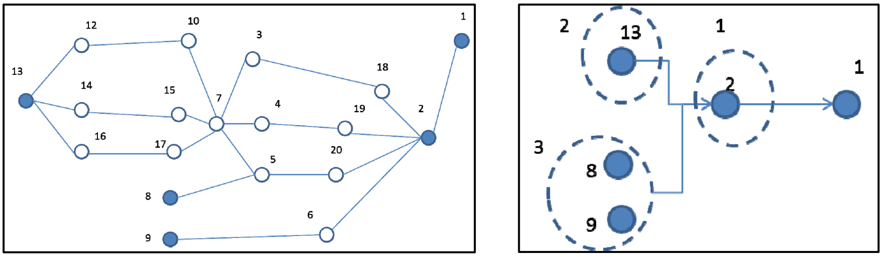
On the basis of the literature review, it seems that research lines faced the management of freight flows across production and logistics networks with the prevalence of specific perspectives and focus, in production, transport or environmental impact performance, or partial combinations of these targets.

2 Problem Definition and Methodology

The problem is to determine the combination of production sites and multimodal routes over an integrated production and transportation network that concurrently minimises the total production and supply costs according to the BOM requirements, the transportation costs as well as the CO_2 emissions of transportation means used to move materials, semi-finished and finished products. The time window constraints represent, at operational level, the output of a negotiated production scheduling process in a manufacturing network as performed in [16].

2.1 Production Network Model

The proposed approach considers a production network model in which components are produced and assembled in different plants in order to build the required final product. In the network depicted in Fig. 1a, coloured nodes represent production and assembly centres, while white nodes represent intermediate logistics nodes. When the customer in node 1 issues an order for a final product, a shipment for the final product is associated from the node 2 to the node 1. Under the hypothesis of a “make-to-order” or “source-to-order” [17] production model, upon each request of final product k from an origin o_k (node 2 in the Fig. 1a) to a destination d_k, and under the hypothesis of zero inventories for intermediate and final products, correspondent orders for the components to be produced or assembled upstream in different locations are issued.



a. Production and logistics network

b. BOM with alternative sources

Fig. 1.

2.2 Integration of BOM and Suppliers in the Production Network

In order to consider the assembly relation among the different product flows in the network, a representation of the BOM must be associated to the production and logistics network. The production/assembly nodes in Fig. 1a are put in a “BOM relation” as in Fig. 1b and must be considered in the mathematical model as flow and time constraints. The representation should consider also alternative sources for the same component in a specific position of the BOM.

2.3 Integration of Transportation Impacts

The approach considers multimodality in shipments. Transportation modes are drawn at graph level as done in [6], [14], [15]. Each physical arc is duplicated to represent a single mode of transport. Mode changes are modelled by duplicating nodes and drawing virtual arcs representing the modal change. This choice allows separating the costing and the sustainability considerations for each transportation mode.

Different approaches are used for considering sustainability factors in logistics and manufacturing modelling. Sustainability factors are considered in our model at objective function level. The objective function must minimise both transport costs and emissions that are produced by vehicles. A sustainability factor comes from the CO_2 emissions of each transportation vehicle. The emission factor e_{ij} is associated to each arc $(i,j)\in A$ of the network (i.e., to each transportation mode).

2.4 Solution Approach

As described in [13], a multimodal transportation problem can be modelled as a multi-commodity capacitated network design problem defined on a directed graph $G = (N, A)$ where a set of commodities (shipments) K have to be routed according to known demands and a set of facilities have to be installed on arcs (arc-based formulation). This model was used in different variants in order to solve transportation problems over integrated networks for short-haul and long-haul freight transport (see, for instance, [14], [15]). In the proposed approach, arcs and nodes are replicated in order to have a single arc for each multimodal transportation mean (e.g., a specific scheduled rail service). With respect to the mentioned formulations, K commodities are originated from specific, different sources according to the hierarchical product decomposition included in the BOM. The synchronisation of inbound and outbound freight flows is imposed through appropriate constraints in order to make materials and components available in a production plant for the final assembly. Different transportation means are made accessible between each pair of nodes by replicating the arcs corresponding to each available transportation service. A transportation service is a capacitated, single modal transportation operation that can be carried out in a specific time window. The optimisation procedure simultaneously minimises both the sourcing costs and the transportation costs including the contribution of the environmental impact.

For each node $i \in N$ let $\Delta^+(i)$ the nodes $j \in N$ such that $(i, j) \in A$ and $\Delta^-(i)$, the nodes $j \in N$ such that $(j, i) \in A$. $\bar{k} \in K$ be the shipment of the final product. Time windows are defined as $[a_i, b_i]$ for each $i \in N$ while $[E, L]$ is the earliness and lateness of the problem. Let moreover s_i the service time at node i, for each $i \in N$; t_{ij} the time needed to traverse an arc $(i, j) \in A$; w_{ik}, $i \in N$, $k \in K$ the arrival time at node i for shipment k; x_{ijk}, $(i,j) \in A$, $k \in K$ equal to 1 if shipment k uses arc (i, j), 0 otherwise. Other parameters of the model are: M, a large constants; q_k the quantity of shipment $k\in K$; C_{ij} the capacity of arcs $(i,j) \in A$; c_{ij} the cost of traversing arc $(i,j) \in A$; f_i the activation cost of node $i\in N$; p_i the production cost of node $i\in N$; $\alpha, \beta : \alpha + \beta = 10$ the weights for cost and emission factors in objective function.

In the proposed model, the k shipments are linked due to the BOM structural constraints. To this aim we define a set $B \subset K$ x K containing the precedence constraints between shipments which define the BOM structure. A tuple $(h,k) \in B$ defines the shipment h as a requirement (a material or a subassembly) for the shipment k (a final product or a subassembly).

The model considers alternative sources (i.e., suppliers) for materials and assemblies. At each shipment $k \in$ K is associated a subset of alternative origin nodes $O^k \subset N$ in which the shipment can be produced. d^k $k\in K$, is the destination node for shipment k while I^k are the subsets of intermediate nodes for shipment k with $I = \cup I^k$. The following relation between origins and destinations can be stated:

if $(h, k) \in B \Rightarrow \exists\, d \in O^k \;:\; d = d^h$.

Therefore, the origin of the shipment k corresponds to the destination of the shipment h. At each node $i \in O = \cup_{k \in K} O^k$, a fixed activation cost f_i and a variable production cost p_i are defined, while a production cycle time for node i is defined as r_i.

The integrated model can be formulated as follows:

$$\min\ \alpha[\sum_{k\in K}\sum_{(i,j)\in A} c_{ij}x_{ijk} + \sum_{k\in K}\sum_{i\in O^k}\sum_{j\in \Delta^+(i)} q_k p_i x_{ijk} + \sum_{k\in K}\sum_{i\in O^k}\sum_{j\in \Delta^+(i)} f_i x_{ijk}] + \beta[\sum_{(i,j)\in A}\sum_{k\in K} e_{ij}x_{ijk}] \tag{1}$$

subject to

$$\sum_{j\in\Delta^+(o^{\bar{k}})} x_{o^{\bar{k}} j\bar{k}} = 1 \tag{2}$$

$$\sum_{i\in\Delta^-(d^{\bar{k}})} x_{id^{\bar{k}}\bar{k}} = 1 \tag{3}$$

$$\sum_{i\in O^k}\sum_{j\in\Delta^+(i)} x_{ijk} - \sum_{i\in\Delta^-(d^k)} x_{id^k k} = 0, \quad \forall k\in K\setminus\bar{k} \tag{4}$$

$$\sum_{j\in\Delta^+(i)} x_{ijk} - \sum_{j\in\Delta^-(i)} x_{jik} = 0, \quad \forall k\in K, \forall i\in I^k \tag{5}$$

$$\sum_{i\in O^h}\sum_{j\in\Delta^+(i)} x_{ijh} - \sum_{j\in\Delta^+(d^k)} x_{d^k jk} = 0, \quad \forall h\in K, k:(h,k)\in B \tag{5'}$$

$$w_{ik} + s_i + t_{ijk} - w_{jk} \le (1 - x_{ijk})M \qquad \forall k\in K, \forall (i,j)\in A \tag{6}$$

$$w_{ih} + s_i + r_i - w_{ik} \le (1 - \sum_{j\in\Delta^-(i)} x_{jih})M \qquad \forall h\in K, \forall i\in D^h, \forall h:(h,k)\in B \tag{6'}$$

$$a_i(\sum_{j\in\Delta^+(i)} x_{ijk}) \le w_{ik} \le b_i(\sum_{j\in\Delta^+(i)} x_{ijk}) \qquad \forall k\in K, \forall i\in N \tag{7}$$

$$E \leq w_{ik} \leq L, \quad \forall k \in K, \forall i \in \{O, D\} \tag{8}$$

$$\sum_{k \in K} q_k \sum_{j \in \Delta^+(i)} x_{ijk} \leq C_{ij}, \quad \forall (i,j) \in A \tag{9}$$

$$x_{ijk} \in \{0,1\}, \quad \forall k \in K, \forall (i,j) \in A \tag{10}$$

The objective function (1) consists of four terms. The first term expresses the transportation cost. The second and third terms consider, respectively, production and activation cost, while the fourth term considers the emission factors (weighted with β, whereas the first three terms are weighted with α). Constraints (2) – (5') characterize the flow to be followed by shipment k without splits in the inner nodes. Constraints (5') states that a shipment h is activated only if the related shipment k is activated with $(h, k) \in B$. Constraints (6) – (8) guarantee schedule feasibility with respect to time considerations. The constraint (6') imposes time synchronization between shipments following the BOM definition. Constraint (9) guarantees feasibility with respect to capacity considerations while constraints (10) define the binary decision variables.

3 Test Scenario and Experiment Design

The network consists of facilities located in central and northern Italy. For the test purposes, a subset of facilities representing the major sources and destinations of freight flows has been selected. More specifically, they are the freight flows with the highest levels and importance travelling on the network from Lombardia and Piemonte regions (north-western Italy) to Lazio region (central Italy), through hubs located in Lombardia region (blue circle in Fig. 2) as well as Emilia Romagna region (green circle in Fig. 2).

According to the BOM representing, e.g., the assembly of kits for the telecom market, four facilities and nine modal transport connections are considered in the test instances. Transportation costs consist of a fixed and variable component dependent on the distance to be covered. The maximum distance from an origin to a destination is approximately 700 Km. Additional service times represent transhipment between different transport modes or vehicles. The transport modes considered are road and rail. The CO_2 emissions are expressed in Kg CO_2/Tonne-Km.

The model has been also used to quantify the impact of links capacity on transportation costs and emissions. To this aim, restrictive link capacity constraints have been set for the connection of the shipments related to components and materials (not for the final product) and allowing flow splits (x_{ijk} not integer). Under these settings, the objective function can be used to evaluate investments in link capacity in order to reduce transportation costs and emissions. Regarding the solution approach to the presented optimisation problem, a solver has been used.

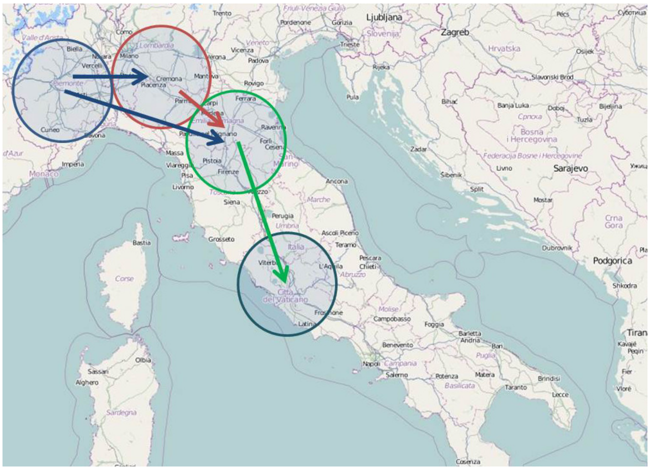


Fig. 2. Test scenario

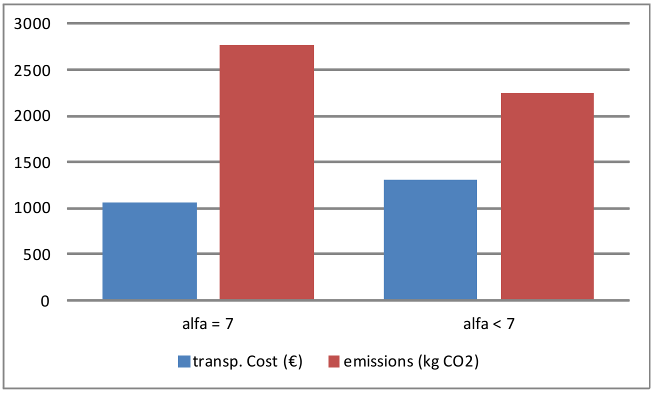


Fig. 3. Transportation cost and emissions

4 Computational Results and Discussion

The model has been implemented on IBM ILOG CPLEX Optimization Studio®. The case study presented in this paper consists of a production network of 19 nodes, 22 arcs, 3 shipments, with 1 shipment having 2 alternative sources. This case study was solved in 0.37 seconds on a windows PC with Intel® Core™ 2 Duo T5750 2.00 GHz processor with 4 GB RAM. In the case study, the incidence of transportation costs on the production costs is lower than 5%. Moreover, since the alternative sources have similar production costs, the solver selected the node 9 (see Fig. 1b) as the best source alternative. Different sensitivity analyses have been conducted. The most important is related to the tuning of the weights for transportation costs and emission factors (α and β). The results (see exhibit in Fig. 3) demonstrate that it is possible to obtain a maximum reduction in CO_2 emissions of 19% if compared to the case where only transportation and production costs are considered. On the other hand, this emission reduction corresponds to an increase in transportation costs approximately equal to 23%. The model can be effectively used in order analyse the desiderated trade-off between cost and CO_2 emission.

Concerning the experiments related to the modification of capacity of links and implications in terms of environmental impacts, Fig. 4 shows a simulation which demonstrates the tight connection between link capacity and CO_2 emissions. More specifically, this experiment suggests that the introduction of more stringent constraints on the capacity of the links leads to the selection of alternatives paths over the network in order to move the requested quantities. In fact, the increased material flows entail an increase in the emissions due to solutions that tend to allocate the shipments to modes with higher environmental impacts (e.g., road mode) or to paths with longer distances. Therefore, this type of experiment can be used for evaluating potential adjustments of link capacity on the most critical arcs. This could be carried out both in terms of (*i*) further development of logistics and transportation infrastructures as well as (*ii*) increase in the number of transportation services with lower environmental impacts on specific paths.

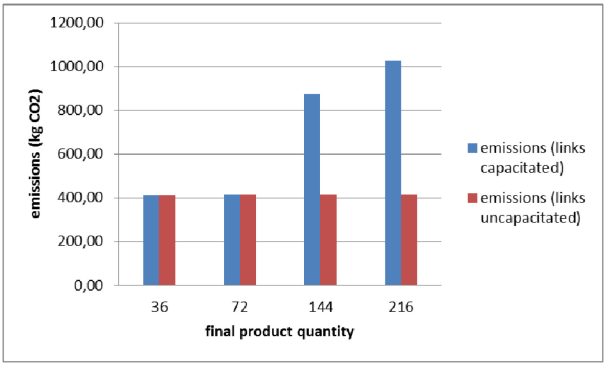


Fig. 4. Emissions and link capacity constraints

5 Conclusions and Future Research

This work presented a methodology integrating production and sustainable freight transportation in a production network including BOM constraints and multimodal connections. A MILP model effectively solved the presented case study and the sensitivity analysis demonstrated the model robustness. Moreover, the model can support the evaluation of the capacity of the network or sub-networks that may lead to lower environmental impacts of freight transport operations.

The main limitations of this work concern the solution of large instances and the inclusion of capacity constraints at sourcing level together with issues related to make-to-order systems. Regarding the former aspect, the model can encounter difficulties in solving large instances over highly detailed networks due to the complex graph representation. This entails the need to elaborate in future research tasks a smarter solution approach able to reduce the complexity of the problem or by decomposing the model, as performed in [18]. Concerning the latter limitation aspect of the work, the study has been conducted by focusing on a robust, integrated model with a degree of complexity compliant with the purpose of the development step of this research. The choice of the production model setting has been made in order to limit, at the current stage of the research, the complexity of the inclusion in the model of inventory level issues. The current research stage considers the hypotheses that the required materials or components are available at the suppliers' sites and no inventories are available at the production and assembly sites of the final products. Therefore, future developments of the research may consider the increase of the model complexity degree by including further elements (e.g., in terms of supply capacity, production lead-times, depth of penetration of customer orders) useful for improving the decision-making in make-to-order production models (see, for instance, [19], [20], [21]).

Future works may also consider the use of cross docks, inventory as well as reverse flows of materials in closed loop supply chains. From the solution approach viewpoint, the implementation of metaheuristics or alternative methodological approaches will be possibly considered.

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Environmental Concerns in the Design and Management of Pallets

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Abstract. Planning for sustainable reindustrialization necessitates considerations for environmentally sustainable production processes, packaging and logistics. Pallets are essential for the movement of goods around the world. Millions of pallets enter the global supply chain every year and are used, reused and either discarded or recycled. Since billions of pallets of different types are in use at any time, minimization of overall environmental impacts can be achieved only through process improvements and careful consideration of pallet types for various activities. The paper reviews the current management practices with respect to pallets and identifies issues in different points of the life cycle.

Keywords: Pallet life cycle, pallet management, environmental sustainability, stakeholder theory.

1 Introduction

A recent observation by John Mead, the previous Chair of the International Organization for Standardization (ISO) Technical Committee (TC) 51, *Pallets for unit load method of material handling*, provides an useful context for the discussion in this paper: “Although pallets are largely taken for granted, these humble, flat, structures can be said to form one of the basic blocks of global supply chains. Billions are currently in existence, a mark of confidence based on 50 years of worldwide experience” ([1], p. 18). His comments highlight two important issues that have an impact on resource scarcity and sustainable landfill usage considerations: pallets are an indispensible component of global trade and millions of pallets enter the global supply chain every year. As various arguments over the environmental impacts of different types of pallets and management practices continue to rage within the pallet industry, there appears to be a growing volume of information in support of all sides of these arguments. Practitioner driven pallet life cycle assessments have served to add more confusion to these arguments. However, there is limited independent academic research that could provide some informed guidance for business decision makers. While there has been a recent attempt at modeling the cost and environmental

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 569–576, 2013.

trade-off for companies when selecting pallets [2], the model does not address the complexity of relationships between various stakeholders and the diversity of conditions influencing pallet choice and usage practices. In practice such choices may be driven by the regulatory environment and the dominant exchange/ pooling services in the region, and there may be a range of issues associated with subsequent management practices. This paper outlines key practices around the globe in relation to different stages of the pallet life cycle and discusses their environmental implications while highlighting the roles played by different stakeholders.

2 The Pallet Life Cycle and Environmental Concerns

2.1 Pallet Design and Manufacturing

Pallet design and associated innovation needs to be guided by the needs of key players along the supply chain. In essence, a shipper's choice of pallet is informed by the weight of the product, the environment through which a product will travel and the types of vehicles that will be involved in moving the pallet load [3]. A pallet buyer must also consider the standard pallet sizes used in a particular industry and in different international destinations [4]. To facilitate shipping between major trading regions, ISO/TC 51 has defined six sizes of pallets in the standard ISO 6780:2003, *Flat pallets for intercontinental materials handling – Principal dimensions and tolerance* [1]. Thus evolution in pallet manufacturing has involved the adoption of a variety of materials and designs.

Pallet buyers are faced with an increasing number of options whose environmental impacts need careful consideration. Wood (see Fig. 1) remains the material of choice for pallet design (estimated to be used in over 90% of applications around the globe) but plastic pallets have been gaining in popularity because of their durability and light weight [1]. A debate continues to rage over whether wood (which requires the felling of trees) or plastic (created from a non-renewable resource) is the more eco-friendly raw material [5]. However, wooden pallets are seen to have an advantage over plastic in terms of the carbon dioxide emissions during the manufacturing process. There are other considerations in the wood versus plastic debate. The requirements outlined in the International Standard for Phytosanitary Measures 15 (ISPM 15) imply additional costs for shippers with the inclusion of processes such as heat treatment or fumigation of wooden pallets [6]. This makes plastic pallets an attractive option for shipping time-sensitive products which could be affected by delays in the certification of wooden pallets. As more buyers consider plastic pallets, there is likely to be an increased focus on the flame retardant capabilities of these pallets and the adequacy of sprinkler systems in existing warehouses [3]. However, chemicals added to give plastic pallets their flame retardant quality may turn out to be toxic in nature. The plastic pallet company, Intelligent Global Pooling Systems (iGPS), for instance, recently reached a voluntary agreement with the US Environmental Protection Agency (EPA) to end the use of the chemical decabromodiphenyl ether (DecaBDE) as a flame retardant in its pallets over a period of three to four years [7]. The EPA was concerned by the persistent and toxic nature of the chemical and the possibility of it leaching into food carried by iGPS pallets.

Fig. 1. A single-use wooden pallet (European size: 1200 mm X 800 mm X 150 mm). (Source: Second Author).

The cost and shortage of wood in Asian countries have also led to an examination of other options [1]. Corrugated paper pallets for lighter loads and pallets made from reconstituted wood are other options. Lightweight aluminium pallets have also become a reliable option. The arguments in favor of steel pallets that are coated to prevent rusting are similar to those for aluminum pallets: light weight, durability and recyclability at the end of a multiyear life [4].

2.2 The Working Life of a Pallet – Pallet Use, Reuse and Repair

Pallets may be custom sized according to user requirements and designed for single-load use [1]. However, the reuse of general purpose pallets is a more cost-effective and environmentally sustainable solution. While both wooden and plastic pallets can be repaired several times during their working life, the former are easier to repair [5]. The ISO standard (ISO 18613:2003) specifies the maximum defects allowed before a flat wooden pallet needs to be repaired; however, the responsibility for carrying out appropriate inspection processes and ensuring the safety of reused pallets lies with companies that maintain pallet pools [1]. A range of practices have been developed across the globe in relation to pallet reuse.

Pallet use and reuse may occur between members of a designated industry group in a particular country or region. In the US, the Grocery Manufacturers Association (GMA) exchange pallets that constantly circulate between various owners with the ownership of a pallet being transferred with the product load [8]. In Canada, the Canadian Pallet Council (CPC) provides a pallet exchange system (a pool of about seven million distinctive orange hardwood pallets) for its 1200 pallet-user members. While initially created in 1977 on the basis of pallet ownership, the CPC now provides pallet rental, repair and retrieval services through its pallet industry members. Its services also include the provision of online asset management tools. In

Europe, the European Pallet Association (EPAL) was formed in 1991to maintain a Europe-wide exchange wooden pallet pool for the European Railways. Its membership includes users, producers, dealers, repairers and transporters. It undertakes regular inspection of pallets produced by EPAL licensed manufacturers.

Pallet reuse may sometimes be facilitated through partnerships between individual companies with different core capabilities The UK based building materials provider, CEMEX addressed the need for reuse by forming an alliance with packaging specialists European Logistics Management to ensure the collection, repair and return of pallets. Without such an arrangement these pallets would either have to be thrown or shredded. From the perspective of both CEMEX and its customers there were financial benefits from the implementation of such a system. The cost of wooden pallets had risen by 15% in 2007 and 20% in 2008 and the landfill tippage charges were increasing as well [9]. By the end of the first year the company claimed to have recovered 20% of the 250,000 pallets sent out to customers.

With the growth of pallet pooling services, it has become less of a necessity for suppliers/ manufacturers to buy and own their own pools. Pallet pooling service providers such as CHEP, iGPS and Loscam provide similar services which involve issuing pallets to manufacturers or growers, collection of empty pallets from downstream supply chain partners and performing inspections and repairs of the returned pallets. The pooling process has its share of problems as highlighted by this recent court case in Australia between the hardware chain Bunnings Warehouse and CHEP Australia : “In May 2010, Justice McDougall in the Supreme Court of New South Wales ordered Bunnings to pay $11 million in damages to Chep for conversion and detinue of 64,690 pallets it had unlawfully detained over a five year period……This is despite the fact that during that entire time, a customer of Chep (whomever that may be) was paying hire charges for precisely the same pallets” [10]. Inadequate auditing of pallets remains a common occurrence within the pallet hire industry in Australia. As illustrated by the judgement in favour of CHEP, such incidents can prove to be quite costly for pallet hirers and companies that exchange pallets with them in the course of their normal business processes. John Stuart, owner of the Melbourne based consultancy firm Pallet Loss Prevention Pty Ltd, aptly summarizes the problem: “If someone doesn’t transfer their pallets off their account into your account, they will lose them… Pallet controllers on the receiving end can see that they haven’t put their transfers through. Standard practice at the moment is not to tell them because everybody is losing pallets, so they can’t afford to tell anybody else… Pallets are like a black art. People don’t understand how easy it is to lose pallets. When you lose pallets, if you don’t realize, they keep on paying and paying the hire charges, in the hope they will get them back, and they don’t” ([11], p. 89). Although hire agreements are in place between pallet hire companies and hirers in Australia, the application of these agreements in the practices of companies that use hired pallets when conducting business with each other is fairly limited. The Pallet Hire Industry Code of Conduct (2010) has recently been developed for the local industry in Australia but this is voluntary. The use of appropriate software packages, much greater emphasis on the development of adequate internal policies and procedures for pallet control, better relationships between pallet controllers in adjacent companies in the supply chain and appropriate training for truck drivers transporting the pallets have all been suggested as potential solutions for addressing this problem [11]. In essence, for pallet pooling to continue to be an environmentally sustainable solution it needs to remain a cost effective option for different players in the supply chain. However, the right combination of people, process and technology in this context still appears to be eluding many companies.

2.3 The Working Life of a Pallet – Transportation

The more durable the pallet, the more trips it can make during its lifetime. While manufacturers of plastic pallets claim these are more durable than wooden ones [12] and others highlight the durability of aluminium and steel pallets (e.g., [4]), there is a lack of independent estimates regarding the number of trips that can be handled by pallets built from different materials. The fact that these pallets may be used for very different purposes also makes the comparison a complex issue. Two key sides of the debate iGPS (leading plastic pallets pooling service) and CHEP (leading wooden pallet pooling service) continue to disagree over the number of trips that their respective pallets can handle [5]. A significant issue in relation to pallet transportation is the weight of the pallet. It is argued that the transportation of plastic pallets requires the consumption of less diesel fuel since these pallets generally weigh only about half as much as wood ones. Apart from transportation needs associated with the working life of a pallet, the repair and reuse of pallets, discussed in the previous section, also implies the need for transportation of damaged pallets to repair locations and hence additional fuel consumption. CHEP claims to have minimized greenhouse gas emissions from repair related pallet transportation in the US by building service centres close to where their customers use these pallets [5]. However, there is inadequate research regarding the practices of pallet related service providers around the globe.

2.4 Pallet End-of-Life

There are issues to consider in managing end-of-life related issues as well. The disposal of plastic pallets is also problematic as plastic is not biodegradable and emits methane gas when it starts to decompose [5]. While wood does not have the same problem, landfill disposal of wooden pallets has become an unwelcome practice across many states and municipalities in the US (e.g., Buehlmann, et al., 2009). Recycling is increasingly seen as the acceptable option. Wooden, plastic, aluminium and steel pallets can all be recycled ([4]; [5]). A damaged wooden pallet can be used ground up and used to produce mulch or animal bedding. A plastic one can also be melted to produce a new plastic pallet, but there is an energy cost associated with this process. Recyclability brings other problems with it as well. Between November 2010 and May 2011 the Los Angeles County Sheriff's department has been reported to have recovered US$1.3 million in stolen pallets and reusable packaging [13]. Such thefts have been attributed to factors such as the lack of adequate security in larger stores and inadequate secure storage space in smaller ones and have been estimated to have cost businesses in the San Gabriel Valley around US$10 million per year. These incidents have led to lawsuits against some recyclers and highlighted the need for law enforcement authorities to work with recyclers to prevent the purchase of stolen plastics. This also suggests that the point at which a pallet is recycled may depend on issues other than ISO standards and inspection processes of pallet owners. While theft results in an obvious cost for businesses from which they are stolen, the repeated recycling of pallets has significant energy costs associated with it as well. These issues suggest the need for further research into the implementation of end-of-life solutions for different types of pallet in the context of business practices in different industry sectors, law enforcement and regulatory environments.

2.5 Pallet Life Cycle Assessments

Both CHEP and iGPS provide online calculators in a bid to assure customers of their green credentials. Both have commissioned studies by independent consultancy firms to make their respective cases. The report developed by Franklin Associates for CHEP concluded that CHEP's pallet pooling systems "produce much less production waste and recycling/disposal waste than exchange and one-way systems because of the high material efficiencies and controlled end-of-life management for CHEP pallets" ([8], p. ES-5). Another life cycle assessment by consultancy firm Environmental Resources Management for iGPS concluded that, "iGPS plastic pallet had lower environmental impacts in all impact categories compared to the typical pooled wooden pallet, and a substantially smaller environmental footprint than the single-use pallet" ([14], p. ii). A subsequent study by CHEP in 2009 suggested that wooden pallets perform better than their plastic counterparts in relation to the generation of solid waste, energy consumption and greenhouse gas emission [16]. Clearly, independent studies which take into account a broader range of pallet types as well as industry and country/region specific pallet management practices could help to provide some clarity and better inform the decisions made by pallet hirers/owners.

3 A Stakeholder Theory Perspective

A useful theoretical perspective in this context is stakeholder theory which is built on the premise that effective firms need to manage all relationships that affect or are affected by the achievement of the objectives of the organization [17]. Broadening Freeman's [17] original conceptualization, Clarkson [18] defines the concept of primary stakeholders as: "Primary stakeholder groups typically are comprised of shareholders and investors, employees, customers, and suppliers, together with what is defined as the public stakeholder group: the government and communities that provide infrastructure and markets, whose laws and regulations must be obeyed, and to whom taxes and other obligations may be due" (p. 106). Stakeholder groups have been classified in a number of different ways in relation to issues such as power, dependence, reciprocity, legitimacy and actual and potential relationships. Synthesizing the relevant literature, Mitchell et al. [19] provide a comprehensive classification which identifies the following types of firm-stakeholder relationships: a firm and a stakeholder are in a non-trivial relationship (potentially of a transactional nature); stakeholder is dominant; firm is dominant; stakeholder and firm are mutually dependent; stakeholder and firm are in a contractual relationship (the contract is the basis for legitimacy); and stakeholder has an interest in the firm (legitimacy is not implied). While the development of stakeholder theory has taken a number of directions, the basic ideas of the influence of stakeholders on the firm and vice versa and the classification of different stakeholder groups could provide useful lenses for examining activities of different organizations involved in the life cycle of a pallet. Wal-Mart, for example, requires its globally distributed suppliers to complete a sustainability assessment [20]. However, the impact on the pallet management practices of upstream supply chain partners based on the environmental sustainability requirements of downstream players requires further research. Practices of government agencies around the globe are likely to vary from those of the EPA as well.

Pallet life cycle assessment appears to be an area where further work is required beyond the claims and counterclaims of dominant pooling services. Stakeholder influences on life cycle assessments has recently been discussed in the research literature in the context of oil and gas and agricultural biotechnology [21]. Similar considerations for greater stakeholder engagement could potentially enrich the analysis of pallet life cycles. Furthermore, broadening the concept of life cycle assessment to economic-ecological efficiency analysis and incorporating both environmental impact and costs/value added could provide greater value for pallet hirers.

4 Discussions

This paper highlights key practices and sustainability issues in the management of the pallet life cycle around the globe. While the diversity in pallet life cycle management practices poses many challenges, it presents a great opportunity for researchers to identify solutions that are sustainable in the long term. The authors are currently involved in modeling environmental impacts for different pallet types based on current pallet life cycle management practices and a number of data sources. The outcomes of the modeling exercise will be presented at the conference.

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Assessing Supplier Sustainability Using the Analytic Hierarchy Process

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Abstract. Supplier assessment is a relevant decision-making process that aims at monitoring the progress of suppliers in relevant performance aspects and, if results are worse than expected, establishing action plans to improve performance. The works developed for assessing supplier sustainability usually lack of proper structure to monitor supplier sustainability and mechanisms to weight and consolidate performance data into a global evaluation that allows deciding if the supplier is achieving its sustainability goals up to a proper degree. This paper introduces a methodology that fills this research gap and shows a case study in the automotive sector.

Keywords: collaborative enterprise networks, sustainability, performance, supplier assessment.

1 Introduction

Supplier assessment is a relevant decision-making process that enterprises must deal with. This process may comprise not only the initial stage, the supplier search and selection, but also the monitoring of the supplier performance evolution in the long term. The idea is to monitor the progress of suppliers in relevant performance aspects and, if results are worse than expected, it is possible to obtain the feedback in order to establish action plans to improve performance.

In a collaborative environment, there is a need to integrate the multiple linked processes of the supply chain/enterprise network in order to provide a sound execution of the activities that aid to achieve the strategic goals. In this context, assessing suppliers in key performance aspects for the enterprise network possesses a high value as any improvement in the performance of the supplier will positively impact on the performance of the network.

Achieving sustainability is a major issue for any collaborative enterprise network. Sustainability comprises several dimensions. The three sustainability dimensions, known as the triple-bottom line, are economic, environmental and social dimensions. However, other business dimensions should be considered when the purpose is to analyze the sustainability of suppliers that are to compete within collaborative enterprise networks, due to their specific nature. Such dimensions include aspects of

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 577–585, 2013.

managing collaboration relationships. This is an important characteristic as many enterprises have engaged in collaborative relationships despite the fact that proper understanding of collaboration implications is often overlooked causing collaborative relationships to fail. Then, the assessment of a supplier should include not only the evaluation of the sustainability dimensions but also the evaluation of the quality of the collaboration relationship. From a methodological point of view, it can be said that reducing all these dimensions into a single unit of assessment can be an issue. In fact, all these dimensions involve qualitative and quantitative factors so that the problem of assessing supplier sustainability can be defined as a multi-criteria decision problem. Specifically, this work uses the Analytic Hierarchy Process (AHP) multi-criteria method.

This paper proposes an AHP novel methodology for assessing the sustainability of suppliers that participate within collaborative enterprise networks considering four dimensions (three sustainability dimensions as well as collaboration relationship management dimension). With this tool, enterprises that are collaborating will have a tool to assess the most sustainable suppliers aligned with their own strategy and operations enhancing the supplier assessment process as well as their competitiveness in long term. The structure of this paper is as follows. First, a literature review of multi-criteria decision analysis methods applied for supplier assessment is presented focusing attention on the Analytic Hierarchy Process (AHP) method. Then, the multi-criteria methodology to assess supplier sustainability is described. After that, a case study showing the application of the approach within the automotive sector is presented. Finally, conclusions are exposed.

2 Background

Several methods have been proposed for solving the supplier assessment/selection problem such as vendor profile analysis (VPA), multi-objective programming (MOP), linear programming (LP), fuzzy set theory (FS), data envelopment analysis (DEA), analytic hierarchy process (AHP), genetic algorithm (GA), simple multi-attribute rating technique (SMART) as well as their hybrid approaches. The importance of this problem has been acknowledged in the literature and there are at least four journal articles reviewing the literature regarding supplier evaluation and selection models [1-4].

Assessment of potential suppliers involves both tangible and intangible criteria. This is because assessments of suppliers should not only consider quantitative performance data but also some other criteria that are critical for successful partnerships and are not directly quantifiable, e.g. trust and commitment [5]. Therefore, the AHP method developed by Saaty [6] is a useful method to select suppliers as it deals with both types of criteria. In addition, AHP aims at integrating different measures into a single overall score for ranking decision alternatives [7].

The AHP method has been previously used for supplier assessment under a wide variety of applications [8]. In [9], it is presented an integrated AHP and linear programming method for choosing the best suppliers and placing the optimum order quantities among them. In [10], it is proposed four different vendor assessment systems (VSSs) depending on the time frame (short-term versus long-term) and the content (logistic versus strategic) of the co-operative customer/supplier relationships using an AHP framework. In [11], it is proposed an AHP model for supplier assessment based on four groups of criteria: product development capability, manufacturing capability, quality capability, and cost and delivery. In [12], it is applied AHP in the field of project management to assess the best contractor to perform the project based on six criteria: experience, financial stability, quality performance, manpower resources, equipment resources, and current workload. In [13], a multi-criteria group decision making model for supplier ranking based on AHP is developed by combining group member's preferences into one consensus ranking. The criteria used to rate suppliers are quality, delivery, price, technical capability, financial position, past performance attitude, facilities, flexibility and service. In [14], an AHP model to structure SCOR (Supply Chain Operations Reference) model metrics to evaluate overall supplier efficiency is proposed. In [15], it is developed a model for supplier selection process using AHP. In [16], a multi-criteria supplier assessment procedure using AHP is presented. The first level criteria used to compare suppliers involve: supplier, product and service criteria. In [17], it is developed an AHP approach for virtual enterprise partner selection using the SCOR model and the AHP method. In [18], it is presented an AHP approach to select global suppliers according to five criteria: cost, quality, service performance, supplier profile and risk factor.

From the literature review, it is observed that there is not a specific model developed for assessing suppliers that integrates sustainability performance (in fact environmental and social dimensions are usually overlooked) as well as the collaboration relationship performance of suppliers. For this reason, the purpose of the remaining of this paper is to present a multi-criteria AHP methodology for supplier assessment that fills this research gap. With this approach, enterprises that are collaborating will have a tool to assess suppliers based not only on common performance data of suppliers (cost, delivery time, quality, etc.) but also on the other two sustainability dimensions (social and environmental dimensions) as well as the collaboration relationship assessment and, therefore, have a tool to improve their competitiveness in the long term.

3 The AHP Supplier Sustainability Assessment Methodology

The methodology is composed of seven phases (see Fig. 1). In the phase 1, the performance elements are defined in four perspectives (business/economic, environmental, social, and collaboration perspectives). It has to be noted that the business/economic perspective does not only cover the strictly economic aspects but also the rest of business ones as performed by [19]. In the phase 2, the AHP method is applied to build a model. The AHP method structures the decision problem in a hierarchy of levels. These levels are linked by unidirectional dependence relationships. In the upper level of the hierarchy, it is defined the ultimate goal of the decision problem. Then, the criteria that contribute to achieve the goal stand in the second level. Then, various intermediate levels may be modelled to represent different levels of sub-criteria. Finally, in the last level, the decision alternatives are established. The AHP method provides relative weights to each element within a level depending on its contribution to an element linked to it that is located on the immediate upper level. In our case, as we use the AHP model to obtain the weights of the performance attributes, we will have three levels (see Fig. 2): ultimate goal (supplier sustainability assessment), perspectives (criteria), and performance attributes (alternatives).

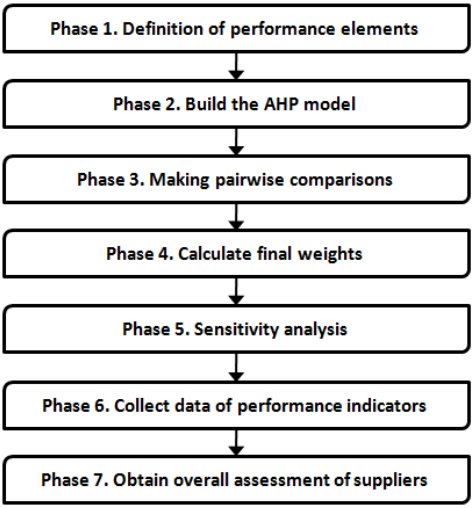

Fig. 1. Methodology phases

In the phase 3, following the application of AHP, pairwise comparisons are made within each level using the fundamental scale of Saaty [6], and the local priorities of the compared elements (priority vector) are calculated. Then, the final weights for the alternatives are calculated (phase 4). For that purpose, priorities of attributes are combined together with the sets of priorities of the performance perspectives.

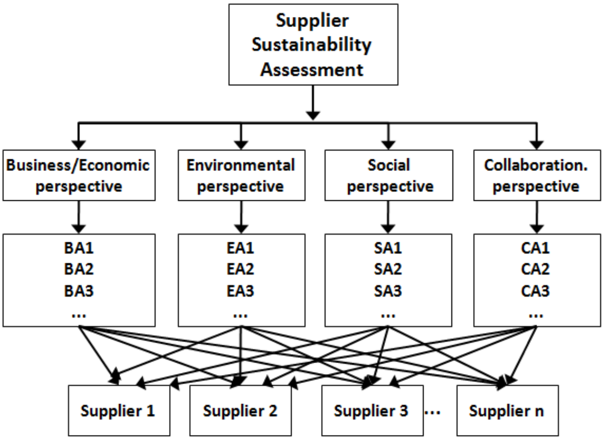

Fig. 2. AHP model for supplier sustainability assessment

Then, in phase 5, it is performed a sensitive analysis to check how changes in the local weights of one of the perspectives or attributes affect the final priorities previously obtained. The purpose of this phase is to verify that the solution obtained is robust enough. In case that the solution is not robust, it is needed to go back into the phase 3 to analyze the pairwise comparison matrices obtained. In phase 6, the data regarding the key performance indicators (KPI) is collected. Finally, in phase 7, it is obtained the overall performance evaluation by multiplying the priority of every performance attribute (given by the normalized priority) and the value reached in its corresponding key performance indicator. This overall performance evaluation has to be contrasted with a value defined as goal, if any, that will represent the degree of sustainability of suppliers to be reached (defined as a percentage of achievement).

4 Case Study

The methodology has been applied to the assessment of four suppliers of a multinational first tier supplier that supplies automotive parts to major OEMs. The four suppliers have been working with the enterprise for some years. The Purchase manager, Engineering manager and Quality manager were the decision-makers in the development of the methodology.

The first phase of the methodology consists of the definition of the performance elements for the four perspectives: business, environmental, social and collaboration perspectives. In this activity, managing directors have to reach an agreement on the main attributes to assess the suppliers. These attributes have to be in coherence with the strategic aspects that are followed by the enterprise and the collaborative enterprise network. Table 1 shows the performance elements (attributes and corresponding KPIs) defined for the business, environmental, social and collaboration perspectives. It consists of seventeen attributes and KPIs. For example, the first Business Attribute (BA1) is Cost and the performance indicator defined to measure it is the ‘compliance with sectoral price behaviour’ which is a parameter that translates the price offered by the supplier into a range [1-100] that specifies the price level of that specific supplier. The range [1-100] is established to homogenize the price of different types of products into a single scale, meaning 1=more expensive and 100=less expensive. Then, a supplier with a price of 50 means that that supplier offers an average price compared to its competitors. If the price is lower than its competitors, then the decision-makers will rate the supplier from 51 to 100. If the price is more expensive, then, the decision-makers will rate the supplier from 1 to 49. Among the measures defined, some of them have been translated into a similar scale to homogenize the assessments while other KPIs are directly measured such as KPI3 = % of parts delivered on time.

It took two meetings of 1.5 hours, what seems reasonable, to complete the list of attributes and KPIs for the four perspectives. During these meetings, a short definition of each attribute was obtained by consensus of the experts to be sure they understand the same concept. For that purpose, definitions for every attribute were provided from the literature. It has to be noted that qualitative attributes, e.g. trust and commitment, are evaluated as ‘perceived trust’ and ‘perceived commitment’ by the group of decision-makers.

Table 1. Performance elements for assessing supplier sustainability

Perspect.	Attributes	KPIs
Business	BA1 Cost	KPI1 = compliance with sectoral price behavior.
	BA2 Quality	KPI2 = conformance quality
	BA3 Delivery time	KPI3 = % parts delivered on time
	BA4 Product development time	KPI4 = time to market
	BA5 Flexibility	KPI5 = product-volume changes
	BA6 Innovation	KPI6 = Technology development
Environmental	EA1 Process controls	KPI7 = implementation of process controls
	EA2 Pollution prevention	KPI8 = product components and design
	EA3 Environmental Management	KPI9 = ISO 14 000 certification
	EA4 Supplier Environmental Management	KPI10 = ISO 14 000 supplier's certification
	EA5 Environmental practices	KPI11=environmental activities
Social	SA1 Employment practices	KPI12 = training programs
	SA2 Health & safety (H&S) problems	KPI13 = H&S incidents
	SA3 H&S implementation culture	KPI14 = H&S practices
Collaboration	CA1 Trust	KPI15 = Level of trust
	CA2 Commitment	KPI16 = Level of commitment
	CA3 Information shared	KPI 17 = Level of information shared

After building the AHP model and making the pairwise comparison matrices, in the phase 4, the weights of the attributes are calculated. The most important attributes representing around 68% of the total weight were: BA1 cost (with normalized weight of 0.14), BA2 Quality (0.13), BA3 Delivery time (0.10), CA1 Trust (0.09), CA3 Information shared (0.08), EA1 Process controls (0.07), and SA3 H&S problems (0.06). It is important to note that the critical attributes belong to all performance perspectives but the importance of the perspectives differ, being the business perspective the most relevant followed by the environmental and the collaboration perspectives. In the phase 6, the data of the KPIs is collected for all four suppliers. Table 2 and 3 show the assessments of the business and collaboration perspectives of supplier 1. Finally, in phase 7, it is obtained the overall assessment of all four suppliers. The analysis provided that supplier 2 (80% of achievement) was the one that reached highest degree of sustainability followed by supplier 1 (77% of achievement) and supplier 4 (72%). For the decision makers, values of overall sustainability below 70% mean a low level of sustainability. That is the case of supplier 3 that will need to improve considerably its ratings performance in some of the most relevant attributes (cost, delivery time, and information shared) if they desire to be kept in the supplier base. For those KPIs that have not reached the expected results, actions plans are to be developed which allow improving the current values. In general, sustainability performance has to be improved in all four suppliers in different attributes. This fact can be seen as an expected result as this is the first time in adopting and assessing the sustainability using this methodology and, indeed, this is the main purpose of its application: to be able to provide the key attributes that suppliers have to be focused in order to improve their sustainability. The enterprise has requested suppliers the definition of a global action plan as well as reassessment in one year to analyze the evolution of all four suppliers after implementing these action plans. It has to be noted that decision makers filled a questionnaire to assess their satisfaction where they agree with the approach and the results obtained.

Table 2. Assessment of business perspective of supplier 1

Perspect.	Attributes	Weight	KPIs	KPI value
Business	BA1 Cost	0,14	KPI1 = compliance with sectoral price behavior.	70
	BA2 Quality	0,13	KPI2 = conformance quality	80
	BA3 Delivery time	0,1	KPI3 = % parts delivered on time	92
	BA4 Product development time	0,05	KPI4 = time to market	90
	BA5 Flexibility	0,04	KPI5 = product-volume changes	70
	BA6 Innovation	0,05	KPI6 = Technology development	60

Table 3. Assessment of collaboration perspective of supplier 1

Perspect.	Attributes	Weight	KPIs	KPI value
Collaboration	CA1 Trust	0,09	KPI15 = Level of trust	80
	CA2 Commitment	0,04	KPI16 = Level of commitment	60
	CA3 Information shared	0,08	KPI 17 = Level of information shared.	80

5 Conclusions

In the recent years, many works have been developed for assessing supplier performance but usually they lack of proper structure to monitor supplier sustainability and mechanisms to weight and consolidate performance data into a global evaluation that allows deciding if the supplier is achieving its sustainability goals up to a proper degree. This paper has introduced a multi-criteria performance methodology that aims to fill this research gap. In addition, the paper has described a case study of an enterprise assessing four suppliers belonging to the automotive sector giving the main features in the development of the application of the methodology. Further research work will be focused on three main aspects. The first research line is to validate this methodology in other case studies of different characteristics and other sectors (for that purpose, a questionnaire will be completed by the experts to assess if they are satisfied with the methodology and the results obtained as was done in this first pilot). The second research line is to deploy further the connection between the methodology developed to assess suppliers and the performance measurement framework for the collaborative enterprise network and the individual enterprises performance measurement framework.Finally, the third research line is to develop similar multi-criteria methodologies using other multi-criteria methods in order to contrast the results obtained.

Acknowledgments. This work has been developed within the research project called "Integration of the sustainability indicators within industrial supply chains strategy by applying mathematical techniques (SP20120890)" funded by the Universitat Politècnica de València.

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Sustainable Collaborative Networks I

Reverse – Green Virtual Enterprises and Their Breeding Environments: Closed-Loop Networks

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Abstract. Green Virtual Enterprise Breeding Environments and their Reverse-Green Virtual Enterprises, as dynamic reverse supply networks, represent a promising paradigm to face the reverse logistics and end-of-life manufacturing challenges towards closed-loop industrial processes, closed-loop supply networks and sustainable industrial development models. This paper explores different collaborative product recovery business opportunities and strategies for capturing current missed value at the end-of-lifecycle with new activities, relationships and network configurations, put forward based on the disciplines of Industrial Ecology, Collaborative Networks and Lifecycle Management.

Keywords: Collaborative Networked Organisations, Green Virtual Enterprises, Breeding Environments, Industrial Ecology, Lifecycle Management, Reverse Logistics, End-of-Life Manufacturing, Circular Economy.

1 Introduction

Nowadays, customers and authorities are starting to demand that manufacturers and service providers minimise their environmental impacts of products and services. Customer pressures will continue rising in the coming years to the extent that a new generation of *green consumers* will get more and more concern about environmental protection. Government actions encompassing new legislations and law enforcement for environmental protection will also continue eco-restructuring the way industry operates. As a result, a new industrial environmental protection *action framework* is needed to shift from the exclusive tracking of economic objectives to a consideration of ecological and social objectives as part of a *new sustainable industrial development model* [1] [2]. Hence, there is a strong necessity to combine powerful concepts like: Industrial Ecology, Collaborative Networked Organisations & Lifecycle Management [3] to shift from linear industrial processes (open systems), in where resources move through the system to become waste, to closed systems where waste can become inputs for new processes, reducing in this way the impact on the natural environment.

Industrial Ecology (IE) can be used as an eco-efficiency strategy focusing on eco-restructuring the industrial processes by: optimising the use of resources, closing material loops and minimising emissions, dematerialising activities, and reducing and eliminating the dependence on non-renewable sources of energy [4]. Meanwhile,

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 589–598, 2013.

Collaborative Networks (CNs) at intra- (e.g. eco-factory and eco-service office) and inter-organisational (e.g. green supply network) levels can support the implementation of different IE strategies by creating sustainable business units and eco-systems as close as possible to being a closed-loop system by keeping a close interaction of material, energy, information and technology among their members towards a near complete cyclic flow and sharing of resources for producing and/or delivering green products and/or services to the market [5]. Furthermore, *Lifecycle Management (LCM)* can act as an "green" product lifecycle management tool, from the product Beginning-of-Life (BOL), including its design, engineering and production, passing thru its Middle-of-Life (MOL), counting its use, service and maintenance, and End-of-Life (EOL), characterised by various scenarios such as: direct reuse/resale, product recovery by: repair, refurbishment, re-manufacturing, cannibalization and/or recycling, and waste management by: incineration or landfill [6] [7].

In this paper, a *Green Virtual Enterprise Breeding Environment (GVBE)* model will be presented as an *integrated supply network* (collaborative forward and reverse supply networks) [5], supporting closing the loop at the end-of-life of any product, and creating a cyclic flow with the highest degree of resources circulation within an industrial system (e.g. industrial symbiosis[1]) and a product lifecycle (e.g. product up-cycling[2] or down-cycling[3]). Moreover, a *GVBE operational model* compromises not only the development and delivering in a sustainable way of a new product, but also its service provisioning, product recovery and waste management during its lifecycle. As part of a *GVBE extended producer responsibility,* products will return from the end-user to undergo a product recovery operation, and thereafter will be integrated back into a forward supply network; if not possible will be safely disposed.

2 Green Virtual Enterprises and Their Breeding Environments

A *Green Virtual Enterprise Breeding Environment (GVBE)* is a long-term strategic alliance of green enterprises and their related support institutions aimed at offering the necessary conditions to efficiently promote the sharing and recycling of resources such as: information, materials, water, energy and/or infrastructure with the intention of achieving sustainable development in a collaborative way. A *GVBE* it-self is an intelligent network for competences and resources management from different green enterprises aiming to combine their green capabilities to develop triple top-line strategies[4] to create sustainable value - thru *GVEs creation* [1] [2] [5].

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[1] *Industrial Symbiosis* - can be defined as an industrial ecology strategy, based on collaboration and synergetic possibilities, aimed at sharing/exchanging information, materials, water, energy and/or infrastructure (e.g. services) among industrial actors in order to increase economic gains and achieve sustainable development in an eco-industrial network [8].

[2] *Up-cycling* - is the process of converting waste materials or useless products into new materials or products of better quality or for better environmental value [9].

[3] *Down-cycling* - is the process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality [9].

[4] *Triple top-line strategies* - promote the establishment of sustainable business requirements as initial values rather than after the fact effects (vs. triple bottom-line) [10].

A *Green Virtual Enterprise (GVE)* is an emerging sustainable manufacturing and logistics networked enterprise model focused on offering, delivering and recovering green products/services to/from the market, under a lifecycle thinking and supported by its source network (a *GVBE*) [1] [2] [5].

Depending on its delivering or recovering goal, a *GVE* can be tailored to become a *dynamic forward supply network* for delivering new green products (virgin or used/ recovered) to the market, or a *reverse supply network* for recovering the products sold under the *GVBE brand* (product stewardship) for service provisioning, product recovering or safe disposal [1] [2] [5].

GVEs as *dynamic forward supply networks (F-GVEs)* are temporary alliances of green enterprises that come together in order to better respond the market demands through the most efficient use of their complementary skills or core-competences and shared resources, for developing and delivering in a sustainable way new products to the customer with a minimal environmental impact [1] [2] [5].

In this research work, authors will focus on the case of *GVEs* as *dynamic reverse supply networks (R-GVEs)* operating as temporary alliances of green enterprises that come together in order to better respond a business opportunity based on a sustainable reverse logistics and end-of-life manufacturing approach for recovering products, parts, subassemblies and/or scrap through the most efficient use of their complementary skills or core-competences and shared resources for their direct-use (re-use), repair, refurbishment, re-manufacture, recycle or safe disposal - within a *GVBE* (see Fig. 1)[1] [2] [5].

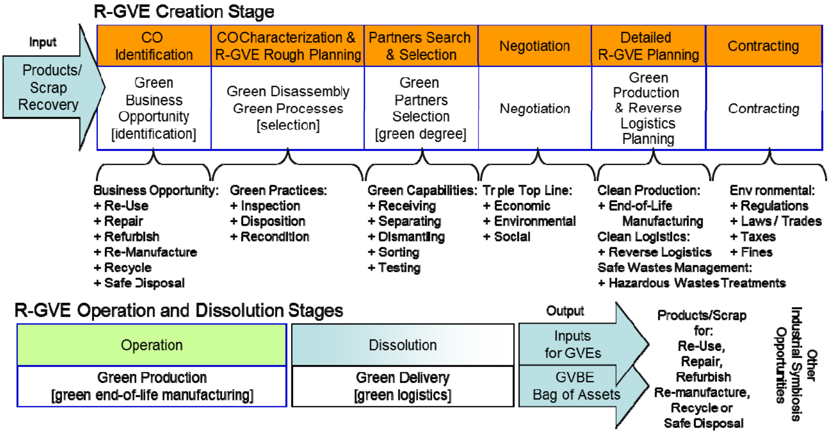

Fig. 1. Reverse Green Virtual Enterprise Lifecycle: Dynamic Reverse Supply Network

The *GVBE model potential* for closing the loop of products at their end-of-life arises from its ability to dynamically configure and launch *R-GVEs* according to a product lifecycle recovery needs and opportunities from/of the market and keep these *reverse supply networks* operational as long as these opportunities persist [1] [2] [5], suggesting a number of sustainable benefits when it comes to the uncertainties of return flows/returned products in order to recover as much of the economic and ecological value of a product, thereby reducing the ultimate quantities of waste [7].

3 Strategic Issues in Product Recovery Management and GVBEs

By analysing different *Product Recovery Management (PRM)* opportunities and their implementation challenges [7] [11], *GVBEs* represent a promising paradigm to face those challenges and overcome them towards *closed-loop industrial processes, closed-loop supply networks* and *sustainable industrial development models* [1] [2] [5].

Following sections will explore those opportunities and challenges, and propose different collaborative strategies to design *dynamic reverse supply networks,* named: *R-GVEs,* capable of managing in a sustainable way the uncertainties of return flows in a *closed-loop supply network,* and take advantage of new value creation opportunities such as: second-hand markets, improved customer service in case of defective product returns (e.g. warranties), under-utilised materials and products (e.g. up-cycling and/or down-cycling) and social-environmental responsibility (e.g. product stewardship).

Product Recovery Opportunities and Goal-Oriented Collaborative Networks. There are eight types of product recovery/disposal options or opportunities: (1) *direct reuse/resale* when a virgin product can be second-hand used for the original purpose it was designed or a different one, without going into a product recovery operation (e.g. old clothes, old home-appliances, old toys, old furniture… are resold and/or donated - sustainability goal: waste avoidance); (2) *repair* when a durable product is fixed and/or some of its broken parts replaced to return the used product to "working order" or functional condition state (e.g. fixing a computer or replacing an auto part by a spare-part - sustainability goal: waste reduction by extending product durability); (3) *refurbishment* when all critical modules of a durable product are inspected and repaired, replaced and/or potentially upgraded to recondition the product to a specific quality level or functional state (e.g. restoring or renovating an antique, a building, a vehicle, an electronic equipment - sustainability goal: waste reduction by extending product durability); (4) *re-manufacturing* when all modules and parts of a durable product (used and new) are inspected, repaired, replaced, potentially upgraded and tested to bring the product to "as new" quality level (e.g. air condition units, heavy duty equipment, vending machines… - sustainability goal: "like-new" products for a second life); (5) *cannibalisation,* in the past three product recovery options the product identity was preserved, but in the case when a product is *cannibalised* or *selectively disassembled,* some parts of the product will be retrieved/recovered for their use in repair, refurbishment and/or re-manufacturing activities and some other part will be recycled and/or disposed (e.g. a machines boneyard as a source of spare parts inventory - sustainability goal: waste reduction by used parts reutilisation); (6) *recycling,* as opposed to previous product recovery options, when recycling a product its identity and functionality will be lost, but its component raw materials will be processed to make the same raw materials or useful degraded materials available for use into new products (e.g. glass, paper, metal, plastic, textiles… sustainability goal: consumption reduction of "fresh" raw materials), (7) *incineration,* is a disposal method for a product based on combustion or thermal treatment to convert it into heat, gas, steam or ash (e.g. sustainability goal: waste-to-energy), and (8) *landfilling,* is the last resort and less desired disposal method based on burying the waste (e.g. sustainability goal: properly designed and managed landfills) [7].

Fig. 2 depicts an integrated view of the different *PRM opportunities* and *activities* that will trigger an *R-GVE creation* with the required reverse logistics and end-of-life manufacturing capabilities and capacities to repair, refurbish, re-manufacture/ cannibalise, recycle, or safe dispose a product. Considering the uncertainties in the timing, quantity, quality, composition and location of potential returned products from customers [7], the *R-GVEs dynamic creation* within a *GVBE,* offers a great opportunity to *GVBE members* (green enterprises[5]), on the one hand to close the loop in their supply chains based on a collaborative supply chain model, and on the other hand to explore new collaboration (business) opportunities based on creating value through product recovery (e.g. creating value from waste by recycling; delivering added-value thru function not ownership by repair, refurbishment and/or re-manufacturing; encouraging sufficiency by direct-use/re-use; and maximising resources efficiency by any of the previous).

PRM opportunities call then for innovative sustainable collaborative business models, and networked green enterprises, capable of unlocking new business opportunities at the end-of-lifecycle. The *GVBE model* [1] [2] [5] is the authors response to explore new collaboration strategies for capturing current missed value at the end-of-lifecycle with new activities, relationships and network configurations.

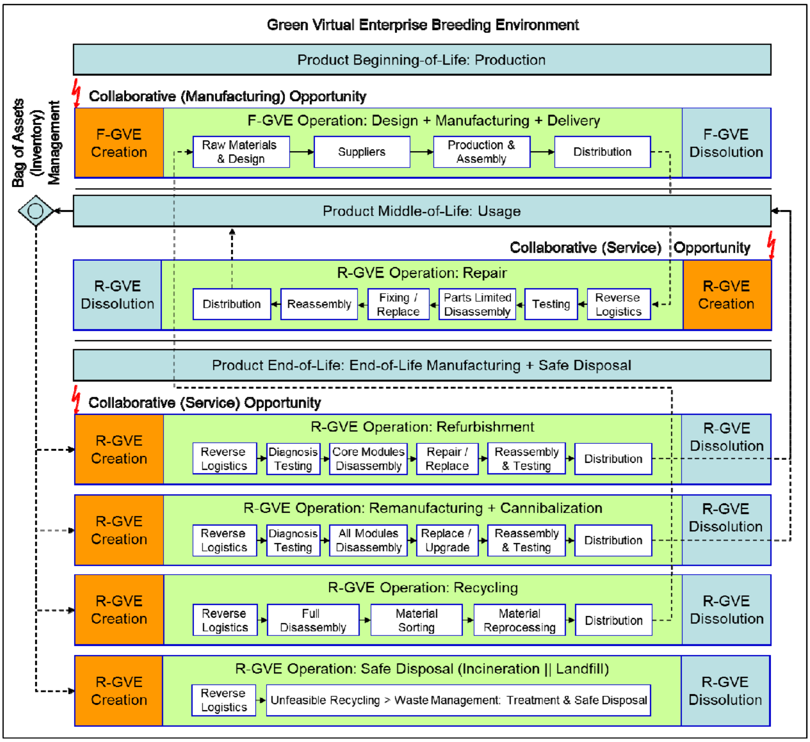

Fig. 2. Product Recovery Opportunities-driving R-GVEs Creation

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[5] *Green Enterprise* - is an enterprise that strives to meet the triple bottom line by ensuring that all its activities in its business operation address the sustainable principles [1] [2] [5].

Moreover, in order to generate new solutions that capture new value at the end-of-lifecycle, green enterprises need to achieve sufficient volume and cost-efficiency, flexibility and competency in their reverse logistics and end-of-life manufacturing activities. These requirements are often drivers for inter-organisational collaboration in industry, and authors approach based on *GVBEs creation* [1] [2] [5] puts forward the conditions and environment to support green enterprises to set-up their *closed-loop supply networks* by means of collaborative business infrastructures enabling multiple coordination and cooperation mechanisms like: shared commuting, shared shipping, integrated (reverse) logistics, joint product recovery operations, information exchange, etc. to create *closed-loop business ecosystems (F-GVEs + R-GVEs).*

Centralised vs. Decentralised Reverse Supply Networks: Why Not Both? *RGVEs* focus on responding to collaborative product recovery business opportunities. Returned products or product recovery opportunities can be recovered/emerge from *forward supply networks* due to warranties and/or unsold products, from market-driven streams based on "bring-back the old and take-back the new one cheaper" promotions, and waste streams from manufacturing discarded products due to quality and/or technical issues [12]. The uncertainties in the timing and quantity of returns are clear and call for diverse *reverse supply networks* configurations with different life-spans of existence in order to cope with the uncertain life of products.

For example, in some cases "responsive and decentralised" *reverse supply networks* may be needed to deal with high-time sensitive products (e.g. electronic equipment with a short-lifecycle as a result of high-speed technology grow) where a faster response to a product recovery opportunity is needed to capture the returned value effectively at the end-of-lifecycle and fast-track move on to resale on a secondary market for: (a) *products* in case of repair or refurbishment; (b) *components* and *parts* in case of re-manufacturing and cannibalization; or (c) *raw materials* in case of recycling. In other cases, "efficient and centralised" *reverse supply networks* may be required where the sense of urgency is lower and the focus is on the design of cost-efficiency *RGVEs* (e.g. functional and long-lifecycle products like household appliances) (see Fig. 3) [13] [14]. In this sense, *GVBEs* as *breeding environments,* underline the possibility of rapidly forming a consortium of green enterprises (an *R-GVE*) triggered by a product recovery opportunity and specially tailored to the competency requirements of that opportunity (e.g. capabilities, capacities, time, cost, quality, risk) and dissolve once their mission has been accomplished [1] [2] [5].

"Efficient and centralised" *reverse supply networks* use a postpone strategy or later product differentiation in order to achieve processing economies by delaying inspection, sorting, and disposition activities until the returned products are collected at a central location. Furthermore, "responsive and decentralised" *reverse supply networks* use an early product differentiation to maximise assets recovery and fast-track returns for disposition and 5R[6] or safe disposal (see Fig. 3) [13] [14]. *GVBEs* as long-term strategic alliances of green enterprises (e.g. manufacturers and logistics providers), geographically distributed, offer the possibility of collaboratively

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[6] 5R - Re-use, Repair, Refurbish, Re-manufacture, and Recycle.

managing a single or multiple bag(s) of (returned) assets[7], traditional named: shared warehouses and distribution centres, providing an agile and flexible (inventory) approach when warehousing volumes, returning times and 5R possible operations are uncertain [1] [2] [5].

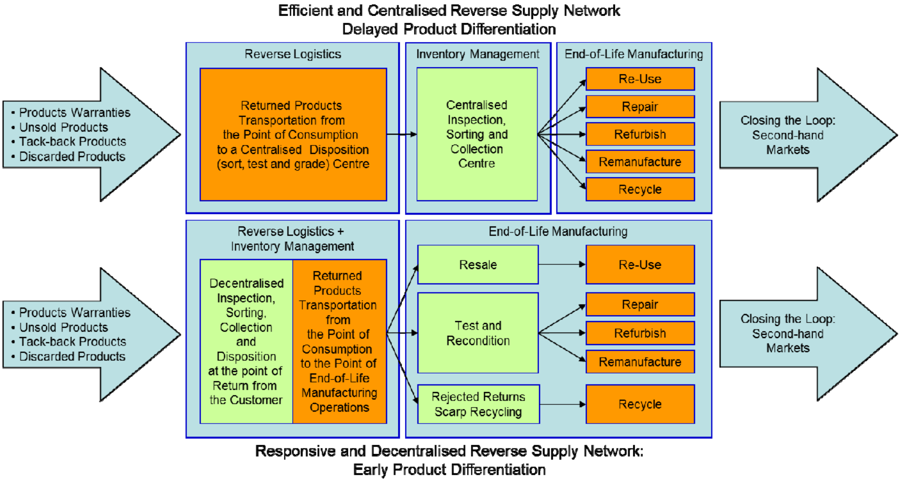

Fig. 3. Efficient-Centralised & Responsive Decentralised Reverse Supply Networks Adapted from [13] [14]

Information Management for Product Recovery Strategies and Net Design. *Reverse supply networks* or *R-GVEs* are created by a number of collaborating (legally) independent green re-manufacturers and reverse logistics providers in order to recover back products from the market. Their belonging to a long-term collaborative network such as *GVBE* offers those green enterprises the opportunity and time for developing a common ground for communication and information exchange for mutual benefit (e.g. collaborative ICT business infrastructures [see 15]). Recalling, *GVBEs* are aimed at offering the necessary conditions (e.g. human, financial, social, infrastructural and organisational) to support the rapid and fluid configuration of *F-GVEs* and *R-GVEs. GVBEs* mainly focus on creating an adequate environment for the establishment of cooperation agreements, common operation principles, common interoperable infrastructures, common ontologies, and mutual trust among others, with the objective of preparing their members to be ready to collaborate in potential *GVEs* that will be established when a collaboration (business) opportunity arises [1] [2] [5]. In this context, *GVBEs* cooperation atmosphere and *GVBE members'* preparedness for collaboration facilitates the reduction of information asymmetries and improves the alignment of potential *R-GVE partners,* emphasizing in the dynamic creation and operation of *information-driven reverse logistics networks.*

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[7] Bag of assets - is a common virtual and physical warehouse to make easier the share of tangible and intangible assets between GVBE members for different collaborative purposes [1] [2] [5].

Information management, starting from information creation to exchange and exploitation for decision-making, is vital for the process of common planning and scheduling of *R-GVE partners* activities in a *reverse supply network.* Efficient design of *R-GVEs* strongly depends on information available not only about the potential returned products but also the potential members available for joining a *dynamic reverse supply network* to tackle a product recovery opportunity.

Regarding product related information management, two strategies may be pursued: (a) a *product-centric information management strategy* based on treating a product as an "intelligent object" capable of creating (e.g. thru sensors and actuators), storing (e.g. in smart-tags) and sharing (e.g. using communication technologies) information about itself over its lifecycle [16]. In this strategy, *F-GVEs* will need to consider these product features as part of the product design and engineering in order to make the product entity the central repository and access point for its historical information, supporting in this way all information provision requirements for conducting middle- and end-of-life after-sales services and product recovery operations on the product, which will trigger the creation of different types of *GVEs* and help to characterise the collaboration opportunity in terms of its competency requirements when a product arrives to a service or recovery location [17], or (b) a *product-integration information management strategy* based on the integration of product-relevant information from multiple enterprise information systems (e.g. CAD, PDM, PLM, ERP, SCM, CRM) from all the product lifecycle stakeholders *(GVE partners)* to build a common database (e.g. knowledge repository): the *GVBE collaborative ICT business infrastructure* [15] - with the entire product historical information for data-mining it to forecast possible after-sales services and end-of-life product operations that will also launch the creation of different types of *GVEs* [17].

With respect to information on potential members of a *dynamic reverse supply networks, GVBEs integral management system* [18] offer a very complete set of information management systems covering: *GVBE members membership structure, profiling and competency information* [19], and *GVEs creation* [20] and *operation assistance information services* [21]. All these information management systems aimed at supporting the identification and characterisation of a product recovery opportunity, and a dynamic *R-GVE creation* and *operation,* including its partners search and selection, planning, set-up and operation, and dissolution management [20] [21].

Authors and [22] believe that by combining *products'* and *GVBE members' information,* better decision-making can be done to forecast and identify reprocessing lead-times for particular products, volume of returned product flows, possibilities for grouping products families (commonalities), locations of potential collection points (distribution points), waiting time for returns, volume of returns inventories in distributed locations, and availability of recovery services in order to better design *R-GVEs* and locate *GVBEs bag of assets* (shared warehouses and distribution centres).

Second-Hand Markets, Brokers and Green Consumers: Collaboration Again. *Reverse supply networks* also highlight the activity of "resale" of repaired, refurbished or re-manufactured products in second-hand markets in order to up- or down-cycle a product in a *Circular Economy* [2] [23]. Therefore, *GBVE brokers* [1], play a vital role in the identification and/or development of new collaborative product recovery business opportunities in the market. *GBVEs brokers* are perhaps the most important factor for successful and profitable *reverse supply networks* and *closed-loop supply networks.*

GBVEs brokers will be responsible for (re-)marketing the returned recovered products and negotiate with (potential) green customers thru different channels such as other re-manufactures (e.g. for product recovery cannibalisation strategies), green internet-based auctions, specialised retailers in returned products or second-hand products (e.g. outlets) among others [23]. Furthermore, *GVBE brokers* will leverage on the *GVBE sustainable industrial development model* for eco-branding and eco-marketing as well as for building a green strategic competitive advantage in a growing environmentally conscious market.

Moreover, in order to promote the acceptance of returned recovered products in the marketplace, *GVBE brokers* may promote the creation of *green consumer networks* around the *GVBE* aiming the creation and expansion of secondary markets.

Collaboration between green customers and green manufacturers is foreseen again by the authors as trend that will led the manufacturing industry to responsive (profit) actions to a growing demand for eco-friendly products, acceptance of products with recycled materials, and increasing market requirements for after-sales services and take-back programmes, stimulating the emergency of product recovery opportunities at the end-of-lifecycle: *R-GVEs creation.*

4 Conclusions and Further Research

Dynamic *R-GVEs* represent an intelligent integration of green enterprises' competences, best practices and technologies for responsive and efficient (hybrid) reverse logistics and end-of-life manufacturing activities in response to the challenges, but also emerging collaborative (business) opportunities for product recovery operations.

Future research aims the refinement and proof of concept of the *R-GVE - dynamic reverse supply network - model* introduced (a case study), and the study, development and validation of sustainable product recovery business models [24] for reducing waste, recovering value at the end-of-lifecycle, and improving profit in a *closed-loop supply network* and *Circular Economy.* The research work represents an exploratory work in progress aiming to create synergies between the *IE* and the *CNs* disciplines.

Acknowledgments. The research presented in this document is a contribution for the ECOLEAD Project (FP6 IP 506958), for the S-MC-S Project (FP7 NMP-ICT-FoF 260090), and for the ITESM, Campus MTY & CCM, Research Chairs.

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Promoting Remanufacturing through Collaboration

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Abstract. Remanufacturing is an ultimate form of recycling by manufacturing "good as new" products from used products. Through remanufacturing, materials and energy can be saved and less waste is produced. However, at present, the application of remanufacturing is common only in specific industrial fields and geographic areas. This paper describes challenges identified and discusses how collaboration and networking of companies can support the implementation of remanufacturing. In addition to cases described in literature, the study uses information collected from Finnish case companies operating in remanufacturing.

Keywords: remanufacturing, life cycle, collaboration.

1 Introduction

Remanufacturing is one form of product end-of-life strategies, often called 6R: reduce, reuse, recycle, recover, redesign, remanufacture [1], aiming for resource efficiency. Remanufacturing can be seen as an ultimate form of recycling: it re-uses more of the assets put in a product or a component than recycling: in recycling large amounts of energy and labor are lost [2]. The idea is not to refit the product or product part for the same user but systematically take back end-of-life goods and re-use them or their components for new users.

There are several definitions for remanufacturing, for example:

"recycling by manufacturing "good as new" products from used products" [3],
"the process of restoring a non-functional, discarded, or traded-in product to like-new condition" [4].

Remanufacturing is one form of so called "circular economy", defined as "*an industrial system that is restorative or regenerative by intention and design*" [2]. Circular economy is not based on consumption but on restorative use. A recent report [2] reviews the potential of circular economy from a European viewpoint and estimates enormous potential for savings at the European level and new innovation potential to realize the circular economy. Thus it can be seen as one path to reindustrialization in Europe.

Remanufacturing has been performed in some form for decades but as an industrial activity it is well known mainly in specific industrial fields and few geographical areas, like photocopier, printer and camera industry in Japan [5], motor vehicle parts, electrical components, industrial machinery and office furniture industry in USA [4] and car industry in Germany [3]. Currently, as the awareness and interest in ecologic

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 599–608, 2013.

sustainability is growing, also remanufacturing is achieving more attention. In Europe interest for remanufacturing is highly linked to the European requirements of recycling in car industry. In China remanufacturing is still in the primary stage but there is political pressure to grow in this area [6].

To move from small-scale remanufacturing to industrial remanufacturing, radical rethinking of physical products, their lifecycle and the production and service system as well as the creation of totally new operations and value networks is needed. Chapter 2 presents the background of this paper. Chapters 3-4 describe the benefits and challenges of remanufacturing, both based in literature and commented with the Finnish case company experience. Chapter 5 describes the remanufacturing processes and how collaboration and networking between enterprises could support overcoming some barriers. Chapter 6 gives the conclusions.

2 Research Context and Approach

In Finland a research programme “Green Growth” was started by the national research funding organization Tekes in 2011. The aim of the programme is “to identify potential new growth areas for the sustainable economy business, which are essentially based on lower energy consumption and sustainable use of natural resources” [7]. Within this programme, in 2012, project DemaNET was started. DemaNET comes from “Dematerialization and Sustainable Competitiveness through New Models for Industrial Networking”. One of the focus areas of the project is remanufacturing. The aim is to study how remanufacturing can best be applied in Finnish industry. The project is participated by ten industrial companies which have interest for sustainability and part of them specifically in the remanufacturing business. The companies are on different application levels. Four of them have currently some commercial remanufacturing activities; one of them just started a new remanufacturing factory for specific product components. In future the companies may also act in different roles: One of them is looking for partners to develop the activity in a specific region; as an SME it is not able to perform remanufacturing alone. One of the companies is a potential service provider for remanufacturing but has no activities and experience yet in this field.

This paper is based on the work carried out in DemaNET during the first year. Previous research about remanufacturing has been studied to identify its benefits, challenges and applications and to analyze the processes and systems applied. The industrial views have been surveyed through semi-structured interviews and workshops with the case companies. The observations from outside Finland and the experience of the companies have been shared and discussed between the participants. Finally in the project the aim is to consider how the remanufacturing concept could be applied in Finnish industry; how the barriers could be overcome and what kind of actions are needed in the long term to promote remanufacturing on a larger scale in industry and economy.

3 Remanufacturing Benefits

Within the IMS (Intelligent Manufacturing Systems) a vision and roadmap for sustainable manufacturing has been developed in 2010 [8]. The vision foresees that

"Successful European enterprises have to adapt to sustainable manufacturing approaches, based on a precise esteem of the whole life-cycle environmental impact." Thus sustainability is seen as a competitive factor for future industries and reindustrialization. The roadmap [8] also recognizes remanufacturing: "The development is going towards an "eternal life-cycle" of products and remanufacturing is becoming more important as many countries are tightening environmental regulations or legislations in economic activities".

Remanufacturing is referred to as a "win-win-win" situation: customers need to pay less for the remanufactured products or components, remanufacturing companies earn more and the environment benefits [9]. As a whole, remanufacturing is expected to contribute to all three dimensions of sustainability (environment, economy, society): Remanufacturing "saves material and energy resources, prevents waste, creates skilled jobs and produces substantial savings over new goods with new components". While looking at remanufacturing from the American perspective also Lund & Hauser [4] identify several benefits at the level of society: It makes products more broadly available at lower prices, it makes a contribution to conservation of materials and energy and it provides employment income and acquisition of skills and expertise which can lead to additional business opportunities for repair, remanufacture, or manufacture, thus providing local employment and training. Thus through becoming more common remanufacturing can support the reindustrialization.

The case companies involved in DemaNET project also recognized the importance of all the three sustainability dimensions as benefits of remanufacturing. Even if sustainability is often used as a selling argument, the companies regarded that so far only part of their customers are highly interested in sustainability. The main driver of the case companies for remanufacturing is profitable business. Through remanufacturing new markets and customer groups may be reached. As two of the companies apply remanufacturing for spare parts of heavy machines they see remanufacturing also as a method to keep up the spare part market for themselves. Sometimes there is a concern if remanufactured products decrease the sales of new ones. This was not seen relevant in the case companies. On the contrary they saw that remanufacturing may support sales of new products through taking back the used ones; this is seen as a part of the "whole service" to the customers. Remanufacturing also supports the feedback of product experience: information flow from product use to new product design.

4 Barriers and Challenges

Even if remanufacturing is widely spread in some limited fields or geographical areas, in other fields it is small scale activity. Partly this is because the raw materials or components are currently not expensive enough, the awareness of remanufacturing is still low and the regulations do not oblige for ultimate recycling. On the other hand, there are also barriers to implement remanufacturing as a profitable business. Matsumoto & Umeda [5] and Lundmark et al. [9] have identified three main areas of challenges according to the main phases of remanufacturing:

(1) Challenges related to the *collection of used products / availability of cores*: To establish remanufacturing sufficient volume of cores (used products or components to be remanufactured) need to be available and brought together for remanufacturing.

Even if there is potential for sufficient core volume in the market area, the remanufacturing companies need to take care that the cores are returned to them.

(2) Challenges related to *remanufacturing processes* (remanufacturing phase): Not all products or product parts can be remanufactured in a reasonable way. There may be technical challenges, it might be difficult to assure of the required quality, or the costs and lead time are too high. It is often difficult to identify the potential products for which remanufacturing is profitable, technically feasible and really sustainable [10].

(3) Challenges related to the *demand for remanufactured products* [5] and redistribution [9]. One main challenge of demand is to reach the customers' acceptance and trust in remanufactured products.

A challenge related to all these phases is the difficulty of *balancing the supply and demand* [5, 9, 10, 11]. Remanufacturing companies most often do not have control about the quantity, quality and timing of the returned products.

Additionally, other types of challenges can be identified, related to *management and business* (for example cost-effectiveness and pricing), *legislation and IPR issues*.

The challenges identified by the project case companies were mainly in line with the observations in literature. One of the main criteria to start and run profitable remanufacturing is to reach sufficient volume. For part of the companies this could be managed through the selection of proper components or modules for remanufacturing the volume of which is high enough. Because of insufficient volume one of the companies is currently able to perform remanufacturing only in the primary market area. In one SME case, the manufacturer of large and heavy products, the product volume is distributed globally and no region has sufficient volume for remanufacturing. In addition to the mentioned challenges, the companies highlighted the need for local market understanding and knowing the local government regulations (for example sometimes the export of cores may be prohibited). When developing new activities in remanufacturing, the companies also experienced a need for resources and knowledge: technical information and test specifications are needed. Additionally the products should be better designed for reuse and remanufacturing.

5 Remanufacturing Processes and Collaboration

5.1 External and Internal Processes

Remanufacturing processes can be seen as consisting of external and internal processes, figure 1. The external process has two parts: "external in" taking care of the collection and input of cores and "external out" distributing the output of remanufactured products to customers. The figure presents different routes for the external processes; they are not present simultaneously for one product. The remanufacturing internal processes contain the needed manufacturing steps to recondition the incoming cores to the needed quality level. Not all used products qualify for remanufacturing; the pre-check of the cores may be performed in different phases, depending on the case. Storage and transport operations are needed both inside the phases and between them. In figure 1 storage and transport are left out, to keep the description more simple. To perform remanufacturing it is necessary to build up the whole remanufacturing system, not only the actual remanufacturing activities.

External in Process (Collection of Cores)

The external in process takes care of the collection of the used products or components (cores) from the customers. As seen in figure 1 there are several options for the core return. Delivery of spare parts or receiving used products when buying new ones, are typical occasions for core collection. Other sources of cores are for example salvage operators and core brokers, rental units returned at the end of lease, and items found defective during an initial warranty period [4]. As mentioned above in chapter 3, the market needs to be high enough to create the collection channels and the reverse logistics system.

The collection of cores needs to be organized easy for the customer and cost-efficient for the remanufacturer. To support the core availability the remanufacturing companies often create incentives for returning them. They offer cash or deposits of used products or discounts when purchasing new products and returning the used ones. Offering *products as a service*, leasing or collaboration with leasing companies can support managing the used products or parts and thus may help both to reach sufficient volume and to decrease the supply uncertainty.

Internal Remanufacturing Processes

The remanufacturing internal processes include the steps for the recondition of the incoming cores to the needed quality level: inspection, cleaning, disassembly, reprocessing, reassembly, testing and storage [3, 12]. Depending on the core, these phases may be performed in a different order.

Not all products are suitable for remanufacturing. Hauser & Lund [13] identify the following remanufacturing criteria from the product viewpoint: Technology exists to restore the product, product is made up with standard restorable parts, cost of core is low relative to savings in product cost achieved through core reuse and the product technology is stable over more than one lifecycle.

The most cost-efficient and sustainable solution can be achieved if the product is specifically *designed for remanufacturing*. This means that the products are easy to disassemble and assemble, more durable material is selected, the parts are easy to recover and test and standardized as far as possible. Currently, only few products have been designed for remanufacturing and few designers are aware of design for remanufacturing [14].

External Out Process (Remanufactured Products to Customers)

There are also several options for the sales and distribution of remanufactured products and components to the market but not all of them are applied simultaneously for one product. Sometimes they are sold through the same channels as new ones (spare parts) but often the market areas or the customers for used and remanufactured products are different from those of new products. In some fields with high volume specific remanufacturing marketplaces are available in the internet. The customer base can be enlarged by identifying proper cores for the remanufacturing (for example spare parts), a credible quality offer (for example longer guarantee than for new parts), lower pricing and financial incentives for the used cores when buying remanufactured products.

One way to stabilize the demand of remanufactured parts is to use them as *components in new products*. According to Matsumoto & Umeda [5], in Japan remanufactured components are used also in new products in photocopier and camera industry. The advantage is that the timing of supply does not depend on the timing of returns, the customer does not define the reuse ratio and the potential conflict between sales of new and remanufactured products is avoided.

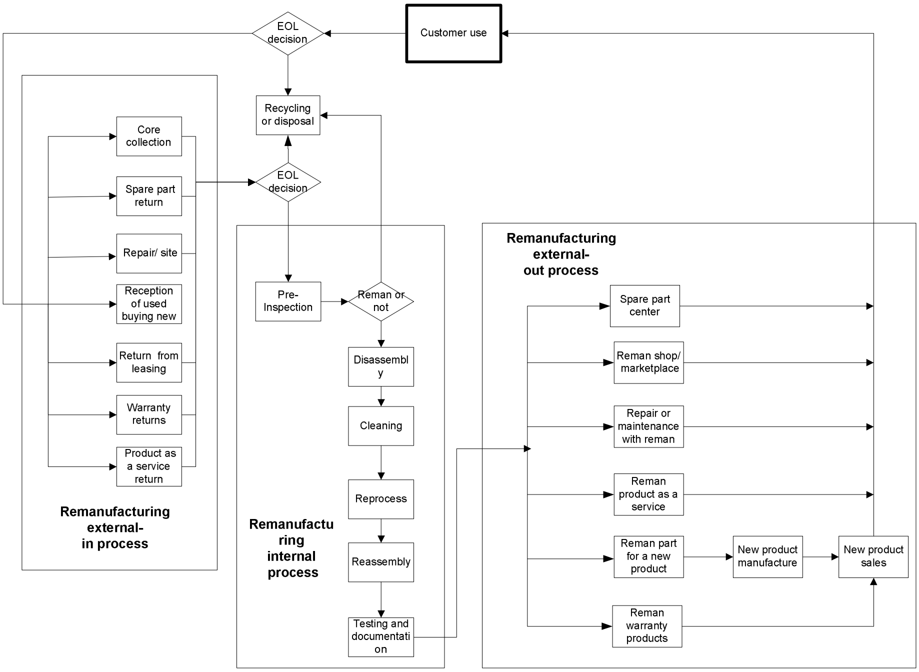

Fig. 1. Remanufacturing processes

5.2 Actors and Roles in Remanufacturing

In previous research, three main categories of remanufacturing are identified [15, 16, 17], according to which partner takes care of remanufacturing:

1) the OEM (Original Equipment Manufacturer) itself,
2) contracted remanufacturers; “official” contractors / agents, and
3) independent or 3rd party operators.

This classification mainly focuses on the internal remanufacturing process – taking into account the external processes brings out additional roles and actors. There are important tasks to be performed also in the external processes, in the collection of cores and the distribution of remanufactured products. These tasks offer potential for additional roles and services as the company performing the real remanufacturing is not always able or the best option to take care of the logistics.

The involved case companies already active in remanufacturing all followed mainly the OEM approach: they had the control of the whole remanufacturing process even if they could use the original suppliers of the components also for the remanufacturing.

The other ones interested in remanufacturing could as well select the contracted remanufacturing option or operate themselves as 3rd party actors in the remanufacturing process.

5.3 Enterprise Networking in Remanufacturing

To succeed in remanufacturing business, the companies need to achieve sufficient volume and cost-efficiency, flexibility and quality. These requirements are often drivers for inter-enterprise collaboration in industry [18]. Could collaborative networks -approach and the developments in the field [19, 20] support also companies as they are striving to set up remanufacturing?

In collaboration networks -research [18, 19] two main enterprise networking concepts are distinguished, based on the objective and the duration of the collaboration. The *Collaboration network* or Breeding environment -concept refers to long-term co-operation and creation of preparedness between the enterprises while virtual organisations or *Virtual enterprises* (VE) are temporal and focused on achieving a specific task. After fulfilling the task a VE is dissolved. Using these concepts in the remanufacturing context the collaboration network creates the preparedness for collaborative remanufacturing while the remanufacturing itself could be performed by a *Virtual remanufacturing enterprise*. When talking about what happens inside the factory walls as well a term "virtual factory" could be used. From the outside world the *Virtual Remanufacturing Enterprise* behaves and acts as a single company, but internally it consists of several partner organisations. Examples of companies that together could perform the process are cleaning, reprocessing, painting, coting, testing and logistics companies. The participation partner can be replaced over time. The *Virtual Remanufacturing Enterprise* could be created from the remanufacturing network for a specific product or component. Depending on the product type its duration could extend over the product generation lifetime or be even focused on one large product with low market share and volume.

Collaboration between different actors may be needed both in internal and external processes. Through the analysis of the project cases and their potential forms in the future three different network types were tentatively identified:

- OEM centric remanufacturing network: managed by the OEM but may include contracted remanufacturers,
- Industry-specific remanufacturing network: managed by a contracted remanufacturer or an independent actor,
- Location-based remanufacturing network / "Remanufacturing park": mainly independent actors but may also have contracts with OEMs.

In future, also remanufacturing ecosystems could emerge, extending over the different types and allowing collaboration and enriching across different industrial fields.

As mentioned above, the case companies already active in remanufacturing follow the OEM approach in remanufacturing. Analysis of their processes, however, shows, that the one having most wide remanufacturing activities is not performing the whole remanufacturing process alone, but has collaboration partners both in the internal and the external processes. Here the partners in the remanufacturing network are a subpart of the network of new product manufacturing: most of them also participate in the logistics, manufacturing or maintenance activities of new products. Only few specific centres for remanufacturing have been created. This kind of remanufacturing network could be called "*OEM-centric remanufacturing network":* it is managed and controlled by the OEM. In this way the OEM can take care of its brand, keep the customer relationship and ensure the quality of the remanufactured products or components.

The two other case companies already active do not have a corresponding network created but they also do not have as high volumes. However, while increasing the volume they could also benefit about creating collaboration in external or / and internal processes.

One of the case companies experienced difficulties to set up remanufacturing activities outside its main market area, because of too low market share and volume. In this case manufacturers of similar or near-by products could create common reverse logistics and/ or remanufacturing to reach the sufficient volume. One option is to collaborate only in the core collection and to perform the remanufacturing itself, another to share resources also in internal remanufacturing. This kind of networks could be called "*Industry-specific remanufacturing networks*". Even if this option might look attractive, many companies consider it impossible because of competition, fear of losing brand or market position. However, there are examples of collaboration also between competitors. In some cases the collaboration only involves the collection of cores, like used ink cartridges in Japan [5].

One of the SME case companies manufactures heavy machines and had identified the need for collaboration in remanufacturing and reuse of old products. The company is looking for partners in Central Europe to start the activity. In case of heavy products and low volume the sufficient volume could be achieved through collaboration in the same geographical areas. These networks could be called "*Location-based networks*". Sometimes also specific sites or "*Remanufacturing parks*" are created which may be operated by one or many partners, to remanufacture a wide range of products. In this collaboration, with high enough volumes, some partners could specialize on a definite remanufacturing process phase (disassembly, cleaning etc.) which could support the cost-efficiency. By extending and distributing the activities into several locations and fields the Remanufacturing park -idea could become a "*Remanufacturing ecosystem"*.

Thus, it can be observed that as there is a large variety of products, there is also a large variety of potential collaborative networks in remanufacturing. It is not the same to remanufacture a high volume of low value components as low volume of high value products. The collaboration may support overcoming some of the challenges: for example the challenge of core collection, achieving sufficient volume and also balancing the supply and demand. It may also contribute to the accumulation of knowledge and experience regarding remanufacturing.

6 Conclusions and Way Forward

Remanufacturing can be seen as an ultimate form of recycling. Through remanufacturing, materials and energy can be saved and less waste is produced. At its best, a win-win-win situation is reached: the manufacturer can get additional income and profitable business, the customers get products with a lower price and with a quality guarantee, and the natural resources are used less. It should be noted that in addition to saving product value remanufacturing is already now but increasingly in the future able to add value to the remanufactured products. This is already done for example in engine or vehicle remanufacturing through improving energy efficiency and cutting emissions of engines.

Also benefits at the level of society are seen as remanufacturing can provide industrial employment in skilled jobs and may create new opportunities supporting the product lifecycle and its extension. As part of circular economy [2], remanufacturing can support sustainable re-industrialization.

To progress in circular economy, actions on several levels are needed. These may include governmental and legal actions, like environmental standards, waste penalties and incentives from taxation. At the company level barriers and challenges need to be solved. As a whole, the awareness and knowledge about remanufacturing needs to be built and disseminated. However, it is important to understand that going to circular needs systemic changes in product design, customer attitudes, business models and value networks. These will be further studied in the Finnish national DemaNET project.

Acknowledgement. This work has been partly funded by the Finnish Funding Agency for Technology and Innovation (Tekes) Green Growth program.

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Designing a Sustainable Recycling Network for Batteries from Electric Vehicles. Development and Optimization of Scenarios

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Abstract. Since the 2008 crisis, the automotive industry is shifting towards a new paradigm and repositioning around the green mobility, using mainly lithium battery technology. Given this new development, the issue of recycling batteries arises for ecological, economic and geostrategic reasons. Our work consists in formalizing a methodology to help design a sustainable recycling network applied to batteries, under uncertainty. The proposed approach involves two steps. The first step is about modeling the recycling network and the characterization of the problem's elements, using systemic analysis. The second step consists in developing scenarios about the configurations of this value chain, and then optimizing their functioning. We'll choose different positioning for the actors and make assumptions about logistic data. In this paper, we will try to summarize the issues of recycling lithium battery, explain in detail this approach and present the first results of application.

Keywords: Recycling, Value chain, System analysis and design, Lithium batteries.

1 Introduction

Everyone agrees that we are at the beginning of a second automotive revolution, induced by the decline of the life cycle of the internal combustion engine (ICE) vehicle, the limits of the economic and financial model of the automotive industry and the effect of the current mobility system on the environment. These factors raise a reflection about a new mobility system and its impact on territories, resources allocation and regulations. These new constraints have led the automotive industry to reposition itself around the green mobility. Several technologies exist, including fuel cell technology. However, they are not yet marketable. Thus, the industry turned to hybrid or fully electric vehicles (EVs), using mainly lithium batteries.

Given this new developments, the issue of recycling batteries arises for ecological, economic and geostrategic reasons. This recycling network will be implemented by the original equipment manufacturers (OEMs). This is because, firstly, they have a legal responsibility on batteries at end-of-life [1] and secondly, they are the actors

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who have the most power and resources in the automotive value chain. Currently, the industrial-scale recycling of these batteries is non-existent. The prospective nature of the study encompasses uncertainties, caused by the development of electric vehicle market, the evolution of battery technology and the maturity of recycling processes [2]. The interest of this subject lies in the identification of a configuration of the value chain associated to batteries at the end-of-life. This value chain should be able to comply with regulations while controlling the overall cost of batteries.

This paper will be focused on lithium ion batteries (Li-ion), because it's the most promising technology for vehicles electrification [3] - [4]. In this article, "recycling" will be referred to as the treatment and recovery of batteries after the automotive use, including: reparation, second life applications and materials recycling. The term EV includes: hybrid-electric vehicles (HEV), plug-in hybrid vehicles (PHEV) and battery-electric vehicles (BEV).

Next section provides an overview of the existing literature about end-of-life products recovery, as well as Li-ion battery recycling. The third section illustrates the specificity of our topic. We will identify the drivers for recycling batteries from EVs. We will also describe the related value chain, in order to highlight its complexity, caused by uncertainties and the multicity of stakeholders.

The last section justifies and explains in detail the proposed approach. It also presents the first results of application.

2 Literature Review

The issue of recycling end-of-life products has been treated by several strands of literature: Environmental value chain management (EVCM), green supply chain management (GrSCM), and reverse logistics (RL), may also be called: Closed-loop supply chains (CLSC). Reverse Logistics is emerging as an area suitable for the study of recycling networks. Rogers and Tibben-Lembke [5] define RL *as the process of planning, implementing and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value, or for proper disposal.* Fleischmann, one of the biggest contributors on the logistics of recovery systems, described in [6] a typical structure for products recovery, as a network converging from disposer markets, going through recovery facilities and diverging to re-use market.

Research carried out in products recovery concerns mainly; either the assessment whether or not the recovery of used products is economically more attractive than disposal, or the organization of the recovery network if the disposal option is prohibited by legislation. Many products specific studies were conducted regarding recycling, such as sand, carpet, bottles and waste electrical and electronic equipment (WEEE). We found it; the most pertinent ones for our work are either end-of-life vehicles (ELV) or products disassembled from ELVs (plastics, lead batteries, etc.).

Kumar and Sutherland [7] explored the effect of innovative vehicle designs (material composition, new power-train technologies) on the sustainability of the automotive recovery infrastructure. Maudet-Charbuillet [8] investigated the issue of integrating recycling plastics networks in the automotive supply chain, by proposing a modeling tool used in order to stabilize these networks. Mathieux and Brissaud [9] used material flow analysis to get insights about aluminum material flows and stocks, identification and quantification of relevant processes. Farel et al. ([10] - [11]) provided a five steps method to design a value chain for ELV glazing recycling: modeling material and information flow; establishing value network; structural analysis; scenario generation and simulation and evaluation. Farel et al. [12] for the same issue in [10] used a linear programming model to simulate the conditions of costs and benefits situations for the upcoming glazing recycling chain in 2015 in France. Kannan et al. [13] proposed a heuristics based genetic algorithm (GA) to solve a closed loop supply chain model for spent lead–acid batteries in India.

Regarding Li-ion battery recovery, the number of articles attests to the recent emergence of this issue. Several industrial, academic or joint initiatives have emerged to explore the end-of-life of EV batteries, mainly concentrated in the USA, Europe and Japan. In the USA, the National Renewable Energy Laboratory's Second Use Project Objective is modeling the actual battery degradation behavior; identification, assessment, and verification of PHEV/EV Li-ion second use profitability. One of the results of this project, published in [14] is focused on estimating the possible value of battery second use strategies to reduce the cost and accelerate adoption of PHEV/EVs. *LithoRec* and *LithoRec II*, a consortium of 12 academic and industrial partners, financed by the German federal government aims to assess the development of an industrial scale structure and process for used Li-ion batteries in Germany, in an economic and environmentally-friendly way. The strategic framework for designing a recycling network developed in *LithoRec* is highlighted in [2]. It involves three steps: analyzing problem characteristics; description of actors and requirements that need to be considered and an integrated planning approach of the network.

The reading we make about this literature reveals the following common features:

- Focus on material recycling, actually few articles deal with multiple recovery options at the same time
- Deals mainly on logistics aspects; location of recovery facilities, transport planning and inventory control;
- Considers only quantitative uncertainty; volume and quality of returns, costs and prices;
- Does not consider conflicting objectives from multiple stakeholders
- Focus on the economic objective

We will see in the next section, that the existing literature is not suitable for our topic. The recycling drivers imply the consideration of all the recovery options (reuse and recycling). The value chain complexity implies to go beyond the logistics aspects, and consider the actors positioning and expectations in this value chain.

3 Focus on Electric Vehicle Batteries

3.1 The Geostrategic Issue

Demand and production of lithium have increased substantially since 2000, with nearly 6% average annual growth [15]. Lithium is traditionally used in glass, ceramics, metallurgy, pharmacy... etc. According to the US Geological Survey, these batteries held 21% of the market share in 2009 [16]. This proportion will be higher in the future, with the widespread introduction of electric vehicles.

Market development of lithium, which is expected to double in 10 years, raises the question of the availability of resources and the security of supply. In fact, these resources are more than 70% located in the "ABC" zone: Argentina, Bolivia and Chile. Today, the availability of lithium is not an issue. In EV Traction batteries, lithium carbonate (Li2CO3), accounts for less than 10% of a battery weight and lithium price was nearly 6 $/kg in 2010 [3]. The recycled lithium is more expensive than extracted lithium. So, we understand that today it is not interesting to retrieve lithium from used batteries. It will not be the case in the future, when recycled lithium will represent the largest cumulative source [4]. Although experts do not consider a scenario of lithium depletion [17], the question of emancipation from suppliers remains crucial. Miedema and Moll [18] confronted the supply capacity of lithium to the needed demand from the automotive industry. They concluded that undersupply can be expected in the near future, before a large scale recycling of batteries. The challenge in the future is to meet the growing demand without causing price volatility and to implement early enough recycling networks to provide a capital of lithium in countries using it.

3.2 The Regulatory Issue

Taking into account the effects of human activities on the environment has become one of the criteria for assessing decision-making process in the industrial world. In this context, the automotive industry is fully involved, as it was among the first industries subject to environmental regulations.

Directive 2000/53/EC [19] lays down requirements for the treatment of end-of-life vehicles (ELV) in Europe. In addition, Directive 2006/66/EC [1] sets the legal framework for the treatment of batteries and accumulators in Europe. This directive requires particularly for electric vehicle batteries the implementation of:

- A dedicated collection system at no cost to the end user;
- A system of treatment, recycling and disposal of batteries waste.

3.3 The Economic Issue

The economic stakes are induced by the possibility of a second life use of batteries. In fact, these batteries; when out of use for optimum automotive propulsion could be used as energy storage for stationary or other embedded applications based on their technical, economic and environmental feasibility. Among the possible outcomes, the use in cars exploited over shorter distances is considered, as well as stationary energy storage. The topic of the second life of batteries is attracting interest worldwide, but it is still the object of research projects at an early stage [20].

3.4 The Related Value Chain

Since the EV technologies are recent, the recycling of these batteries is not yet industrialized. Industry players do not necessarily exist today, which raises the question of their emergence and the disruption of the actual value chain. In addition, legislation (recycling targets and the Extended Producer Responsibility "EPR" concept) is pushing towards more cooperation between the OEM, the ELV recovery infrastructure, the consumer, and other stakeholders. OEMs are shifting from traditional paradigms to innovative business models [7].

Value chains for end-of-life products recovery are not considered as "natural value chains", in the sense that their implementation does not meet a market demand. This description of value chains and their origins, explains the difficulties of different actors to project economically viable systems and organize themselves [8].

The key factor to the sustainability of this recovery chain is the ability to prove its economic profitability as a whole. This assumption seems idealistic, considering the differences in the business logics of the stakeholders and the issue of redistributing profit among them.

4 Our Approach

Bringing together the remarks formulated about the literature and the specificity of our topic, we formalize a methodology to help design a sustainable recycling network applied to batteries, under uncertainty. This methodology encompasses the following features:

- Uncertainty and business models for value capture will be modeled by scenarios
- The scenarios will reflect: (i) the governance and the several positioning of the actors in the considered value chain, and (ii) assumptions about quantitative data (volume of returns, batteries quality, etc.)
- Considering the multicity of stakeholders, by optimizing objectives deriving from expressed requirements
- Considering the hole recovery options (reparation, second life applications, recycling)
- Designing a sustainable network, considering economic, social and ecologic performances.

Our approach involves two steps:

- Network modeling & problem characterization
- Scenarios development and optimization

4.1 Network Modeling and Problem Characterization

If we consider the recycling network as a complex system with multiple stakeholders, the tool that seems most suitable for the design and deployment of such a system is the systemic analysis. Applying systemic concepts to the design of complex logistic networks under uncertainty, Patay et al. [21] developed a method called SCOS'M; Systemics for Complex Organizational Systems' Modeling. It comprises five steps:

- Isolate the system and its subsystems to define the scope
- Describe the phases of the system's life cycle

- Describe for each phase of its life cycle, the expectations on the system in terms of satisfaction and performance
- Develop the functions to be performed by the system to meet these expectations
- Determine the parameters and variables of the system allowing the satisfaction of expectations.

This method seems ideal, since it meets some of the requirements of our approach, namely, the multicity of stakeholders, the multicity of performances and the identification of parameters that allow scenarios simulation. At the end of Step 5, we have identified the variables and parameters influencing the economic dynamics of the value chain.

This step is crucial, since it will lead to characterizing a network type and the elements of the problem, by defining the objectives, constraints, variables and parameters. As well as values (economic, environmental, flexibility, security) expected by stakeholders. These elements will help address the second step of this approach.

4.2 Scenarios Development and Optimization

The second step in our approach consists in a projection to the future to formalize possible value chains for recycling batteries, and then optimize their functioning. It is an approach coupling simulation and optimization. Scenarios development is about identifying several configurations for the value chain, by making assumptions about uncertainties, which we could categorize into two kinds: (i) quantitative (volume of returns, batteries quality, costs, etc.) and (ii) qualitative (monopoly of a recycler, internalization of the recycling activity by OEMs, recycling opportunities, etc.).

Regarding quantitative uncertainties, Hoyer et al. [2] identify the following ones:

- Sources (quantity, spatial distribution, composition of battery returns);
- Outputs (reuse opportunity: products, components, materials);
- Process (combination and configuration of processes).

In order to tackle these uncertainties, firstly, we'll link the parameters (results of SCOS'M) to these uncertainties, and then use system dynamics (SD) approach to predict the system's future behavior. The choice of SD has been made given the complexity of interactions existing within the system. Donnadieu & Karsky [22] define SD as a science of change and evolution. It is concerned with understanding the phenomena and their causes, identifying the factors that create change, or otherwise oppose it. System dynamics simulation is a renowned approach to simulate the effect of future changes, several system dynamics-based studies were conducted in the area of recycling ([11], [23], [24]).

Regarding qualitative uncertainties, based on the work of Williamson and the work on global value chains [25], we will imagine different positions of OEMs in this value chain, as well as those of the other actors. Examples:

- OEM will internalize transportation from collection points to recovery facilities;
- There will be a unique recycler in Europe (monopoly)

Assessing the sustainability of a supply chain goes by identifying the appropriate performance indicators, which proves to be a difficult task. The lack of social metrics is a serious challenge [26], while there is a multicity of environmental indicators (energy efficiency, greenhouse gas emissions, waste generated, waste recycling rate, etc.). In our work, we identified the metrics that seem to be most relevant to our topic, namely the economic and environmental balance. "Fig. 1" gives an overview of the causal loop diagram modeling the recycling network. This latter includes the interaction between virgin and recycled lithium, the macroscopic view of costs, benefits and environmental performances, which are also developed in other diagrams.

These scenarios will be used to develop linear programming models for the network design problem. These models will be addressed by an approach coupling simulation and optimization. The simulation enables us to test the scenarios with economic and industrial data, by the mean of SD. The optimization will allow, for each scenario, identifying the optimum solution in terms of: location and sizing of treatment facilities, planning of their implementation, as well as transport planning.

In summary, step 1 of the approach will be used to characterize the elements of the problem modeling the dimensioning of the value chain and optimizing its flows. Step 2 will adopt assumptions about the role of actors, as well as data to enable the optimization of the developed models. The results will be used to estimate sustainability of this value chain. At last, we'll synthesize the results of scenarios analysis in order to bring out the conclusions and recommendations for the recycling network deployment. This approach features some characteristics; developed in this section, that enable meeting the requirements to establish a recycling network for batteries from EVs, such as identifying the actors, the choice of governance and implementation planning.

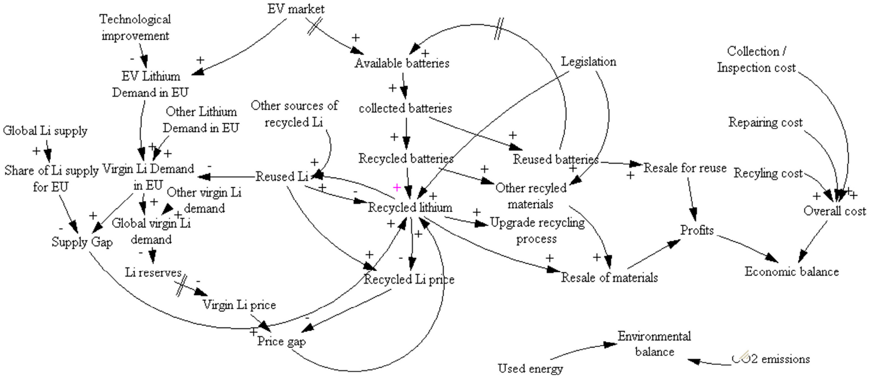

Fig. 1. Overview of the recycling network

5 Conclusion

By regulatory constraints or economic opportunism, the recycling network of batteries from EVs will be implemented. The prospective dimension of the study is a significant challenge, which requires the use of an efficient approach, able to overcome the various uncertainties and provide useful results. The emergence of this topic and the limits of the existing literature have driven us to propose a novel approach, more suitable to the specificity of our topic. This approach is multidisciplinary, involving knowledge from:

- Complex systems engineering
- Business and economic sciences
- Operational research and logistics optimization

In this paper, only modeling results are exhibited. More findings will be included in our future contributions. The perspectives after this first contribution are:

- Data collection and simulation using stock & flow diagrams. The exposed SD model being validated by the car manufacturer, the next step is data collection by the mean of interviews. Meetings are scheduled with experts within the car manufacturing company and its partners;
- The scenarios building methodology and the scenarios elaboration;
- Integration of the multi-objective optimization in the whole approach. Some of the variables identified in the causal loop diagrams are decision variables such as “investment in collection centers” and “Upgrade recycling process”. The idea is to optimize these variables, while evaluating the economic and environmental balances of the recycling network;
- Recommendations about the collaborative governance of the recovery chain, including role-play definition and profit redistribution.

We will strive to ensure the robustness of the results and the inclusion of possible new data. Since we are in a context of value chain emergence, several factors can disrupt established patterns in our work, namely the composition of EV batteries, the arrival of new actors or the evolution of legislation. This dynamic aspect of the subject will be treated with a permanent monitoring of the real value chain, allowing us to make adjustments in our scenarios.

Acknowledgments. This work was benefited from the support of the chair “PSA Peugeot Citroen Automobile: Hybrid technologies and Economy of Electromobility. So-called Armand PEUGEOT Chair”, led by Ecole Centrale Paris, ESSEC and SUPELEC, and sponsored by PEUGEOT CITROEN Automobile.

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Sustainable Collaborative Networks II

Modeling a Logistics Pooling Strategy for Agri-Food SMEs

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Abstract. This paper presents an innovative approach to improve sustainability of logistics pooling strategy by reducing CO2 emissions and social incidents. Our approach aims to increase the collaborative network efficiency in the context of agri-food SMEs. The combination of discrete event simulation and analytical optimization approaches enables to analyze different pooling scenarios and to optimize pooled distribution network. The developed model takes into account the specificities of agri-food SMEs flows. The thereby improved utilization of logistics resources impacts economic and ecological and societal performance indicators.

Keywords: Logistics Pooling, Sustainable development, Agri-food SMEs, Discrete event modeling.

1 Introduction

To be competitive, manufacturers must optimize their supply chain. This optimization, long based on an economic approach; happen today through the integration of environmental and social concerns, in line with the objectives of sustainable development [1]. In addition, a constant pressure of European regulations pushes industry to integrate sustainability concerns in their supply chains. The regulatory developments translates into economic terms, with the Modernization Law Economy-LME whose objective is lower selling price to consumers [2], or notably with Grenelle law (- 20% emission of greenhouse gas emissions by 2020), or with the new Ecotax law.

In this context, new requirements have been added to the requirements of economic efficiency. Logistics systems must now meet the requirements of sustainable development, namely:

- ***At the Economic Level*:** reducing logistics costs.
- ***At the Ecological Level*:** reduce both CO2 emissions and energy consumption, with an incentive to make more recycling and waste treatment [3] and [4].
- ***At the Societal Level***, take into consideration the expectations of different stakeholders in the process of making business decisions [5] and [6].

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These requirements are more difficult to reach for SMEs, because their logistics performance does not allow them to engage in a sustainable approach [7] and [8]. In addition, Just in Time-JIT policy has been implemented in most sectors: to deliver faster, more frequently and in small quantities. These changes in flow management explode SMEs logistics costs, which endangers the entire implementation of a sustainable development approach. In this context of accelerating flow and inventory reduction, logistics sharing between SMEs is more than ever at the heart of priorities. These are strategic decisions for these companies: what is the structure of a pooled logistics network to ensure a better economic, environmental and social performance?

2 Research Context and Approach

In the continuation of literature review presented in [9], logistics pooling was treated in three ways: *i*) The pooling of transport and platforms from a single source in order to serve a set of customers [10], [11] and [3]. *ii*) The pooling of transport and platforms of a set of suppliers to serve one or more clients [12], [13], [14] and [15]. *iii*) The pooling of transport with vehicle routing and exchange delivery orders between carriers to reduce empty returns and increase the use of means of transport [15] and [16].

In this literature, taking into account the objectives of sustainable development is recent. The research work of [13] focused on the economic dimension, while the work of [17] and [14] introduced the environmental dimension by calculating the CO2 emissions of their scenarios. Sustainable development is mostly treated as an environmental perspective while the societal dimension is generally not considered.

Finally, previous studies consider important flow treaties in number of pallets, mostly in retail distribution. These studies generally consider a stationary demand and call upon distribution systems of batch of products which occur according to long delays in the distribution network, particularly through storage platforms. The importance of massified flow in these contexts provides the ability to transit to other means of transportation that are more economical and ecological (e.g. rail), as studied in [17] and [12].

The specificity that we have identified in the context of agri-food sector, resides on a modality of logistic flow of small quantities, expressed in number of parcels (a few pounds) to be distributed in J+1, J+2 or in J+3 to different destinations through different operations: loading, consolidation, unbundling and distribution. This service falls within the "express mail" and based on small transport systems. Economic criteria sometimes push these agri-food SMEs to delay deliveries, even losing orders to avoid logistical costs associated with too small shipments.

Finally, research on logistics pooling as in [13], [14] and [17] are based on analytical methods and call upon strong constraints to simplify their models: e.g. fixing the carrying capacity, or the failure to take into account the factor "loaded weight" for the calculation of CO2 emissions in vehicle routing.

For our research, it is essential to consider the constraints of transportation as a variable in the performance evaluation of pooled networks, which bring us to test various hypotheses, more appropriate to express small package. For this, we chose use methods based on simulation. Among its advantages, simulation offers the possibility to take into account realistic assumptions (compared to analytical models). However, the results are only valid for studied scenarios, and to be generalizable, it must conduct a sensitivity analysis of the model relative to different parameters. Our goal is to compare the performance of a traditional logistics network with different models of pooled logistics networks. Given the complexity of logistics systems and the difficulty to take into account different constraints in analytical model, the simulation appeared to us as the most appropriate tool for this research.

3 Modeling a Logistics Pooling Strategy

Logistics pooling is a partnership agreement that involves voluntary pooling of physical and information and skills in order to achieve economic and environmental and social gains, or to counter in the short term a constraint or to access a service unavailable individually [9]. The framework of this partnership can assume various organizational forms depending on the nature of the partners and resources and products [18].

Modeling Approach. To model a logistics pooling strategy, we first define different pooled schemas (sharing scenarios). To model these different scenarios, we construct a model which consists of a simulation model coupled with an optimization model. The simulation model is used to simulate different scenarios and the optimization model is used to optimize vehicles routing in certain scenarios. To choose the most relevant scenarios, we develop a system of performance indicators to evaluate and compare different scenarios.

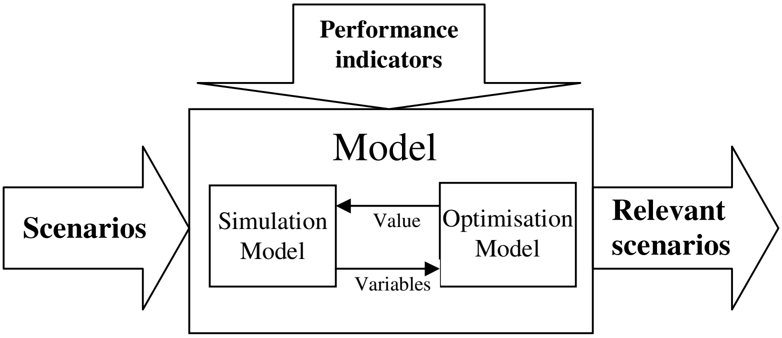


Fig. 1. Modeling approach

Scenarios Development. The various possibilities of pooling are based on two main principles: transport pooling and platforms pooling. Based on these two types of pooling, we identified different scenarios (Table 1).

We consider two configurations: C1 (Many to one) where a set of manufacturers distribute their products to a single common client and C2 configuration (Many to Many), in which several clients deliver a set of manufacturers that are not necessarily common using or not a cross docking platform. Scenarios with a storage platform are normally possible in a logistics pooling strategy. In our particular case, given the above requirements on the agri-food SMEs, including short delivery time of small parcels, we will not take into account these scenarios.

Table 1. Various scenarios of logistics pooling

Configuration	Scenarios	Transport upstream		cross dock plateform		Transport down-stream	
		Direct	Multi-pick	Yes	No	Direct	Multi-drop
C1 Many to One	S0	✓			✓	✓	
	S1		✓		✓	✓	
	S2	✓		✓		✓	
C2 Many to Many	S0	✓			✓	✓	
	S1		✓		✓		✓
	S2	✓		✓			✓
	S3	✓		✓		✓	
	S4		✓	✓			✓
	S5		✓	✓		✓	

S0 scenario for both configurations refers to the initial situation, without pooling. For C2 configuration, transportation between partners can be directly to the cross docking platform or in multipick mode (vehicles routing for collecting products). Delivery transport to different customers can be also either directly from the cross docking platform or in multidrop mode (vehicles routing for the distribution of products).

Proposed Model: Assumptions and Parameters. The proposed model in C2 configuration is a logistics network with I manufacturers and J clients. All companies are at the same level of decision and there is information sharing. Since we are interested only in patterns of distribution, we ignore the production processes of manufacturers, and it is assumed that they have an infinite stock of finished products.

For each customer *i*, the demand for a product of reference j follows a normal distribution with mean X_j^i and standard deviation Y_j^i with an arrival rate F , over a period T_j of the year. To take into account the seasonality of products in the agri-food sector, we consider that a further period T_j' of the year, demand for the same product i to the same customer j follows a normal distribution with mean X'^i_j and standard deviation Y'^i_j with arrival frequency F'. Demand is directly transformed in order of delivery of finished products. Daily delivery orders to the same destination are consolidated.

To give an overview of the modeling we have done, this paper is focused on the example scenario C2S2. This strategy aims to establish cross dock platforms that collect parcels from several manufacturers, consolidates these expeditions, and directs them to the appropriate client in grouped form.

The objective of this scenario is to assign platforms consolidation to suppliers and to customers to improve network performance. We select an appropriate number of platforms from potential hubs, and assign suppliers to different platforms. Platforms receive products from manufacturers and consolidate all products that have the same destination before sending products to the customer in question.

Each company has a physical system composed of an infinite stock module of finished product, a "Preparing order" process and a transport module for the products delivery to the platform. Production processes are ignored. Transport module simulates the transport and delivery times. This module is composed of a transport resource that includes a human resource (driver) and a truck from a heterogeneous fleet of trucks. The capacity of the truck is chosen according to quantity to be carried. A CO2 emissions calculator is connected to transport module.

At the platform, is made cross-docking operations of different manufacturers' references that are consolidate according to different destinations. In this perspective, we can consider that the cross-dock operations are summarized in their time, with generation of costs.

We make the following general assumptions:

- Each supplier produces a single product [if a supplier produces different products, we can create an additional fictitious provider for each additional type of product]
- All products are compatible and stackable.
- Deliveries are made into A to C (Command sent the day J and received the days J+2)
- The capacity of transport is limited by weight and volume.
- Transportation in the logistics network is operated by a carrier.
- Each platform can serve more than one customer and each customer can be served from multiple platforms. There are no links between platforms.

Vehicle Routing Optimization. Among the scenarios that we consider, we find several scenarios that are based on vehicle routing. The optimization of vehicle routing problem is in tactical-operational level of decision-making. While the issue of our research concerns the design of logistics distribution network that reports to the strategic level of decision-making. However, optimization of vehicle routing is important, because it contributes to the evaluation of different scenarios.

For this purpose, we build an optimization system of vehicle routing which is based on three-step, as shown in the following figure. The proposed optimization system begins by determining the optimal tour passes through all manufacturers and minimizes the traveled distance. In a second step, the constraint of back time to the platform is introduced. This time constraint is the maximum duration not to exceed by a tour vehicle. With this constraint, we determine the exact number of tours to do. Knowing the manufacturers included in each tour and the amount to be charged at each, we can specify the capacity truck to send on each tour.

The optimization of vehicle routing model is coupled to the simulation model of different scenarios.

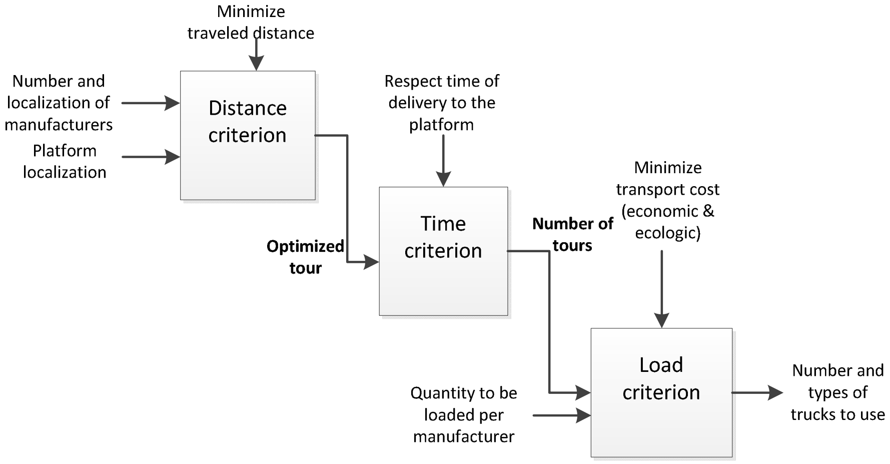


Fig. 2. Optimization model of vehicles routing

4 Parameters and Performance Indicators

We have summarized in Table 2, all data and parameters necessary for the simulation of C2S2 scenario. These parameters are used to evaluate the various performance indicators for this scenario, which then allow us to make a comparison with the other scenarios.

Economic Indicator. Throughout logistics network, three cost factors are considered: transportation cost, cross-docking cost and handling costs. Handling cost includes cost of loading and unloading. The total logistics costs of each scenario are calculated using the following formula:

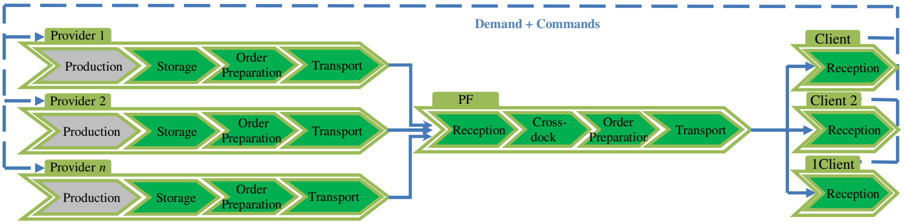
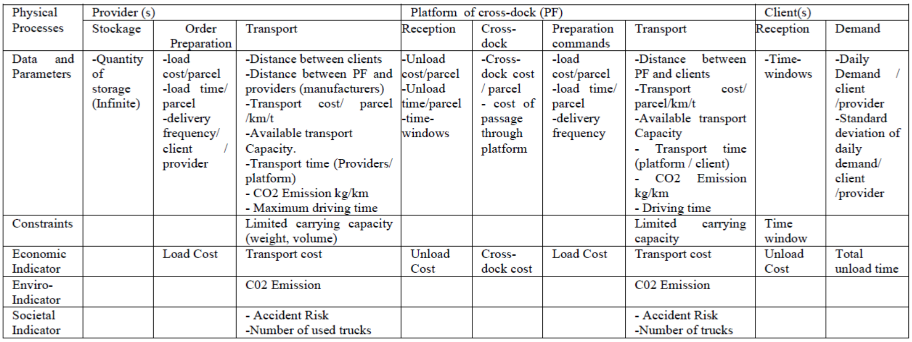


Fig. 3. Simulation Model of C2S2 scenario

Table 2. Parameters and constraints and performance indicators of C2S2 scenario simulation



Physical Processes	Provider (s)			Platform of cross-dock (PF)				Client(s)	
	Stockage	Order Preparation	Transport	Reception	Cross-dock	Preparation commands	Transport	Reception	Demand
Data and Parameters	-Quantity of storage (Infinite)	-load cost/parcel -load time/ parcel -delivery frequency/ client / provider	-Distance between clients -Distance between PF and providers (manufacturers) -Transport cost/ parcel /km/t -Available transport Capacity. -Transport time (Providers/ platform) - CO2 Emission kg/km - Maximum driving time	-Unload cost/parcel -Unload time/parcel -time-windows	-Cross-dock cost / parcel - cost of passage through platform	-load cost/parcel -load time/ parcel -delivery frequency	-Distance between PF and clients -Transport cost/ parcel/km/t -Available transport Capacity - Transport time (platform / client) - CO2 Emission kg/km - Driving time	-Time-windows	-Daily Demand / client /provider -Standard deviation of daily demand/ client /provider
Constraints			Limited carrying capacity (weight, volume)				Limited carrying capacity	Time window	
Economic Indicator		Load Cost	Transport cost	Unload Cost	Cross-dock cost	Load Cost	Transport cost	Unload Cost	Total unload time
Enviro-Indicator			C02 Emission				C02 Emission		
Societal Indicator			- Accident Risk -Number of used trucks				- Accident Risk -Number of trucks		

$$Total\ \boldsymbol{Cost}\ (\boldsymbol{S}_i) = \sum transport\ Cost + \sum loading\ Cost\ + \sum unloading\ Cost \\ + \ (Mode)\left[\sum unloading\ Cost\ + \sum Cross - docking\ Cost \\ + \sum loading\ Cost\right]$$

With:
Mode = 0 : No passage through Platform
Mode = 1 : passage through Platform

We have proposed a method of calculating the total cost of transportation (provided by the carrier) summarized in this formula:

Transport cost = Variable cost + hourly cost + Fixed cost

Variable cost = Traveled distance cost per kilometer*
Hourly cost = (Load time + Transport time + Unload time) cost per hour*
*Fixed cost = [(Load time + Transport time + Unload time)/Working time]*Fixed cost*
Transport time = Traveled distance / average speed

The transportation cost for each manufacturer is a function of the quantity transported, the distance, travel time and the type of truck used.

Environmental Indicator. We summarize the environmental indicator in CO2 emissions. To model CO2 emissions, we rely on references [17], [19] and [20].

To calculate CO2 emissions, we must model the distance between manufacturers, between clients, and the distance between platforms and manufacturers and customers. We must also consider the weight carried. In fact, CO2 emissions depend on the weight carried, on the capacity of the truck used, the distance traveled and the average speed of the travel. The average speed of course depends on the type of path in regional or national routes.

We have adapted the formula given by [15] and [18], to calculate the CO2 emissions based on truck type k, by setting the value of the average speed for each location:

$$\boldsymbol{\varepsilon}(d,x,k) = d * \left[(\boldsymbol{E}^{k}_{\boldsymbol{full}} - \boldsymbol{E}^{k}_{\boldsymbol{empty}}) * \frac{X^{P}}{\boldsymbol{C}^{P}_{k}} + \boldsymbol{E}^{k}_{\boldsymbol{empty}} \right]$$

Avec :
d : travled distance
$\mathrm{E}^{\mathrm{k}}_{\mathrm{full}}$: Emission of truck type k in full load
$\mathrm{E}^{\mathrm{k}}_{\mathrm{empty}}$: Emission of empty truck type k.
X^{P} : Total weight of transported parcel
$\mathrm{C}^{\mathrm{P}}_{\mathrm{k}}$: Weight capacity of k type truck.

The calculation of emission $\mathrm{E}^{\mathrm{k}}_{\mathrm{full}}$ and $\mathrm{E}^{\mathrm{k}}_{\mathrm{empty}}$ according different transport capacity are based on the data provided in [19] [20].

Societal Indicator. In France, more than 80% of freight transport is done by road transport [21], this leads to strongly solicit transport system and infrastructure. Trade in goods actually creates congestion on some roads, insecurity and various nuisances to the public.

Therefore, other criteria must be taken into account when evaluating logistics pooling projects, which are societal incidents on the various parties involved in such projects. Two parties are mostly affected: carriers and residents. Carriers are the main actors of transport pooling, and their needs and expectations should be taken into account. Any reduction in the number of kilometers traveled, helps reduce the risk of accidents. Decreasing congestion, reducing the number of trucks involved in logistics pooling projects, also plays a role in reducing accident risk. For our purposes, we chose to use the shipping rate and traveling distance for the accident risk assessment.

The second stakeholder is the rest of the population, who are not directly involved in the transport of goods, but who share the same transport network. Network congestion by trucks, which increases especially near to logistics areas (platforms), the noise and blocking streets causes of trucks, and other situations are considered negative by residents. Thus, a logistics pooling system that reduce congestion, or reduce the perception of large vehicles in transportation networks can be considered as a good solution. Note that all of these indicators are difficult to quantify empirically, because they are linked to more sociological aspects. For this reason, we consider the indicator of the number of trucks used, which can tell us about other less quantifiable indicators.

5 Conclusion

The particular case of agri-food SMEs logistics pooling is an original issue not addressed in the literature. In this context, our work proposes a new model that integrates characteristics of agri-food SMEs logistics flow in the Loire region, and that takes into account sustainable development objectives with its three dimensions: economic, environmental and social.

The elements necessary for modeling the research question have now been identified and allowed a first proposal of the conceptual model. As future research lines, we are currently working on its validation in a real agri-food SMEs pooled network.

Acknowledgments. Authors would like to thank Region Rhône-Alpes for its financial support (Research Cluster GOSPI).

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Integrating Intangible Assets within Collaborative Networks Performance Management

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Abstract. It is out of question the importance that intangible assets have acquired during the last decade. The management of such intangible assets is getting more and more the attention of both academics and professionals. It is aimed, through the application of different models and tools, to measure and manage them in order to achieve competitive advantages that will lead to better business sustainability. In this sense, organizations, taking into account both the intra and the inter-organizational level, must be able to seek and find the most efficient ways of integrating their intangible assets within their performance management systems. Up to now, most of the existing scientific works are focused on managing the intangible assets at the intra-organizational context. The key role that collaborative networks has got at the business ecosystem nowadays, and will have in the future, demands to define frameworks that deal with intangible assets management at the inter-enterprise context. This paper describes an approach of how to integrate intangible assets within collaborative networks. It follows a collaborative business processes approach, taking into account both the global ambit of the collaborative network as well as the individual enterprises that comprise the collaborative network ambit. The model includes a simplified and agile intangible assets management model, which might be used as a reference framework for collaborative networks in this field.

Keywords: Intangible assets, Collaborative networks, Performance management.

1 Introduction

From over a decade ago, concepts such as intellectual capital, intangible assets, knowledge management, intellectual assets, etc., have emerged in the literature significantly. Lots of works, projects and publications have focused on researching all these concepts from different areas and under different views. The idea that resides in this effort is clear: to try to measure and manage everything that adds value to the organization, but given its intangible nature, all these concepts have been long overlooked by both academics and professionals. Now, what is meant by intangible assets? A simple but comprehensive definition is provided by [1], "Intangible assets are a firm's dynamic capability created by core competence and knowledge resources, including

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 631–638, 2013.

organization structure, employee expert skills, employment centripetal force, R & D innovation capability, customer size, recognizable brand, and market share". Thus, intangible assets and intellectual capital can be understood as synonyms, or what it is the same: the intellectual capital is composed of all the intangible assets of an organization.

The intangible nature is reflected on their influence for value creation, competitive advantages generation and economic benefits [2], [3], [4]. Thus, a company's capability to create value depends on its ability to implement strategies that respond to market opportunities by exploiting their internal resources and capabilities [5].

Currently, in the knowledge society, the focus is directed to the intangible assets. This reflects the belief that intangible assets are a fundamental resource of corporate growth and organizations need to put into work procedures for managing them [6].

In this sense, this work has been focused over time on various tasks: firstly to clarify, as far as possible, all the concepts used (although up to date there is not any standardization neither of definitions nor concepts); moreover, in developing models and tools to measure and manage in the best possible way such intangible assets; and, ultimately, in creating the mechanisms to incorporate their value to traditional tangible assets, thereby achieving to define the overall value of an organization. Initially, the work is focused on the intra-organizational (the vast majority of the work done is exclusively in this field) and, rapidly, it is seen some works that attempt to address the inter-organizational field. This paper describes an approach of how to integrate intangible assets within collaborative networks. The approach includes a simplified and agile intangible assets management model, which might be used as a reference framework for collaborative networks in this field.

2 Intangible Assets Management

Nowadays, it is completely accepted that there is a relationship between intangible assets and the performance of an organization. Thus, organizations able to measure and manage intangible assets will be in a better position to improve their performance. Although the important influence that intellectual capital (IC) possesses on business performance is greatly acknowledged, few studies have been devoted to demonstrating how the different intellectual capital components influence performance and what specific performance dimensions are affected [7]. However, how the IC is related to the organization's performance? Some authors have worked on this subject although certainly with disparate and unconnected results [8], [9], [10], [11].

On the other hand, other frameworks are focused on the intangibles related to the defined strategies such as [12]. This framework identifies the need of linking the intangible assets with the strategy of the company; this model proposed the identification of the strategic objectives of the company and the critical intangible assets related to each of these strategic objectives. Other studies have focused on defining methods that take into account the relationships between intangible assets, tangible assets and strategic perspectives of the organization [13]. In this sense, an organization should try to understand which of its both tangible assets (TA) and intangible assets (IA) influence the sustainability of competitive advantage the most [14].

Moreover, it is important to note also that IA are affected by various factors, which should be monitored to some extent. Thus, according to [1], the factors affecting intangible assets can be classified into six categories: intangible capital, ownership structure, corporate governance, firm characteristics, industry characteristics, and reactions of analysts and customers. In turn, other authors such as [15] proposed that the variation in value of an intangible asset is explainable by the appreciation or depreciation of its context (market forces, speculation, problems with unions, and competition risks such as new technology, new regulations or new imports). This author suggests that the effective (or ineffective) use of intangible assets also affects value as part of a dynamic system with internal variations and exchanges within the context.

Following the above, we must tackle several problems; firstly, the actual measurement of intangible assets, then the management, and, finally, to find out how these assets influence on performance and how to maximize the value creation. The main difficulty is to integrate the intangible assets with the tangible assets within a performance management system. Furthermore, this problem becomes more complex when the scope of the work is at the inter-organizational context, as it is a collaborative network.

It is in this collaborative network area where less it has been worked when managing intangible assets, and therefore, where greater efforts must be made. Some authors have developed frameworks to measure and manage the performance in collaborative areas [16], [17], [18], [19], [20], [21], [22] but they have not dealt with how to integrate intangible assets. The most important points that need further attention to integrate intangible assets into the performance management systems used in the collaborative networks field are the following:

- There is a set of factors (Collaborative factors) that influence to the collaborative network performance and, therefore, has a direct or indirect impact on intangible assets. Among others it may be mentioned the following factors: trust, equity, coherence, visibility, contradictory objectives, or communication issues [17]. This factors need to be properly managed in order to achieve an effective collaboration. If these factors are not managed, it is possible that this type of relationship can result in problems such as internal and external conflicts, loss of customer satisfaction and cost increase [23,24].
- Establish the linkage between the tangible and the intangible assets of the CN. This is such a difficult task, but it needs to be done in order that CN decision-makers will be able to clearly know to what extent the achievement of a certain degree of intangible assets within the CN is impacting over the fulfilment of the CN's strategic objectives [6].
- Intangible assets are also affected by a number of "structural" factors that may distort their value or hide the true incidence of these on the collaborative network performance. A classification of these factors is the following: intangible capital, ownership structure, corporate governance, firm characteristics, industry characteristics, and reactions of analysts and customers [1].
- Nowadays, individual enterprises take part in several supply chains/CNs and, therefore, it is very likely that some of these CNs will have contradictory objectives. This fact has actually a decisive impact on intangible assets, as if they help to achieve the CN strategic objectives and, at the same time, the achievement of such strategic objectives do increment or improve the IA, the question is: what happens from an indi-

vidual point of view when there are conflictive targets between different CNs in which a particular company is involved? How to find a good "coherence" level between objectives, levels (individual - CN) and intangible assets for achieving both a local and a global performance improvement?

The following section presents an approach to integrate intangible assets within collaborative networks following a Collaborative Business Processes approach, taking into account both the global and the individual ambit. The model includes a simplified and agile intangible assets management model, which might be used as a reference framework for collaborative networks.

3 Integrating Intangible Assets within Collaborative Networks Performance Management

In the previous section, we have described some of the principal points on which to pay attention when trying to build a framework able to integrate intangible assets within collaborative networks performance management. Figure 1 shows a generic framework approach, which illustrates the steps required for such integration, and Figure 2 shows the intangible assets management model.

The Generic framework simply establishes that there are two main phases (Phase I: Strategic framework definition, and Phase II: Processes framework definition), which works on three levels (Collaborative Network, Processes and Individual); because the collaborative factors are affecting to the CN performance, they must be taken into account in both phases. Moreover, it is absolutely essential that there is an adequate coherence degree between levels.

The Intangible Assets Management model establishes the structure and relationships between different elements of performance measurement/management to be used: Intangible/Tangible assets, Objectives, New intangible/intangible assets and key performance indicators (KPIs). Furthermore, as justified in the previous section, there are some structural factors affecting intangible assets, which therefore must be taken into account. As in the Generic framework, elements are structured in the same three levels (Collaborative Network, Processes and Individual).

Next, it is defined each of the elements used:

- Assets: it is any resource, both tangible and intangible, which possesses an organization (or CN single enterprise) or it would be appropriate to posses, and which shall be used when achieving each objective. This paper only focuses on the intangible assets.
- Objectives: They serve to define the desired result and, therefore, the objectives are something that can be evaluated or tested.
- New assets: all the resources, tangible or intangible, which are generated when achieving a certain objective. For example, can be the result of achieving a goal, both creating a new asset not previously available within the organization (by generating it or acquiring it in the market), or the increase in value of a particular asset, which already had the organization. Identification of new assets helps to establish which the direct and concrete results arising from the achievement of each goal are. This paper only focuses on the intangible assets.

- Key performance indicators: they are elements or factors, which characterize and identify one aspect susceptible of measurement in order to evaluate or establish control over such area. If the nature of the intangible asset is quantitative, its measurement is performed; on the other hand, if it is qualitative, it is necessary to proceed to its valuation. KPIs will be established on the Assets, New assets and Objectives.

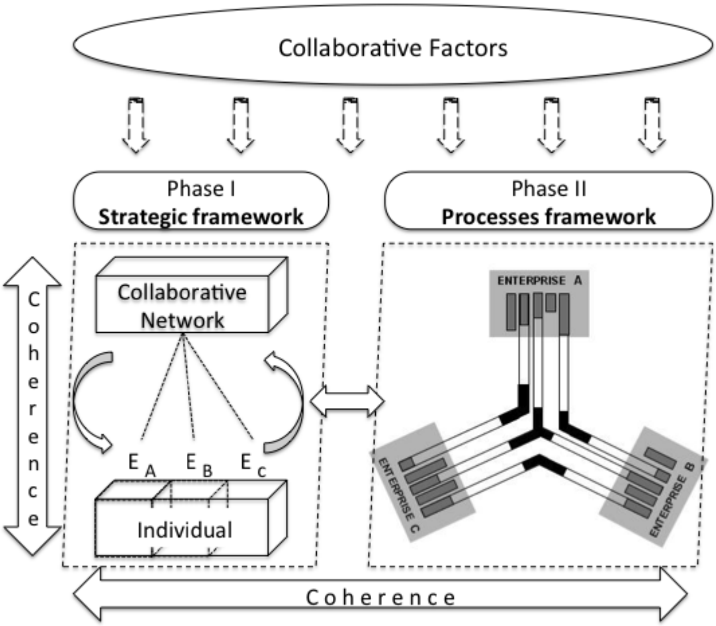

Fig. 1. Generic framework approach

Below, it is described the implementation methodology.

Step A: Business entity conceptualization

At this stage, it is clearly established how the Collaborative Network is made, what its critical business processes are, which activities are related to each business or organization, and finally, the collaborative factors that affect or might affect to the CN performance (at all levels) are identified.

Step B: Performance requirements definition

After the business entity has been conceptualized, all the performance measurement elements (Intangible assets, Objectives and KPIs) are defined. This shall be done in two phases (see Figure 1) and three levels (CN, Processes and Individual):

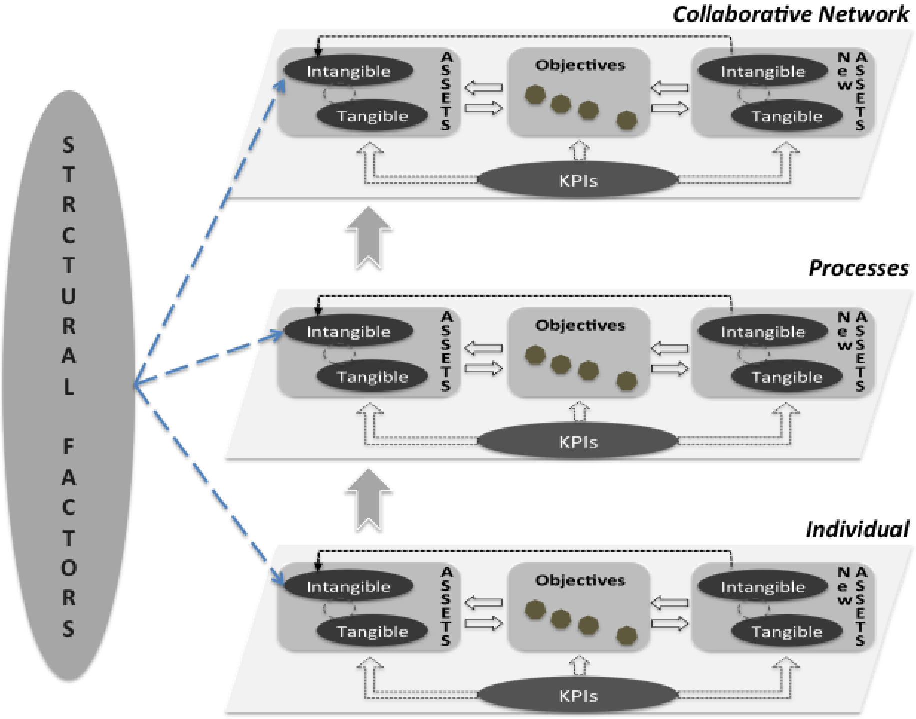

Fig. 2. Intangible assets management model

- Phase I: Strategic framework development. The order between levels will always be: CN, Processes and finally, Individual level. Firstly Objectives are defined, identifying then the intangible assets that will be needed in order to achieve the Objectives. Some of them may be provided directly by the CN but others do not, therefore, the latter will be acquired from outside the business entity. The following is an analysis of possible new intangible assets that may arise as a result of achieving the defined objectives, and how to integrate them into the business entity. Later, the identification and analyses of the main Structural factors that affect or may affect the intangible assets (and therefore should be monitored and taken into account) is carried out. Finally, the definition of the KPIs that help to measure and manage the items is done (see Figure 2).
- Phase II: Processes framework development. This phase tries to make a projection of all the performance requirements defined in the previous step over the main processes or critical processes. In this sense, it is possible to find some new performance elements but they will always be consistent with those defined in the previous level. Finally, the projection process is repeated, but this time at the individual level, although, at this level, each CN partner carries out internally such a projection process. Obviously, there should be a clear consistency with the performance measurement elements defined above at the processes level.

Step C: Analysis and monitoring KPIs

Once it has been operated, the Intangible assets management model must perform an analysis of the KPIs results. By doing this, it will be possible to carry out and establish the correspondent conclusions.

4 Conclusions

In recent years, intangible assets are under a deep analysis. Academics and practitioners are developing a lot of work and effort to identify, integrate and manage them. Most of the works have focused on the intra-organizational context, and efforts should be also directed toward the inter-organizational context.

This contribution has analysed the problem of integrating intangible assets within a Collaborative Network. In particular, it has focused on those intangibles assets that help to improve the performance of a CN and its associated business processes. A Generic framework as well as an Intangible assets management model that allows integrating intangible assets within collaborative networks performance management has been introduced. This work is still under development and will be expanded and tested practically on various CN to refine those aspects susceptible to be improved.

Acknowledgements. This work has been developed within the research project called "Integration of the sustainability indicators within industrial supply chains strategy by applying mathematical techniques (SP20120890)" funded by the Universitat Politècnica de València.

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How to Achieve Dynamic and Flexible Performance Management Systems for Collaborative Processes

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Abstract. One of the main characteristics of successful collaborative networks is their ability to continuously reformulating their processes. The, they can quickly get adapted to environment needs and therefore define more competitive processes. One of biggest weaknesses of Performance Management Systems (PMS) when dealing with collaborative processes associated to collaborative networks, is their low degree of both dynamicity and flexibility to get adapted to the changes that such collaborative processes experiment. The main changes that can take place are, among others, small or large modifications of the own processes, entrance and/or exit of new participants in the process, incorporation and/or elimination of processes, changes in objectives and/or strategies of processes of some participant, or even of the whole collaborative network, etc. All this brings continuous modifications over the components that conform the PMS. Then, it is necessary to structure certain mechanisms that will provide with both dynamicity and flexibility to the PMS. Otherwise, these PMS will become obsolete in the short-time and will be not useful anymore. Further, these PMS will not measure properly performance and then they will become ineffective, becoming the source of troubles. Scientific literature shows that most of the works that deal with PMS dynamicity and flexibility are focused on intra-organizational contexts, leaving almost apart the collaborative networks ambit. This work analyses those aspects that prevent to the PMS to be dynamic and flexible when applied to manage the performance of collaborative networks. In addition, we discuss and analyse several mechanisms that should be incorporated into the PMS, making them more dynamic and flexible.

Keywords: Collaborative process, Dynamic and flexible, Performance management system.

1 Introduction

Inter-organisational co-operation has been one of the most used organisational strategies to compete and become adapted to the exigencies of the global market. Thus, collaboration is becoming more a necessity than an option [1]. In this sense, collaborative business processes are the key components to be developed so that

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 639–647, 2013.

collaboration between companies is useful. For that reason, companies look for both organisational models and tools able to manage these processes at both inter and intra-organisational levels. In this context, it is necessary to measure the performance of these collaborative business processes in a twofold manner, from a global perspective (inter-enterprise) and from an individual or partial perspective (intra-enterprise). The collaborative business processes acquire an extended nature, in which two or more enterprises or organisations participate. Besides, "collaboration" is an amorphous meta-concept that has been interpreted in many different ways by both organisations and individuals, and when it is put in the context of the supply chain it needs yet further clarification [2]. So, when we talk about collaborative business processes, these are understood as "a process where two or more enterprises participate, independently of the degree of cooperation/collaboration existing between them". Figures 1 and 2 show a representation of this concept. Figure 1 shows four extended business processes belonging to three enterprises that are operating at the intra-organisational (white area) and inter-organisational (represented by a grid).

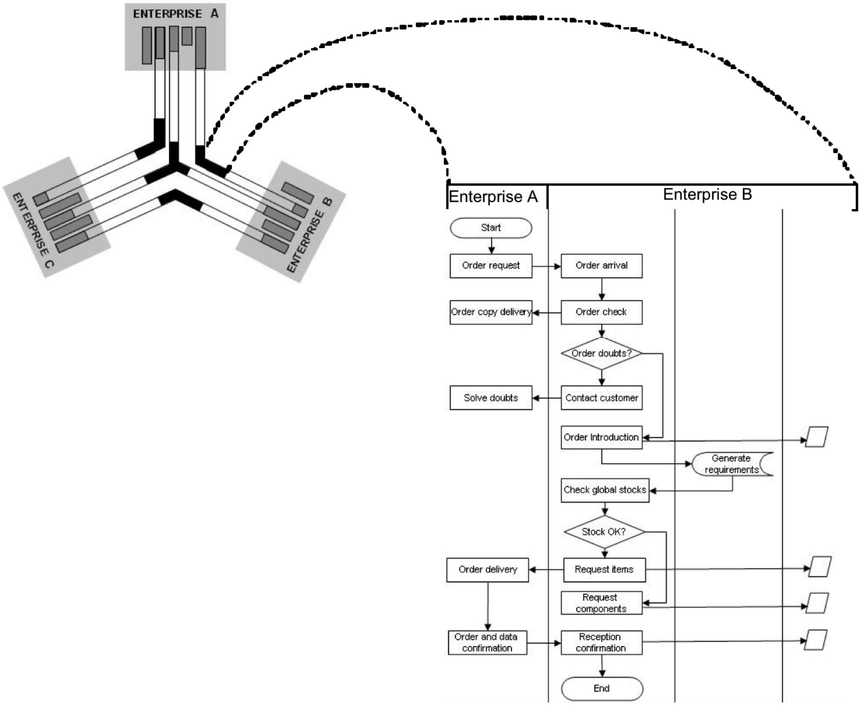

Fig. 1. Concept of collaborative business process [3]

Figure 2 shows the relationship between the internal and the collaborative processes, where they may eventually need to exchange all kinds of resources, being usually necessary to share applications and data for their successful implementation. Then, it is necessary to structure certain mechanisms that will provide with dynamicity and flexibility to the PMS. Otherwise, these PMS will become obsolete in the short-time and will be not be useful anymore. Further, these PMS will not measure properly performance and then they will become ineffective, being the source of troubles. In the next section of this paper we review the literature to analyze the works that address the dynamic issue within PMS, then it will describe the aspects that prevent a PMS to be dynamic and flexible when dealing with collaborative processes; later it will address the mechanisms to provide flexibility and dynamism to the PMS operating in that context, and finally, it highlights the main conclusions.

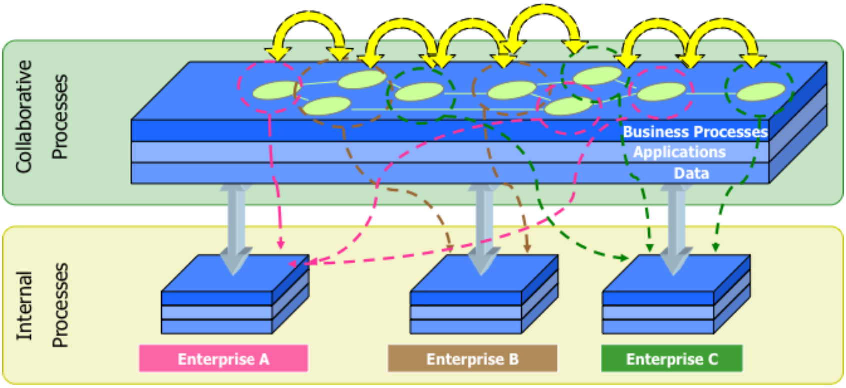

Fig. 2. Concept of collaborative business processes [4]

2 Literature Review

Although many authors have suggested the importance of designing dynamic PMS, few have deepened on how to define mechanisms to provide them with that quality. Furthermore, almost all of the works have focused on the intra-organizational context. This section (see Table 1) presents a brief summary of the most interesting contributions found in the literature, which either directly or indirectly serves to address the dynamism and flexibility concepts within a PMS that deals with business processes of a CN.

Table 1.

Author	Main contribution
Ghalayini et al. [5] (1997)	Developed the Integrated dynamic performance measurement system (IDPMS). This framework integrates three main areas of the company: management, process improvement team, and factory shop floor. Synthesizes three existing tools (PMQ, half-life concept, VFCT diagrams) and provides an integrated approach that supports performance measurement system alignment across managerial and operational levels.
Waggoner et al. [6] (1999)	Created a framework about the forces impacting performance measurement system evolution and change. Established four groups: internal influences, external influences, process issues and transformational issues.

Table 1. (*continued*)

Bititci et al. [7] (2000)	Created a model (the integrated model) in which for different levels (business, business units and business processes) it applies a structure based in an external and internal monitoring system that helps to review the objectives and KPIs for deployment and alignment. Focusing on exploring the use of IT based management tools. This author affirms that the requirements from a dynamic PMS are divided into two categories: A) Requirements of the own framework; B) The requirements for an IT platform.
Kennerley et al. [8] (2003)	Defined a list of enablers and barriers to the evolution of PMS, establishing also the principal internal and external triggers that might affect to the PMS. Besides, it groups together to the enablers and barriers under four critical factors.
Kennerley & Neely [9] (2003)	Derived from the previous work, they developed a Framework of factors affecting the evolution of PMS. This framework is based on the fact that the evolution of a system is possible through execution of four phases, namely use (of the PMS), reflection (to identify where it is no longer appropriate and where enhancements need to be made), modification (to ensure alignment to the organisation's new circumstances. and deployment (of the modified PMS).
Najmi et al. [10] (2005)	Designed a Performance Measurement System Review Framework, on the one-hand reviews the business performance at three levels (on-going review, periodic review and overall review) and on the other, the PMS performance review (focuses on the actions taken by the PMS, being of special relevance the PMS design impact analysis y el PMS implementation impact).
Salloum M. [11] (2011)	Developed a framework for dynamic PMS (See Figure 3). The framework incorporates the factors that constitute dynamics in a PMS, their systemisation and what to consider when realizing them in practice. It uses 19 factors that are systemized into five sub-headings (review process, IT-Systems, management, employees and culture). PMS. Additionally, in order to realise dynamic PMS in practice, two broad factors need to be considered: A) the PMS design: the characteristics of the current PMS and the systems and processes integrated with it; B) the PMS context: the current IT-system capabilities and the level of maturity of management, employees and culture in the organisation.

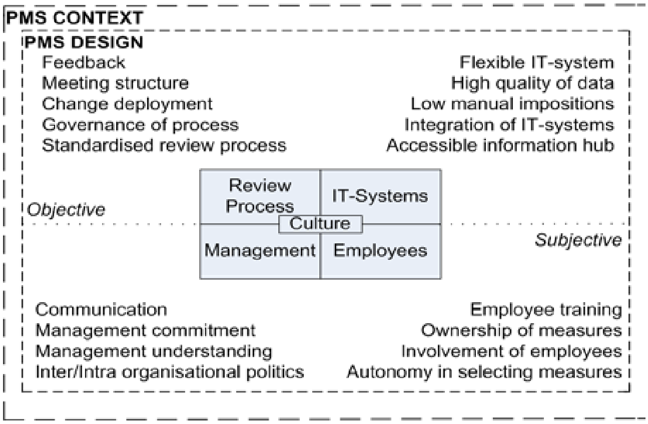

Fig. 3. Framework for dynamic PMS [11]

3 Aspects that Prevent PMS of Being Dynamic and Flexible in the Context of Collaborative Processes

Currently, collaborative business processes have a set of characteristics that prevent them from being properly managed. Thus, PMS found difficult to get adapted to such characteristics and therefore do not carry out a proper management of the processes. Those features are described next:

A) Implication of Various Actors. In a collaborative business processes context, there are at least two companies involved, but it is not common to find collaborative processes crossing four, five or more companies. When designed, implemented and put into operation, a collaborative process must be aware of all the components that influence it: operations, resources, applications, information systems, etc. Any change in one of these components may affect the collaborative process performance and this fact should be registered in the PMS, keeping it in mind when referring to the collaborative process performance. Further, it may objectively assess whether the results are correct or they have been affected by this circumstance. Today, it is increasingly common that any of these components change quite often, because the participation in the collaborative process by multiple companies increases this possibility.

B) Lifecycle Collaborative Processes Are Becoming Shorter. This feature is very important. Our current consumer society demands products and services that must be constantly renewed, in a rapid way. This circumstance forces companies to more quickly develop such products and services. The times spent on both the process engineering phase (definition, representation, design and construction) and on the operation phase (implementation and analysis) are becoming shorter. This fact, together with the number of actors involved in the collaborative process requires the used PMS to be very versatile, able to collect the singularities of both phases in the minimum time. With such short lifecycles, it is essential a perfect cooperation of all the collaborative network members.

C) Equity of Resources Risks and Benefits. When several companies collaborate in a collaborative process, they must provide various types of resources (financial, material, human, etc.); so, it is necessary that the expected benefit they want to get is equitable to the investment risk, but especially equitable compared to other participants in the collaborative process. The applied PMS should be sensitive to this particularity, especially in very dynamic environments in which the creation or modification of processes is constant. Thus, transmitting a feeling of equity between partners is vital to the proper functioning of the collaborative process and, extensively, to maintain a good working environment within the CN.

D) Information Sharing. To properly work, collaborative processes need to share information, and this information has to be useful, meeting three key requirements: accuracy, timely and relevant. The role of IS/ICT is central to assure that the information exchange process is agile, effective and efficient. Moreover, when two or more companies share information, trust between them is essential for the collaborative process to be fully effective.

E) Joint Decision-Making. One problem in collaborative processes contexts is the establishment of a consensus decision-making process, where the assignment of responsibilities is often a contentious element on many CN. Therefore, we must clarify the decision-making process, establishing the scope, level, participants, responsible and procedure. The decision process should be agreed by all the partners, and have to put the necessary resources to make it as dynamic as possible.

Once the main particularities of the collaborative processes have been described, the two main aspects that prevent PMS of being flexible and dynamic in this context are next analysed:

I) Lack of a Structured Framework. Most of the PMS have a structure based on a methodology with several sequential steps, which describe how they will define a set of performance elements (objectives, KPIs, etc.) according to some criteria and hierarchies. The structure of these PMS is designed for relatively stable environments, where the modification of any of the performance elements involves a great effort and, in many cases, a rethinking of other involved downstream elements. Moreover, the methodologies are often tedious, with many phases and where the working groups are relatively homogeneous and therefore have not developed practical deployment scenarios for those working groups. Few PMS count with review mechanisms, and those that have them are thought to employ such mechanisms one or two times per year (totally inadequate regarding today's CN environments). In this sense, In this sense, when we apply the review mechanisms, in most cases, we are obliged to develop virtually all PMS methodology, which takes a lot of effort and time. The lack of traceability between performance elements, levels and participants within the collaborative process of the CN is a critical element that drives the PMS to be inefficient in these environments.

II) Lack of Integration between the PMS and Intra/Inter-organisational Information Systems. The performance management of any type of process requires a lot of information, but when we deal with collaborative processes the problem is not only the generation and processing of information itself, but also the different sources and actors involved in the generation of this information. Surely, if the PMS is not integrated into the information systems of the partners or at least they do not have the tools to connect to the PMS, the effectiveness and efficiency of the PMS will be lowered in a short time. Today, collaborative processes change so fast that necessitate the use of fully integrated PMS within the IS, at both the intra and inter-organisational context. The connection of all the performance elements of the PMS through the IS is a vital task in order to provide the PMS with both dynamicity and flexibility, which would enable that all the possible variations, modifications and adjustments to any of these elements have a rapid deployment by all partners. Currently, the available PMS for collaborative processes do not possess informational architectures to provide a proper and effective integration with ERP systems.

4 Mechanisms to Be Incorporated into the PMS to Be More Dynamic and Flexible

This section describes the mechanisms and actions that should be incorporated into the PMS to provide them with both dynamism and flexibility. It is not intended to make a list of all of such mechanisms but rather to describe those that may have a greater role:

- To Introduce Mechanisms That Trigger Automatic PMS Reviewing Processes. Since changes in any of the PMS elements could not only be due to alterations of exogenous or endogenous events to the CN, the reviews should be remembered automatically following a programmed pattern.
- To Incorporate Tools to Analyse Both the Consistency and Coherence between the Performance Elements. When one or more PMS elements are modified as a result of changes in the collaborative processes, the PMS tends to lose consistency and therefore its ability to manage the performance of such collaborative processes decreases. These tools can be based on consistency diagrams, cause-effect diagrams, some statistical techniques, etc.
- Simplify PMS Methodologies. Sometimes PMS methodologies can be quite complex, which implies to be very laborious and then when any change occurs, the effect is that the PMS becomes a rigid tool, difficult to get adapted to the demands of collaborative processes._
- To Define Specialized Working Groups for Reviewing and Implementation (Training). The implementation and maintenance of the PMS in collaborative environments requires the use of expert working groups of all partners involved. Thus, the higher the formation in this type of tools the greater the rapidity degree in applying the changes.
- Design and Include within the PMS Informational Architectures, Easy to Integrate with the IS, Both at the Intra and Inter-organizational Context. Although many PMS are not associated (because are not developed yet) to any informational architecture that supports all of the necessary information for assuring a correct operation, within collaborative environments this is an essential factor. The use of different informational systems at different levels (intra and inter) requires from PMS to have an adequate information architecture that facilitates the integration of the system, establishing the mechanisms of standardization and compatibility and facilitating the collection and processing of information.
- Add KPIs Monitoring Systems. Monitoring systems are very important. Here, it is necessary to improve the understanding of KPIs changes, and extensively how these affect to the collaborative processes performance. Different levels can be established depending on the type of information needed and the degree of information aggregation that different users need; obviously, the level of monitoring shall include the information required by the type of decision to be taken.

5 Conclusions

Collaborative business processes are the key components to be developed in order to achieve a useful and successful collaboration between companies. For that reason, it is necessary to measure the performance of these collaborative business processes in a twofold manner. Many authors have suggested the importance of designing dynamic PMS, but few have deepened on how to define mechanisms to provide them with that quality. This work has reviewed the aspects that prevent PMS of being both dynamic and flexible in the context of Collaborative Processes (implication of various actors, equity of resources, risks and benefits, shared information, collaborative processes lifecycle becoming increasingly shorter and joint decision-making). Thus, the two most important aspects preventing PMS of being dynamic and flexible in a collaborative context are: lack of a structured framework and lack of integration between the PMS and the intra/inter-organisational information systems. Finally, this work has commented the mechanisms that should be incorporated into the PMS to provide them with dynamism and flexibility. It is necessary to further research about these mechanisms to improve the PMS at the collaborative processes and networks context.

Acknowledgements. This work has been developed within the research project called "Exploring latent information of key performance indicators by identifying their cause-effects relationships at the inter-enterprise context (1992)" funded by the Universitat Politècnica de València.

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Sustainable Collaborative Networks III

Collaborative Inter-firm Relationships Based on Sustainability: Towards a New Framework

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Abstract. After decades of industrial decline, the models of firm competitiveness, green economy, green growth, are making the news. Indeed, there is a growing trend in the reversal of outsourcing or offshoring production of goods and services while inter-firm relationships are under scrutiny. A trend being reinforced by the global awareness on resources scarcity, to integrate in the processes the impacts of climate change and eventually reduce them, to prepare for growing energy costs. The linear economy and it's models of value creation based on trading margins of imported, outsourced, goods and services, global competition between companies, resources spillage, has shown it's limits.

Keywords: Value creation, Inter-firm collaboration, responsible supply chain, business models, industry ecosystems.

1 Introduction

The twenty-first century started on a profound global crisis affecting the fundamental living supports of human kind: it's social and environmental conditions. Now in the era of *anthropocene*, human kind has become a geological agent itself that is able to change the very structure of the biosphere, causing the sixth mass extinction of species and posing a global threat to all our global systems with an "economy that extracts resources at increasing rates without consideration for the environment in which it operates, without consideration for our natural planetary boundaries." [1]

Since the Brundtland Commission has given the first definition of sustainable development as a development that "*meets the needs of the present without compromising the ability of future generations to meet their own needs*" [2], we keep going towards financial crises and natural catastrophes: as the latest report from the World Economic Forum put's it: "Future simultaneous shocks to systems could trigger the 'perfect global storm', with potentially insurmountable consequences" that can doom chances of developing an effective, long-term solution [3]. How did we get there and what can we do to shift the model?

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 651–659, 2013.

2 The State of Our Industries

An Outdated Model Based on Unsustainability. In a paper published in 2011 in Harvard Business Review, Michael E. Porter and Mark R. Kramer declared: “Capitalism is under siege, business being increasingly viewed as a major cause of social, environmental and economic problems”. Indeed, global growing concern for Corporate Social Responsibility speaks for itself.

According to Porter and Kramer, the problem lies in the fact that most companies are trapped in an “outdated model of value creation” which can be summarized in this description: “Facing growing competition and short term performance pressures from shareholders, managers resorted to waves of restructuring, personnel reductions, and relocation to lower-cost regions, while leveraging balance sheets to return capital to investors” [4].

Industrial Decline and Value Creation. Michael Porter and Jan Rivkin asked HBS alumni [5] about where they intended to locate their future business and found that many of them thought wages abroad were lower, and that they needed to reach customers in big new markets, a case to leave or offshore. Though Porter and Rivkin state that firms are now ready to reconsider offshoring, realizing “they overdid it” discovering hidden costs, they argue that “America’s government is not making the country’s business environment attractive enough for companies to want to come back.” One can ask what the government as to do with the responsibility of firms and investors.

A brief look at OECD value added by industry and services, unemployment and commercial balance of goods (figure 1), seems to show some correlation.

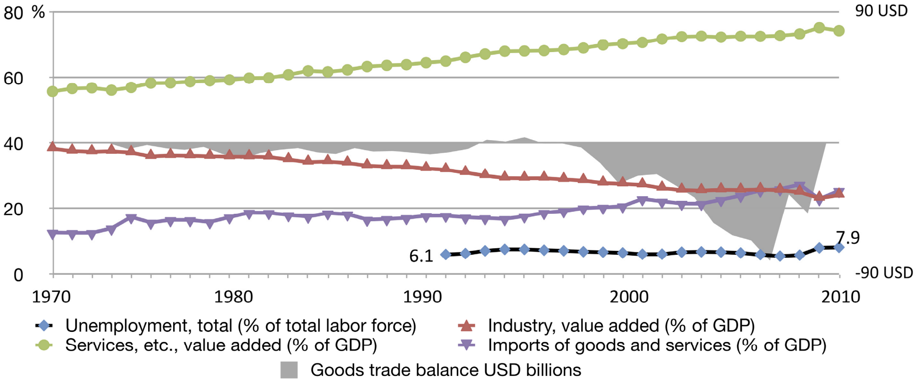

Fig. 1. Evolution of value added by industry and services (source OECD Stats)

The Models Behind the Decline. Michael E. Porter came up with a model that have been at the base of the value creation model he criticizes in 2011:

In 1980, Porter described “Techniques for Analyzing Industries and Competitors” based on “five forces that shape competitive intensity”. This model is focused on the environment of the company and comprises three horizontal threats and two vertical powers [6]. Horizontal threats are new competitors addressing the market (new entrants), new products that could replace the company's products (substitute products) and the existing rivalry between established companies in the same industry. Vertical powers are on the opposite sides of the value chain of the company: the bargaining power of the suppliers on one side, the bargaining power of the customers on the other side. A model exclusively orientated on confrontation (figure 2).

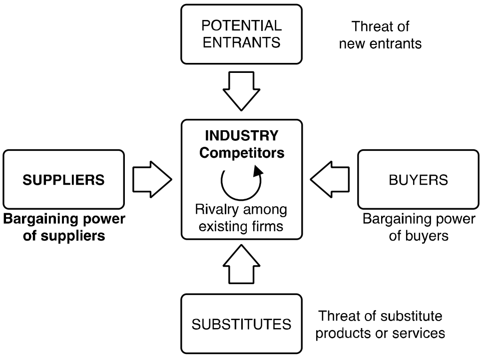

Fig. 2. Porters' five forces that shape competitive intensity

Of course this five forces model is just a part of Porter's strategic model. It has been widely used over the last decades by companies to design their strategies with heavy consequences: in this model, suppliers are exercising a pressure on the company. This vision pushes procurement or buyers to weaken the position of the suppliers [7] by improving the bargaining power of the buyer, for example by using strategies such as "Spread Purchases" (divide to rule) or even manipulate the perception of suppliers to "Create a Threat of Backward Integration: Whether or not the purchaser actually desires to backward integrate into" voluntarily leaking word of internal studies of the feasibility of integration [8]. Is this a justifiable mean for the purpose of gaining power against suppliers? For Porter, "The objective of all these approaches is obviously to lower the total long-run costs of purchasing".

Other strategic models have been studied and advocated in the management of the Supply Chain. In a worldwide opened market, suppliers being available to competitors of the firm, purchasing started to become a strategic function, but most common reference models in dealing with suppliers' portfolio are based on power relations between suppliers and buyers. [9]. Moreover, Porter in 1985, described "Creating and sustaining superior performance" [8] based on two main approaches that can be complementary: competitive strategies based on costs or based on differentiation. In this complimentary book, Porter describes *Generic strategies*, and the *Value chain* of the firm, and goes into a finely grained approach of building strategic advantages through extensive cost analysis in the value chain, but also provides a customer approach to "Buyer purchase criteria" that describes the approaches that can be used to create value on differentiation: Use purchase criteria that lower buyer cost or enhance buyer performance, which can comprise product quality, features, delivery time etc. Signaling purchase criteria that are based on signals that infer on the perception of the value by the customer, and can include advertising, attractiveness or *reputation*.

Though since the 70s research literature reflected growing concerns to integrate stakeholders and environmental issues in the business models of firms [10][11][12][13][14], Porters' strategic models kept five types of stakeholders for which the firm creates value based on their power of influence: customers, employees, financial partners, *community* and shareholders. While shareholders value creation model was gaining momentum, reducing costs and not to mention, neglecting worldwide locations became mainstream. Over the last decades, the evolution of strategic and business models have mainly focused on shareholders value creation and global offshoring and outsourcing [15]. "Overdoing offshoring" is not what we can describe as a discovery.

Regarding industrial decline specifically, the loss of industrial employment was analyzed as not posing a threat for the economies [16] provided it was due to both an increase in productivity in the industries (and a shift to high value industries), improving the population wealth, and, as consequence, a rise of the service economy to absorb the workers, all with the strict provision that the demand for manufactured products wouldn't be satisfied by other industrialized countries. Otherwise, it would lead to a systemic deficit of the balance of payments for countries. We can see that, not only services haven't been able to compensate for industrial jobs losses, but also that the dynamics of the service industry is directly connected to the dynamics of the manufacturing industry, with a ratio connecting both industries [16]. Roughly, there cannot be a service industry without consistent manufacturing industry.

"Improper" outsourcing contributes to the industrial decline of western firms [17]: outsourcing decision can individually make sense and create value, but multiple outsourcing decisions analyzed in the industrial ecosystem reduces the capabilities of a whole industry to remain competitive. Companies get trapped in a "spiral of decline" resulting from defensive incremental outsourcing decisions under the pressure of "underperforming business units to improve cost or profit performance", while corporate executives try to maintain continuous growth in earnings to support stock values, as shown in figure 3:

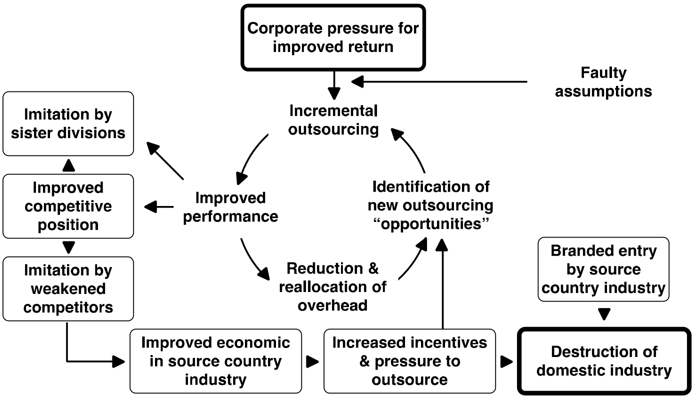

Fig. 3. Spiral of decline of the U.S. and western industries described by Bettis and al

After decades of this industrial decline, the models of firm competitiveness, green economy, green growth and reindustrialization, are making the news. Indeed, there is a growing trend in the reversal of outsourcing or offshoring production of goods and services while inter-firm relationships are under scrutiny.

This trend is being reinforced by the global awareness on resources scarcity, the necessity to protect high value research and development, to integrate in the processes the impacts of climate change and eventually reduce them, to prepare for ever growing energy costs. The business models based on high margin trading on imported, outsourced, goods and services, and global competition between companies and even territories, without sound rules, seem to have shown their limits.

3 Measuring the Losses to Rethink the Models

A Case for Reindustrialization? In the United Kingdom, while the number of companies manufacturing outside the UK increased from 32% to 42% between 2009 and 2012, a survey by the EEF [18] showed that 40% of manufacturers have brought a part of their manufacturing capacities back from overseas. For these companies who still need to be competitive on price, the cost conceptual model has changed: "UK manufacturers are increasingly securing orders based on quality, service and providing complete solutions". More than half of UK manufacturers expect to increase domestic sourcing over the next few years [19]. The balance between trying to enhance the part of the value chain offshored, integrating the costs of managing uncertainty, quality, logistics, production and suppliers, spread all over the world, plus the wage inflation in some emerging markets are adding up to the Total Costs. Strategic thinking can then add more value by having both suppliers and customers nearby: this gives an advantage in term of reactivity, building supplier relationships beyond transactional, to a collaborative relationships on new products and processes, and a visibility on their financial health.

This is not just about UK. Many OECD countries are thinking alike. The United States for example are on the same reevaluation process: the reshoring idea is at the heart of a program from the Obama Administration initiated in June 2011 called Advanced Manufacturing Program [20] to recreate hi-tech manufacturing base to create jobs for American workers and reduce trade deficit, and the trend is on with the president's FY 2013 budget with a strong focus on strengthening advanced manufacturing capabilities. Harry Moser who created a non-profit program called the Reshoring Initiative, declares [21]: "The goal is to balance the U.S. trade deficit, which is $600 billion a year. That is largely due to offshoring of manufacturing jobs. Since the 1950s, about three million manufacturing jobs have been lost to imported goods. So to balance the deficit we'll need to bring back three million jobs." Harry Moser states that in the U.S. 61 percent of larger companies surveyed "are considering bringing manufacturing back to the U.S.".

Industrial Decline and Linear Model. Since the first and the second industrial revolutions, the industrial model and the business models associated with it has been based on a linear flow: raw materials extraction and transformation, use and waste. Though older economies were taking into account reuse or regeneration models, "consumer goods society" has been largely adopted worldwide and a form of prosperity seems to have been achieved for *developed nations*. But the "nature and causes of the wealth of nations" [22] seems to become the nature and cause of doom time for human kind.

First, we are already experiencing the "limits to growth" [23] predicted back in 1972. Developed and emerging markets for consumer goods is estimated [1] around USD 12 trillion in 2012 while tapping into non renewable and finite resources for about USD 3 trillions [1] and producing about 75% of municipal solid waste [1][24]. Second, while the physical and environmental limits and issues are already here, the demand is growing with an estimated middle class to boom from 1.9 billion in 2009 to 4.9 in 2030 according to OECD [25].

Pushed by the competitive cost models we've examined previously, the paradigm of linear economy is based on globally spread actors along value chains, going from raw sourcing and chemicals inputs, globally spread manufacturing processes, global distribution and retail channels to reach consumers that trash products that are, for the best, ending in landfills or being incinerated. This globalized flow relies on intensive energy consumption of fossil fuels. The underlying economic model for each economic actor is competition based on costs and differentiation [6][9], each of them needing to maintain the growth of large volume of the flow, short products lifespan and complex heavy packaging to either meet global transportations requirements for conservation or for simple marketing differentiation.

Consumers are globally spread just like are different economic agents, located according the markets to be addressed and the cost model of agents building models to reduce labor cost by compensating with resource and energy intensity. Cheap non renewable fossil fuels have been the engine of the economic growth [26] with growing transport flows of materials and goods, allowing offshoring of production for consumption to lower costs regions where fiscal and legal regimes left negative externalities easily uncounted, while cheap energy and resources allowed agents to focus on margin and shareholder return on investments.

This actual mismanagement of resources in the linear economy carry vast amounts of value destruction: spillage and degradations all along the value chain of agro-industries, value lost in design and processing, value lost in distribution, use and end of life [1]. All the value lost in spillage adds up to the rising health, environmental and economic costs of disposals. When unmanaged, spillage and waste ends-up in nature, destroying environmental ecosystems, reducing furthermore the "ecosystem services" [27] and ultimately, just like plastic in the Pacific Garbage Patch, affects our own food chain. Environmental risks and their costs can be evaluated, but the intrinsic uncertainties of the consequences in the long run they could cost are not [28] so perhaps it's about time to redesign the models.

Beyond the environmental impacts [29] this vast amounts of resources spillage started to become really visible and in fact turned into a heavy burden when rising prices and volatility on commodity (150% from 2002 to 2010), fossil fuels and agricultural prices revealed the weaknesses of the model. These new risks are putting a high pressure on companies that were not prepared to confront the meeting of limited resource and growing consumption, and in an interconnected world, all issues are related [3].

Closing the Loop. A rapid review on circular economy shows there is limited research literature on this topic for global systems, but rather in the evaluation of eco-industrial parks [30][31]. The models have to be studied on a more global scale and cases studies need to be compiled. New business models are emerging from real life economy and adaptive capacities of a limited part of the players. There is paradigm shift that needs to be taken and both academic institutions, and economic schools need to experiment new models that are currently out of their scope, even when multinational companies are leading the experiments.

4 Towards Circular Economy

As we've seen, the actual linear economy cannot be sustainable and is widely based on reducing responsibility of agents to the minimal requirements imposed by the market and the legal environment. Given the figures of consumption growth, it's self evident that making processes more efficient, even recycling up to 50% of the metals we use for example, by the actual growth, will not change the scarcity of these resources on the market [32], we would just delay the problems.

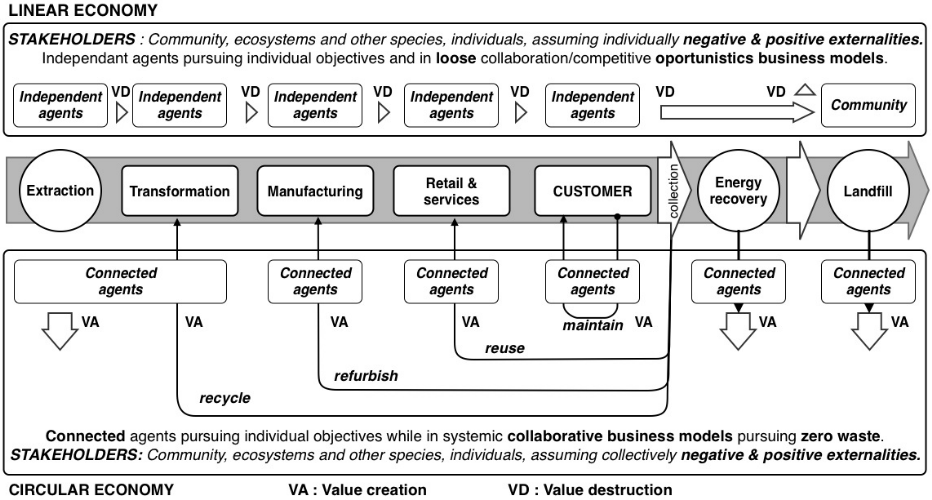

Fig. 4. Value in linear economy and circular economy, adapted from EllenMac Arthur TCE

Moreover, very efficient systems are fragile in essence [33] as they are built with fewer nodes and connections. To build an industrial circular economy, there is a necessary paradigm shift: "Circular economy changes the traditional one-way linear economic model of "resource - product - waste" with value destruction at each step (noted VD in figure 4), into feedback circular economy mode of "resource – product - waste - renewable resource", which conforms to the concept of sustainable development, utilizes resource and protects environment more effectively so as to gain maximal economic and social benefits with minimal resource consumption and environment cost." [31]

Collaboration at the Heart of the Model. Circular economy requires also to change the approach to a view by flows that are of two types [34]: The flow of materials that can re-enter into the biosphere without harming it and even rebuilding it, and the flow of technical materials that cannot re-enter the biosphere and need to be "designed to be recovered, refreshed and upgraded, minimizing the energy input required and maximizing the retention of value" [1].

Circular economy also builds on "functional service" models where the value is not created by the consumption or the possession of products, but by their use and the services they provide [35]. Most of all, it requires to think industry development reusing principles found in nature: systems where agents are connected, pursuing individual or collective objectives but in systemic collaborative business models pursuing zero waste. This requires interdependency and constant feedback, that is actual collaborative models, extracting value in a cascade of transformation through other applications (noted VA in figure 4), for example by converting waste into by-products, design multicriteria models and with a definitive shift to renewable energy.

5 Conclusion

Energy prices, commodity prices volatility, agriculture and food prices, natural catastrophes are exposing every region and every economic agent worldwide by ripple effects. Our specialization models and dependence on globalized infrastructure and markets are threatening all systems [3]. For companies this implies redesign of business models, integrating end of life products by design collection and reverse logistics. Increasing circularity of flows from cradle to cradle, reducing energy intensity and create most value of by-products requires rebuilding local networks of partners and industries: **ecosystems**. As stated in the Ellen MacArthur report "Towards Circular Economy"[1]: "Closing the loop' in the circular economy essentially requires much closer and more extended collaboration between participants. (…) A circular economy could cut net materials costs and reduce price volatility and supply risks. Local job creation will be another important benefit, alongside greater innovation and greater resilience". What else do we need?

Acknowledgements. This paper is part of the PEAK research program (Purchasing European Alliance For Knowledge).

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A Method to Quantify the Power Distribution in Collaborative Non-hierarchical Networks

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Abstract. Collaborative networks are characterised by the establishment of relations in more or less hierarchical power structures. The hierarchy of the network is defined by the partners' power degree. Hierarchical structures and associated barriers limit the decision making and discourage collaboration within partners. This paper focuses on proposing a method to allow researchers to identify the power degree of each network partner, through Markov Chains. Knowing the power distribution, helps researchers to diagnose the power balance, reconsider the status in the network and have a better view of power interaction and collaboration. Therefore, the power distribution analysis is a key issue to understand the partners' behaviour and achieve sustainable networks.

Keywords: networks, power distribution, Markov Chain, sustainable network.

1 Introduction

Research in collaborative networks has increased nowadays due to the companies' participation in this networks leads them to achieve inherent collaborative advantages [1]. Collaboration within a network can be centralised or decentralised. Centralised approaches, [2] in which a single decision unit possesses all the power, are associated with the concept of hierarchical networks (HN) where dominant nodes possess the power and the secondary ones must adapt [3]. In today's dynamic environment, it is important to consider the objectives of both dominant and secondary partners. In light of this, decentralised approaches are considered; in this case non-hierarchical networks (NHN) are identified, in which power distribution is balanced, in principle, and all the partners are equally considered [3]. Nevertheless, the power asymmetry among NHN partners is evidenced [4] as a result of the information restriction, the task dependency, the roles in the network, the activities in the product development, etc. [5]. Thus, the power of each member of the network influences the partners' decisions, making interesting the study of the power distribution in order to promote more balanced networks. The way how industries behave affects their survival in the current environment, characterised by the economic crisis. Besides considering all the alternatives to be applied within the enterprises, researchers have to also consider the inter-enterprise relationships established in the network. In order to deal with the economic issue in a way, the network redesign will allow researchers to achieve

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 660–669, 2013.

power balanced structures; therefore, enterprises will be reinforced and will obtain offset gains allowing them to reinvigorate the economy. Network sustainability issues are clearly in the pole position of the topic under study due to the power distribution analysis implies to build balanced collaborative relationships and achieve value chain networks. For these reasons, the power distribution in collaborative networks needs to be studied in order to achieve and develop a well-integrated network.

This paper particularly focuses on collaborative and non-hierarchical networks due to the emerging importance for researchers [3]; nevertheless, the developed method can be applied for the wide variety of network topologies. Modelling and analysing the individual power will allow researchers to identify or predict conflicts, select potential members that best fit in the network and establish the correct assignment of partners. The main aim of this paper is to propose a method to help researchers on the identification of the relations established within network members with the main aim of quantifying the power distribution in the network.

2 Problem Definition

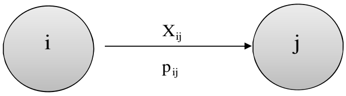
The common understanding of the power concept is similar to authority. Nevertheless, the power notion is far from a simple phenomenon and it is not simply related with the size of the companies. Different authors such as [6] and [7] develop methodologies to analyse the partners' power. Moreover, Liu and Zolghadri [4] focus on the power evaluation according to the partners' activities and involvement in the product development.

This paper goes further and provides a general method to compute the power distribution within the network not only considering variables related with the product, but also considering a wide variety of measures such as contracts established, products exchanged, monetary transactions, etc.

In order to develop the paper, two questions are raised: (i) what are the measures used when defining the power distribution and (ii) how to use these measures in order to compute the power distribution in a network. In light of this, this paper is focused on the definition a set of measures (section 3) and demonstrate how these measures can be properly used to calculate the transition probabilities in order to apply the Markov chains analysis and estimate the network power distribution (section 4). Hence, in networks where there is not a clear leader, researchers can analyse the power distribution to identify those partners with a higher power, with the main aim of balancing the authority.

3 Measures to Identify the Power Distribution

A set of measures considering more than one perspective are given in this section to compute the partners' relationships and quantify the power distribution within the network. The measures are provided taking into account that the method to quantify the power distribution is based on Markov Chain analysis. The proposed measures are set out to identify relationships between nodes. Linkages between partners can be identified through a graph representing pair wise relationships, using *nodes* symbolising the partners, and *arrows* symbolising linkages between them (figure 1).



X_{ij} : quantifiable measure to identify the relationship between node *i* and its partner in the network *j*. Power Measurement

p_{ij} : probability of moving from state *i* to state *j*, this probability is used to analyse the power through Markov Chains

Fig. 1. Transaction diagram simplified for two network nodes

Due to the nature of the developed method, based on Markov chains, the measures to compute the power within a network are led to relate the transactions established between pairs of network nodes (p_{ij}). Table 1 defines and describes the measures to compute the power and relates these measures with the partners' power (PW) considering that t*he higher* (↑) or *lower* (↓) *value of* p_{ij} implies *a higher* (↑) or *lower* (↓) *power* of the node to which the transaction is assigned.

Table 1. Measures to compute the network power distribution (X_{ij})

Measure	**Description**	p_{ij}	***PW***
Contracts	Number of contracts established between node *i* and node *j*. The greater number of contracts accepts the node i with the node j the greater power will have j over *i*	↑	↑
End Product	Participation of the products developed at node *i* on product performed by *j*. The importance degree is associated to the partner who send products more significant for the end product, node *i*	↑	↑
Exchange of Information	Information exchanged between nodes. The most important node is one that receives more information from the other nodes	↑	↑
Frequency	Regarding the payment, exchange of information, products shipped. The powerful node is one that establishes transactions in lower times. That is where p_{ij} is lower	↓	↑
Innovation	Percentage of patents sold to each partner. The powerful partner buys more patents. The measure can also be measured in terms of the economic value of patents	↑	↑
Monetary Units	Based on the transaction of monetary units between nodes. Incomes. The higher profits has the node, the more powerful is considered	↑	↑
Material transactions	Number of products transferred between partners. The greater amount of products shipped to one partner, the more powerful is considered the node that receives the products	↑	↑
Orders	Number of products ordered, order volume, product delays, etc. Average delays to each customer could be an applicable approach to describe the orders measure. The less average delays has one node, the more powerful	↓	↑
	The number of orders involves the workload. The more orders made the more powerful is the node	↑	↑
Partners	Number of partnerships established between the network partners. The greater number of collaborations arranges one node, the most important is the node	↑	↑
Product Value	VAT or benefits obtained by the network node. The higher profits the node has, the more powerful is. Benefits = monetary units from node *j* to node *i* – monetary units spent to manufacture the product in node *i*	↑	↑
Products	Total sales as monetary transactions (Price). The higher sales receives a node, the more powerful is	↑	↑
	Total sales as products transferred from one node to another. The higher products transfer the more powerful is the node	↑	↑
Purchase	Number of purchased products. Returned products: number of products returned from the customer node to the supplier. The more products returned the more powerful is the node that returns a product	↑	↑
	Cost of purchase: monetary units associated with the purchase, material costs, administration costs, etc. Swithching costs: monetary units refunded to the customer due to the product has been returned	↑	↑

p_{ij}: transaction probability form *i* to *j* / *PW*: power.

This paper is bound to generate a methodology for the identification of the power distribution within the network partners. Therefore, it is out of the scope the definition of the method to obtain and calculate X_{ij} and p_{ij} variables. Nevertheless, for better understanding, if the researcher decides to compute the power considering the *monetary units* measure, X_{ij} is defined by the number or value of the monetary transactions between the partner *i* and the partner *j*. The transaction probability is obtained as regards the X_{ij} transactions, considering the percentage of the *monetary units* sent from node *i* to *j* over the total monetary units sent by *i* to all the nodes in which establish transactions → $p_{ij} = X_{ij} / \sum X_{ij}$. In this case, the higher p_{ij} means the higher number of monetary units transacted from the node *i* to the *j*, so that, the node *j* will be the more powerful as regards *i*.

All the measures should be treated with equally importance. The selection of one or another measure will depend on the network, the available data, or even the way the researcher wants to estimate the power distribution. It is difficult to calculate the transition probabilities, however, there can be known through surveys distributed to the networked partners, giving the researcher an insight of the relationships established between the nodes; or just asking partners for data of interest to calculate the distribution of power.

Employing Markov chains for the power distribution implies to relate the powerful node with that one receiving many links (transactions) from the rest of network nodes. Thus, the more links the node has associated, the more important will be due to the measure transactions are defined considering the relations established within the network members.

4 Method to Quantify the Power: Markov Chain Model

Markov chains (MC) analysis provides information about the changes taking place in a system and the probability that at any future time the system will be in a particular state. In network contexts, Markov Chains Models (MCM) are used to model the partners' retention and partners' migration situations regarding the relations they establish [8-9]; being suitable to model and estimate the power within the network. For this propose, this paper is developed to measure the relationships and links between nodes and determine where the transactions lead in order to identify the power distribution. The network is considered the system (S) and the nodes (i) represent the states in the Markov chain analysis. Transactions between nodes are met at most once a period. A key feature of the nodes' transactions is that the future prospects for the nodes relationship are a function only of the current state of the relationship and not of the particular path of transactions took to reach the current state; this property is called the *Markov property* [10-11]. Markov analysis describes the system transition towards a certain state, through probabilities, named *transition probabilities* p_{ij}, that is $Pr(X_{t+1} = j|X_t = i) = p_{ij}(n)$; where, $p_{ij}^{(n)} \geq 0$ for all pairs $i, j \in S$ and $\sum_{j\in S} p_{ij}^{(n)} = 1$. Transition probabilities of a stationary MC can be arranged in the *transition matrix*. Furthermore, the transition matrix measures can be represented in an *associated graph* whose vertex represent the states from the system S and between the vertex i and vertex j an arrow (i, j) is represented, if and only if $p_{ij} > 0$.

The *steady-state* is one of the Markov chains properties used to determine the balance of power among partners. The Markovian property indicates that in the long term the process is stabilised and the operating characteristics of the system become time independent. The *steady state probabilities* are noted as π_j and there are characterised by $\lim_{n\to\infty} p_{ij}^{(n)} = \pi_j$ where π_j satisfy the following equations:

$$\text{(i)} \quad \pi_j > 0 \qquad \text{(ii)} \quad \pi_j = \sum_{i=0}^{M} \pi_i * p_{ij} \text{ , j} = 0, 1, \ldots \text{M} \qquad \text{(iii)} \quad \sum_{j=0}^{M} \pi_j = 1 . \qquad (1)$$

Among the states some are transient and the others absorbing. If the network has some absorbing states the chain is called *absorbing chain* [12]. An *absorbing state "i"* is one that endures; that is, starting from any of the transition states the process terminates once it reaches the absorbing state ($p_{ii}=1$) [10]. For Markov chains analysis absorbing states are not considered implying that all the steady state probabilities are zero $\Pi_{j\neq i} =0$ except those of the absorbing states, $\Pi_i =1$, being the results inconclusive to study any future behaviour of the Markov chain states. Different authors treat the Markov Chain Problem with an Absorbing State [8, 10, 11, 12, 13]. In this paper the absorbing state is treated through dummy players and fictitious transactions.

The *method* used to compute the power distribution within a network is summarised as follows in seven steps.

STEP 1. Once the network is identified and modelled, the researcher proceeds to select the measures (from table 1) to be used in the identification of relations within pair wise nodes. The measures are selected according to the researchers' requirements to calculate the power distribution within the network.

STEP 2. Depending on the measure selected to compute the power distribution, the transactions flow in one direction or another. Two examples are the *material transactions* and the *monetary units*. The first measure produces a flow from the supplier to the customer, whilst in the second the flow is generated from the customer to the supplier. For the network and transactions representation the identification of the flow direction within the network, is to be considered due to depends on the selected measure.

STEP 3. Define the *initial transaction matrix* (*P*) that consists on the transitions established among all the networked nodes. The transition probabilities are calculated through the equations provided in section 3. The use of Markov chains to compute the power distributions is limited by the appearance of the absorbing states. The initial transition matrix (P) is characterised by having absorbing states. The absorbing state location depends on the flow direction, directly influenced by the type of measure.

STEP 4. The absorbing states are to be removed through the insertion of a dummy node(s) and the establishment of a fictitious transaction(s) within the network nodes. In network systems the *network end nodes* are considered as absorbing as all the arrows are headed to these end nodes such as *customer* or raw material *suppliers.* The fact that an absorbing state is one node or another depends on the flow direction. Since one node does not generate any transaction to any other node, then this node is the absorbing state and it is mathematically represented by $p_{ii}=1$. Absorbing states must not be considered in the transition matrix. The introduction of a dummy node and a fictitious transaction does not affect the system and helps researchers to remove the absorbing states in order to calculate the transition probabilities of the modeled network and consequently compute the power distribution.

STEP 5. Final transition matrix (*P'*) with no absorbing states. Markov chains do not admit absorbing states due to this does not make sense to calculate transition probabilities. Therefore, once the dummy nodes and transactions are introduced in the network in order to remove the absorbing states, the new network is modelled. The new network with dummy nodes and transition probabilities is now modelled from the results of the final transition matrix (P').

STEP 6. Steady state probabilities (Π_i) calculation for all the nodes including the dummy players, introduced in the network to remove the absorbing states. Once the transition matrix has no absorbing states, the probabilities are calculated in the long term in order to achieve the steady-state probabilities (equation 1). These probabilities will be conditioned by the results of the dummy nodes. This means that, the calculated steady-state probabilities of all the nodes located after or before the dummy node are also considered in the calculation of the steady state probabilities.

STEP 7. Steady state probabilities normalisation (Π_i'), by only considering the networked nodes, that is without considering the dummy nodes. The consideration of the dummy nodes in the calculation of the steady state probabilities (Π_i) gives us a distorted view of the real distribution of the power. Thus, the steady state probabilities are to be recalculated, regardless the steady state probabilities of the dummy nodes. The recalculation leads to compute the *normalised steady-state probabilities* (Π_i') through the equation provided in table 2.

Table 2. Steady state probabilities normalisation

$\Pi_i' = \dfrac{\Pi_i}{\sum \Pi_j'}$. (2)	$\sum$ ***Π***$_j$**'** the ***sum of the steady-state probabilities*** excluding the steady-state probabilities of dummy nodes
	Π_i the ***steady state probability*** of node *i*, considering the whole system, including dummy nodes
	Π_i**'** ***normalised steady-state probability*** of the node *i* considering only the nodes of the network without taking into account the steady state probabilities of the dummy nodes

In our case, the system is represented by a network with different nodes. The provided method allows researchers to determine how the network evolves in order to identify those members with higher power proportion.

4.1 Numerical Example

The following example illustrates the notion that researchers can use MCM not only to evaluate the power distribution, but also to manage and improve networked nodes relationships and therefore balance the power in the network in order to make it more sustainable. Using Markov chains allows researchers to estimate the power distribution at the long term within a network considering both the *transition probabilities* and the *steady-state probabilities*.

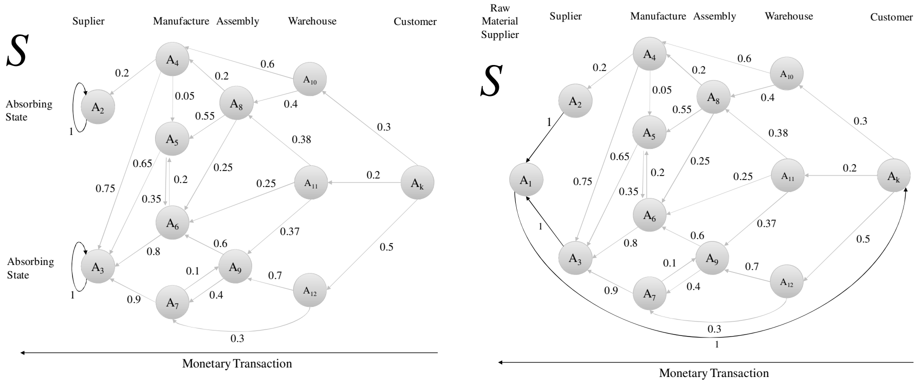
Namely, for the development of our paper, we propose a numerical example. The methodology is in the early stages of development and therefore has not yet reached the stage of implementation in a real network. However we are working on the search of a network in order to apply the methodology in a more complex network environment that would give researchers a better insight of the methodology strength. In the example hereafter developed it is considered the measure of *monetary units' transaction* so that the transaction flow is established from the customer to the supplier. We construct a Markov chain with 11 transient states (networked nodes) $\{A_2, A_3, A_4, \ldots, A_{12}\}$. The absorbing states depicted correspond to the network *suppliers* $\{A_2, A_3\}$ where, $p_{22}=1$ and $p_{33}=1$.

The transition probability matrix is generated as a result of the transition probabilities of the monetary transactions among the different nodes (figure 2). The model may also be represented as a graph as shown in figure 3a.

$$P = \begin{bmatrix} \mathbf{1} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{1} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ 0.2 & 0.75 & - & 0.05 & - & - & - & - & - & - & - & - \\ - & 0.65 & - & - & 0.35 & - & - & - & - & - & - & - \\ - & 0.8 & - & 0.2 & - & - & - & - & - & - & - & - \\ - & 0.9 & - & - & - & - & - & 0.1 & - & - & - & - \\ - & - & 0.2 & 0.55 & 0.25 & - & - & - & - & - & - & - \\ - & - & - & & 0.6 & 0.4 & - & - & - & - & - & - \\ - & - & 0.6 & - & - & - & 0.4 & - & - & - & - & - \\ - & - & - & - & 0.25 & - & 0.38 & 0.37 & - & - & - & - \\ - & - & - & - & - & 0.3 & - & 0.7 & - & - & - & - \\ - & - & - & - & - & - & - & - & 0.3 & 0.2 & 0.5 & - \end{bmatrix} \begin{matrix} \left.\vphantom{\begin{matrix}1\\0\end{matrix}}\right\} \text{Absorbing States} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \end{matrix}$$

Fig. 2. Probability transaction matrix of monetary units' transaction

In order to remove the absorbing states, a dummy node, the *raw materials supplier* $\{A_1\}$ is depicted; moreover, the customer is now considered a dummy node $\{A_k\}$ due to the power distribution is to be calculated by only considering the proper network nodes, that is, suppliers, manufacturers, assemblers and warehouses. An arrow from the *raw materials supplier* node is generated, in the form of *monetary units' transaction,* towards the *customer* to set a fictitious transaction that can be represented by taxes to the society. Thus, considering the new dummy nodes and the fictitious transaction the new graph is outlined in figure 3(b).



(a) Numerical Example – Considering absorbing states

(b) Numerical Example – With none absorbing states

Fig. 3. Associated graph

A new transition matrix is represented considering no-absorbing states and considering the *raw materials supplier* dummy node and the fictitious transaction from the *raw materials supplier* to the *customer* node (figure 4).

Fictitious node → Raw material supplier {A_1}

Transition probability form the {A_1} to the Customer {A_k}

$$P' = \begin{bmatrix}
\mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} \\
\mathbf{1} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\
\mathbf{1} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\
- & 0.2 & 0.75 & - & 0.05 & - & - & - & - & - & - & - & - \\
- & - & 0.65 & - & - & 0.35 & - & - & - & - & - & - & - \\
- & - & 0.8 & - & 0.2 & - & - & - & - & - & - & - & - \\
- & - & 0.9 & - & - & - & - & - & 0.1 & - & - & - & - \\
- & - & - & 0.2 & 0.55 & 0.25 & - & - & - & - & - & - & - \\
- & - & - & - & - & 0.6 & 0.4 & - & - & - & - & - & - \\
- & - & - & 0.6 & - & - & - & 0.4 & - & - & - & - & - \\
- & - & - & - & - & 0.25 & - & 0.38 & 0.37 & - & - & - & - \\
- & - & - & - & - & - & 0.3 & - & 0.7 & - & - & - & - \\
- & - & - & - & - & - & - & - & - & 0.3 & 0.2 & 0.5 & -
\end{bmatrix}$$

} Fictitious node → Raw material supplier

} New probability transactions form the suppliers{A_2, A_3} to the raw material supplier{A_1}

Fig. 4. Probability transition matrix of monetary units with none absorbing states

A matrix with no-absorbing states has been generated ($p_{ii} \neq 1$). Thus we proceed to calculate the steady-state probabilities (π_i) that will allow researchers to estimate the power distribution. Concretely, the transition matrix is set for the transition probabilities considering the exchange of monetary units in a one year period. Thus, the steady-state probabilities are generated to identify the most powerful nodes in the long term, based on the monetary units' transactions.

The steady state probabilities are first calculated considering all the nodes, including the dummy nodes *raw materials supplier* and *customer* (equation 1). The results of the steady-state probabilities for the whole network are depicted in table 3 in the row represented by π_i. As aforementioned and given that the dummy nodes, *raw materials supplier* and *customer*, are not to be considered in the power distribution estimation (figure 5), the equation (2) provided in table 2 is to be applied in order to normalise the results of the steady-state probabilities taking into account only the steady-state probabilities of the suppliers, manufacturers, assemblers and warehouses nodes {A_2, A_3, A_4, ..., A_{12}}. Thus, the *normalised steady state probabilities* are depicted in the second row of table 3, represented by π_i'.

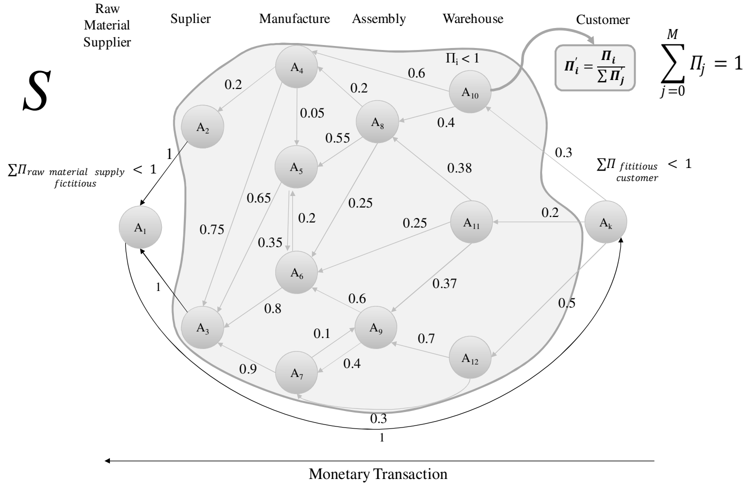


Fig. 5. Normalised steady state probabilities (dummy nodes are not considered)

Table 3. Steady state probabilities

Nodes	**A_1**	**A_2**	**A_3**	**A_4**	**A_5**	**A_6**	**A_7**	**A_8**	**A_9**	**A_{10}**	**A_{11}**	**A_{12}**	**A_k**	**AVG (π_i')**
π_i	0,1707	0,0075	0,1632	0,0374	0,0355	0,0761	0,0568	0,0334	0,0780	0,0512	0,0341	0,0853	0,1707	
π_i'		0,0114	**0,2477**	0,0568	0,0539	**0,1156**	0,0863	0,0508	**0,1185**	0,0777	0,0518	**0,1295**		0,0909

Amongst all the steady-state probabilities already normalised (π_i'), we now proceed to determine which node is more powerful. In order to do that, the average of the normalised steady-state probabilities is calculated regarding equation (3).

$$AVG(\pi_i') = \frac{\sum_{i=2}^{m=k-1} \pi_i'}{Nnodes - Ndummy\_nodes} \quad \text{being k = the number of nodes} \tag{3}$$

Those nodes with normalised steady state probabilities (π_i') higher than normalised state probabilities average ($AVG\ (\pi_i')$) are considered to be more powerful nodes. Specifically, in the numerical example the threshold value regarding the average is $AVG\ (\pi_i') = 0{,}09091$. In our particular case, $\{A_3, A_6, A_9, A_{12}\}$ nodes have greater power within the network. The most powerful nodes of the network, that hinder the network balance in terms of power is concerned, are identified on the basis that the power has been established based on monetary unit transactions.

Most of the networks are controlled by one or two dominant nodes, in that case, the network would be balanced regarding this one or two nodes. Nevertheless, if the network consists of six nodes, four of them more powerful, all the network will be balanced. The way of balancing the power will depend on the results obtained from the methodology application proposed in this paper. Therefore, the balance will be devoted to balance each network node or the one or two more powerful ones.

So that, whether the power accumulation worsens the network operation, researchers must propose a reduction of the power imbalance. Once the researcher has an insight of the power distribution within the network, decisions and actions are led to consider the entry of new nodes or reduce the powerful ones in order to enhance the power balance. Definitely, decisions related with the network redesign and network decision making system to apply decentralised and collaborative relationships, the network integration and the partners' alignment and selection are settled out. The information derived from the methodology provided allows researchers to improve the relationship among the network partners and achieve more sustainable networks.

5 Conclusions

Non-hierarchical networks are considered to be power balanced, nevertheless real networks are far to be balanced, due to the different activities and roles of the networked partners influencing the decision making. This makes interesting the study of power distribution within the network. Therefore, a method with seven steps has been developed to help researchers to estimate the power distribution within a network. The method uses the Markov Chain analysis in order to consider the power distribution in the long term. An example has been provided for better understanding.

Regarding the results derived from the method application, it can be concluded that the provided methodology is a useful tool, for researchers, to establish decisions regarding the identification of new and more appropriate networked partners in order to achieve an optimum network design. A significant outcome of this work is that researchers can use the results to achieve balanced and sustainable networks through selecting the most suitable and power balanced partners. As future research lines, the method is to be applied in a real network, that will give researchers an insight of how useful can be the method and also to improve the weakness parts of it.

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Mass Customisation in Sustainable Networked Enterprises

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Abstract. To cope with the customer-oriented business model in a global competitive market, enterprises tend to be networked for achieving mass customisation: i.e. offering customisable products with the same efficiency as mass production. This scenario highlights two faces of variability: variability of needs (on customer side) and variability of organisations (on production side). Both types of variability induce a huge number of specified products, namely configurations. This configuration variability must be efficiently managed. This position paper discusses trends and issues for rationalising the number of configurations: i.e. engineering the right number of configurations that match both the customer needs and the production strategy. After this positioning, we propose a systemic perspective for addressing the discussed issues from a sustainability point of view. Finally we give a perspective for a product line definition method that leads to models that meet the discussed variability rationalisation.

Keywords: mass customisation, collaborative network, product lines, sustainability.

1 Introduction

Nowadays enterprises tend to a customer oriented business model, but at the same time, the stress is on the efficiency of the organisation. The mass customisation concept fits perfectly these trends, but the consequent product variability and the high production volumes often lead enterprise to network. Then, this complex scenario reveals another source of variability, coming from the heterogeneity of manufacturing facilities in the network.

In this position paper, we analyse the nature of these kinds of variability in order to propose a method for a product line definition in this scenario. The aim of the resulting product line is to rationalise those sources of variability rather than reduce them: reducing the first one, we quit a portion of market; reducing the second one, we abandon advantages coming from the enterprise networking. Therefore, the paper will

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 670–678, 2013.

also show the impacts of the rationalization strategy on the sustainability character of the network.

The structure of the paper is the following: in the section 2, we analyse the mass customisation concept (seen as first source of variability), showing the transition toward the enterprise networking (seen as second source of variability); in section 3, a state of the art of product lines is described according the impact on the variability management for mass customisation and enterprise networking; in section 4, following a systemic vision, the gaps between current approaches and a possible solution are highlighted and our perspective to fill this gap; moreover at the end of section 4, the implications of this approach on sustainability are discussed; section 5 is dedicated to conclusions and future work discussion.

2 From Mass Customisation to Networking

2.1 Customisation: A 1st Source of Variability

If we were a shirt manufacturer: *what if technology made it possible for every one of the five thousand shirts to be customized while on the assembly line […] produced just as quickly as the five thousand identical shirts, yet at not greater expense?* Starting from these words, Davis introduced for the first time in [1] the term Mass Customisation (MC). The MC concept is also analysed in [2] and [3]. In these works, the authors identified two other perspectives of the MC concept: 1) during the selling process, the aim is to offer to the customer, the same product customisation capabilities as an engineer-to-order organisation; 2) during the manufacturing process, the aim is to manage the production variability with the same organisational efficiency as in mass production.

The one-funnel schema in the Fig. 1 describes these two effects. The enterprise has to manage the variability due to different customer's needs. Therefore at each order entry, a transformation has to be performed (on the left side of the figure) from the list of customer's needs to the features of the customized product. A further transformation (on the right side of the figure) is needed in order to find the appropriate organisation of processes and resources (i.e. efficiency optimisation) at the manufacturing level.

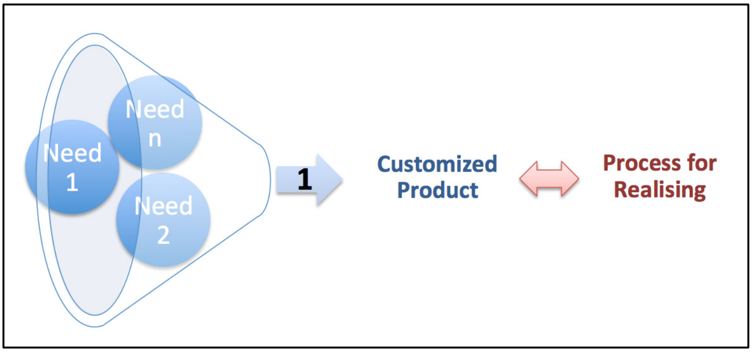

Fig. 1. Variability for MC (i.e. customer's needs)

2.2 The Need of Networking: A 2nd Source of Variability

In MC scenarios, the dynamic network of enterprise operating units (i.e. specific processes or tasks) that allows to decrease the complexity in managing product variability is a quasi-mandatory strategy [3] and is even a requirement [15]. Moreover, by definition, the term MC induces not only variability, but also the presence of high production volumes. Therefore, in the current turbulent market, companies tend to build collaborative networks in order to cope with these two challenges. The enterprise networking *implies sharing risks, resources, responsibilities, and rewards* [4]. In this particular scenario, if the reduction of the single enterprise efforts is easily understandable, the impacts on variability are not evident.

Comparing the Fig. 1 to the Fig. 2, there are in Fig. 2 different realization possibilities corresponding to different manufacturing facilities involved in the network. That means that another source of variability has to be taken into account.

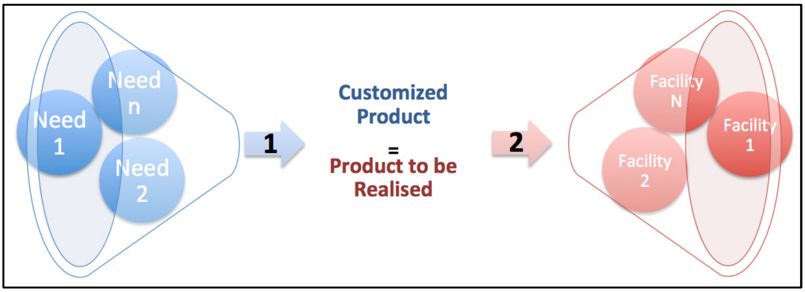

Fig. 2. Variability for MC (i.e. customer’s needs) in enterprise network (i.e. manufacturing facilities)

3 Product Lines for Managing Variability

A commonly accepted solution [5–9] for coping with the previously highlighted two kind of variability is to place, during the order entry process, between the customer and the product to be manufactured, a product configuration software tool. It is based on a product model in which customer can enter values for some options in order to define a specific product. This kind of tools is able to create manufacturable products based on configuration rules formalised by designers. At the design stage, the manufacturability of all possible customised products is verified. Usually this kind of product model is named in different ways, e.g. *product family* [10], *configurable product model* [11] or *product line* [12, 13]. The name *Product Lines* (PLs) will represent here all these types of models.

3.1 Product Lines for Mass Customisation

In this section, we show how the current solution in the domain of PLs can fit the MC variability (on the left side of the Fig. 1 and Fig. 2). In this case, PLs have to be able to identify a link between needs expressed by customers and the corresponding customised product that can be manufactured by the enterprise.

In [14], authors define an ontology for engineering design in which they define the concept of requirement. According to them, requirements are properties of artefacts to be designed. Customer needs are considered to be fuzzy and incomplete; therefore a refinement is required to make them usable.

In [15], the authors present a product configuration tool developed in JAVA and based on CBR (Case Based Reasoning) and constraints representation of PL. The case studied is related to a personal computer (pc) configurator: here most of customer needs are components such as RAM, CPU, etc. These variables evidently describe pc components but not customer needs and not even how the pc meets those needs. In [16], the authors present an initial PL metamodel formalized in UML. Here, customer requirements are defined as a set of values for product attributes.

In [17], the authors justify the importance of a constraint based representation of PL: the product configuration (PC) process is performed solving a constraint satisfaction problem (CSP). They propose a four-concept model: *customer requirements* (i.e. the needs), *component types, design parameters* and *design constraints*. As in other works, the authors mean for needs, the product functions.

In [18], the authors formulate the PC as a multi objective configuration problem. They apply a genetic algorithm to solve the problem. Also in this case, the product functions are used for interfacing the customer with the PL.

In [11], the authors try to extend the configuration impact on customer satisfaction and on production planning. Here customer requirements are products or product components properties.

In [19], the authors propose a method (for an assembly-to-order product) for taking into account the customer and the manufacturer utility at the same time in a PC. A genetic algorithm is used for solving the CSP. Here, the customer requirements are represented as product properties.

In [20], the authors use a technique based on the application of fuzzy multiple attributes decision making for PC. Customer requirements are represented as product technical specifications and prices.

In [10], the authors represent the PC as an optimization problem of customer satisfaction. A genetic algorithm is deployed for finding a solution. Graphs are used for linking product components features with customer needs, but here customer needs are still product features.

In [21], the authors propose a modular-based PC process. The most remarkable point of this paper is the classification of customer needs: *binary, optional, parameter, description and explanation types*. We can yet state that needs are seen as product specifications.

In [22], the authors represent the PC process in a two-stages translation: from customer requirements to product functions; from product functions to product modules. Also here, requirements are expressed by means of product components or product features.

In [12, 23], the authors represent the PL in a CSP. In the first paper a definition of *configuration needs* is given: anyway the *configuration needs* are represented on the basis of product component features.

The analysis of the state of the art shows that current PLs engineering methods are not completely formalising the link between the customer needs and the customised product.

3.2 Product Lines for Networking

In this section, we show how the current solution developed in the domain of PLs can fit the variability coming from the networking (on the right side of the Fig. 2). In this scenario, the most important point is the ability to take into account all local constraints coming from manufacturing facilities. In other words, the PLs outputs must not add constraints that can limit the flexibility of each manufacturing facility in optimising the organisation of its processes and resources.

All work on PLs cited above refer to a single manufacturing facility. Therefore here we can highlight a lack of a method able to take into account this kind of variability.

4 A Systemic Perspective for Variability Rationalisation

In this section we use a systemic perspective in order to highlight the lacks of current approaches for the illustrated scenario. Here the aim is to describe how we can improve the PL definition to meet the variability rationalisation. Finally we show the impact of this strategy on the sustainability perspective of the enterprise.

The General Systems Theory, described for the first time in [24], is an interdisciplinary study with the *system* as the core concept. Starting from this work, Le Moigne built a modelling theory in [25]. He stated that *a system is a structured object that functions and evolves, in an environment, for a fixed purpose*.

The engineering theory based on this concept is called System Engineering (SE) [26]. For [26], three main models define the system:

1. *The System requirements model* contains the required system features in order to fulfil customer needs; this model is independent from solution alternatives and from technology;
2. *The Logical architecture model* describes how the system functions, i.e. its behaviour for the requirements fulfilment; this model is independent from technology
3. *The Physical architecture model* describes the set of elements that perform functions; this model is related to technologies.

4.1 The Approach for Customisation Variability

We propose to classify the research work on PLs according the three main models of SE:

- *Product component features* (i.e. physical architecture) as input: at this stage the customer (not supposed to be an expert) is not able to understand the interaction between components and evidently he is not able to understand their impacts on his needs;

- *Product functions* (i.e. logical architecture) as input: the customer is not able to understand how functions can satisfy its needs and especially about how functions interact for doing so;
- *Product specification (i.e. requirements)* as input: to the customer is provided the knowledge about the effects of how the product functions (and so product components) interact for performing the product behaviour, of which specifications are the description; in this case, the customer still is not able to to evaluate the impact of the product specification on his needs.

Doing so, we can highlight a gap (Fig. 3) between the customer needs and the input of current PLs. In order to fill this gap in the configuration system: 1) customizers use market research [27], therefore the manufacturer designs the products and after looks for potential customers; 2) customizers optimize customer satisfaction [10], but that implies ability for representing and assessing the feeling of satisfaction of each customer; 3) sellers are in charge to fill this gap, performing a real *requirement analysis* process [28]; 4) finally, in the worst (but very usual) case, customers have to fill this gap.

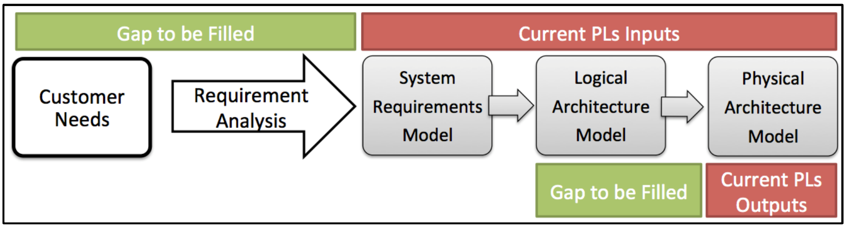

Fig. 3. Gap between current PL approaches and a PL able to cope with MC in a network.

In one-of-a-kind systems, the transformation of needs in system requirements is performed during the *requirement analysis* process. A definition of this process can be found in [29]: here the authors analyse the requirement analysis process in SE. This process is iterative and recursive [29]. But in MC, once the PLs is designed, the requirement analysis process has to be linear, i.e. in order to avoid a requirement analysis at each sold product, we need to formalise the link between needs and system requirements only once, at the PL design stage.

Usually, needs represent the customer point of view on the system requirements. Therefore, the requirement analysis process aims to refine needs in order to translate them into an expert view. In our vision a possible solution is to put the PL inputs at the origin of needs, i.e. the environment. In this way a PL can include the direct transformation of the customer environment into system requirements.

4.2 The Approach for Networking Variability

As pointed out in section 3.2, current PLs take into account only *one* manufacturing facilities. This means that, the output of the PL is very detailed at the technological level (Fig. 3). Applying this solution in a network of enterprises, we can have two resulting scenarios:

1. to take into account all technological constraints coming from all manufacturing facilities; therefore, in order to optimise the efficiency of each single manufacturing facility, it is needed to take into account all constraints coming from all other network participants;
2. to develop a PL for each facility in the network; this implies an increase of the product design effort proportional to the number of enterprises in the network.

In our vision, in order to rationalise the efforts and the resources consumption, a PLs output has to be independent from any technological definition. Using the SE vision, the PLs output has to include concepts belonging to the logical architecture of the system (Fig. 3).

4.3 From Variability Rationalisation to Sustainability

In this section we briefly show how an appropriate design of PLs can impact the sustainability assessment of an enterprise network. Our vision of the solution, shown in the two previous sections, allows the rationalisation of the variability: i.e. we find the right compromise between resource consumption (environmental and economical pillar of sustainability) and the amount of targeted customer needs (social pillar of sustainability).

As seen in section 4.1, the link between the customer needs to the system requirements can be formalised. The implications of this formalisation are doubles:

- On the customer side, the customer is able to ask for products that he really needs;
- Therefore, on the customizer side, the enterprise develops only product that customer needs, avoiding useless resource consumption.

As seen in section 4.2, setting the PL outputs on the logical system architecture, each manufacturing facilities can optimise the resource consumption without taking into account constraints coming from other facility in the network. In this way, the facility resource consumption efficiency is not impacted by the networking strategy. Moreover, already in [30] authors showed how a function-based (i.e. logic) design can be integrated with the enterprise information systems in order to support sustainability.

5 Conclusions and Future Works

In this position paper, we proposed a systemic point of view for analysing the current state of the art of the variability management, particularly of the Product Lines. We also proposed our perspective to meet the variability rationalisation and we showed how the variability rationalisation can lead to sustainability in a customizer network.

We are currently analysing the scenario and working on a solution to be experimented in the Trane Company. Trane, designs, manufactures and develops air-handling systems. The typical Trane product proposes several possible customisations. This leads easily to a large variability: several thousand of combinations to cope with. Moreover, the high volume and the product complexity stress on the need of temporary partnership, usually defined on the basis of one product.

Our future efforts will focus on a detailed design solution for a Product Lines in this scenario. In particular, we envisage to deal with this point using basics of the cybernetic [31] and systemic approaches.

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Event-Driven Collaborative Network

A Platform for Event-Driven Agility of Processes: A Delivery Context Use-Case

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Abstract. The French SocEDA project aims at providing a Service Oriented Architecture (SOA) platform for dynamic and complex event-driven interactions between large highly distributed and heterogeneous service systems. This platform should be able to combine a publish/subscribe mechanism (to collect events coming from heterogeneous and distributed services) with complex event processing of these collected events in order to detect interesting situations a service should react on. The SocEDA platform should also offer suggestions about relevant changes (adaptation) to do in running processes and services. The context of city logistics is chosen to show some of the basic abilities of the SocEDA platform and the relevance of event management in everyday situations.

Keywords: event-driven architecture, agility, complex event processing, detection, adaptation.

1 Introduction

In the literature of the last decade, many authors have proposed the idea of "city logistics" to solve the issues of urban freight transport like congestion and negative impacts on the environment (such as air pollution and noise) [1][2].

But, as it is widely recognized that companies are nowadays operating in a complex economical environment where markets are more open and globalized, the freight transport companies have also to deal now with uncertainties and short-term changes in demand or supply. They need to have agile processes to respond quickly to these changes, whatever their nature (traffic environment, congestion, safety and energy savings, uncertainties on supply or demand).

This article is organized as follows: Section 2 presents the architecture of the SocEDA platform. Section 3 develops the agility service, including the detection of the relevant moment where change is needed, and the proposed adaptation of running

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 681–690, 2013.

processes and services. Finally, Section 4 shows a use case inspired by the delivery of drugs to French pharmacies, with the associated events and business rules.

2 SocEDA Platform

As the SocEDA platform is a global (Internet level scale) structure to combine events from many sources with the goal of connecting and orchestrating services, things and people, it can contributes to support the coordination of shippers, carriers and movements in an integrated logistics system. Through a federated middleware, the platform provides a transparent and distributed infrastructure to allow users and services to be connected in a publish/subscribe mechanism through the whole SocEDA platform. We distinguish the main components that form the federated middleware and the components that are plugged in and using this middleware.

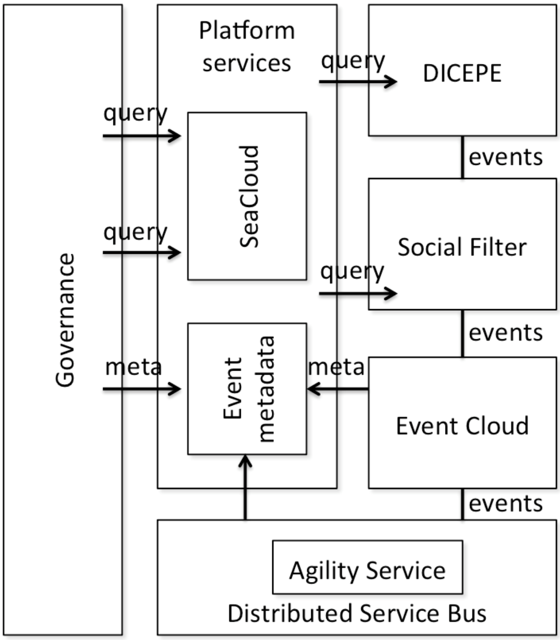

Fig. 1. Overview of SocEDA platform's components

As shown in Figure 1, the main components of the SocEDA platform are:

- Event-Cloud stores and forwards events between the bus and DiCEPE (Distributed Complex Event Processing), which are filtered by the social filter. Every event in the platform must be forwarded to the Event-Cloud to be stored and to be handled asynchronously (pub/sub mechanism) or synchronously by simple query retrieval.
- The Distributed Service Bus (DSB) is in charge of connecting Web Services consumers and providers to the platform (SOA layer). It includes an Event

Broker to integrate events. The DSB implements the Web Service Notification (WS-N) standard [3] in order to provide the core EDA feature.
- The Agility Service has to ensure the agility of the dynamic of the collaboration, in accordance with the evolutions of the context. Its objective can be divided into two sub-objectives: (i) detect the evolution of the context and (ii) adapt the dynamic of the collaboration to the new context.
- The Governance component to govern the services and events.
- SeaCloud allows to subscribe to a specific event producer, to add Complex Event Processing rules or deploy process.

The components of the platform that connects to the federated middleware are:

- The DiCEPE component: reasons on incoming events to generate complex events to the Event-Cloud to be sent to subscribers. It contains a Complex Event Processing (CEP) engine. It detects relevant events or combinations of events by applying event patterns (as described in [4]) on these events.
- Event Sources, i.e. business services in charge of sending/receiving events to/from the federated middleware (partners' devices, sensors, reports, etc.).

3 Agility Mechanism

The delivery processes defined in the city logistics area are subject to issues related to the dynamic adjustments of vehicle, as underlined by [5]. For a decade, several commercial products and research projects have been attempting to provide agility to collaborative workflows. On the commercial side, we can cite Bonita (a suite of tools to design, execute and monitor processes) and the Architecture of Integrated Information Systems (ARIS) tools. ARIS has the ability to combine determined process fragments according to received events. In a way, the ARIS approach manages workflow adaptation (but in a determinist manner) [6]. On the research works side, several projects like the WORKPAD project [7] and the CRISIS project [8] focus more on recovering the disconnecting nodes through specific tasks (WORKPAD project) or supporting collaboration into crisis situation and on exploring decision-making under conditions of uncertainty (CRISIS project). Another research project, the European PLAY project proposes an adaptation recommender service [9] which allows to adapt the ongoing processes on pre-determined milestones, through the addition of relevant pieces of processes (extracted from a knowledge database).

The Agility Service in the SocEDA project is a tool designed to adapt the dynamic of the situation, *i.e.* processes, to the evolution of the context. In this section, we will detail the mechanisms of the Agility Service. The adopted approach of agility in our research work is given by the formula below (which is close to the definition given by [10]):

$$\text{Agility} = (\text{Detection} + \text{Adaptation})*\text{Reactivity}\ . \qquad (1)$$

- *Detection:* this step consists in detecting an evolution of the situation that could not be solved by the ongoing processes or making the running processes not relevant to the current situation,
- *Adaptation:* when an evolution is detected, the adaptation step is executed to modify the ongoing processes in order to make them relevant to the current situation,
- *Reactivity:* detection and adaptation steps have to be done as fast as possible (and real-time if possible).

Agility allows on one hand to detect if the ongoing processes meet the requirements of the current situation, on the other hand to adapt the ongoing processes if necessary.

3.1 Detection

The approach to detect a divergence is based on three major steps:

1. Define the situation model to obtain expected situation model (picture of the expected situation) and field situation model (picture of the ongoing situation),
2. Comparing expected situation model and field situation model,
3. Calculate the difference between these two models to check the adequacy of the running processes with the field situation model.

A situation model is an instant capture of the running collaborative processes, the collaboration itself (all the actors and their services, their objectives, etc.) and the environment in which the processes are running (risks, opportunities, goods, etc.).

We can use these events to track the changes inside the collaborative situation model by this method (illustrated by Figure 2):

- First, we duplicate the initial model of the collaborative situation (i.e. model at time 0),
- Then, both models are automatically updated with the received events (the Agility Service subscribes to all the events emitted by the DiCEPE). We obtain two models through this update:
- The *expected situation model*: the planned and expected situation model at time t (i.e. what we expect to obtain when we apply the collaborative workflows to the collaborative situation). It is obtained by updating the initial model with monitoring events,
- The *field situation model*: the real situation model of the collaboration at time t, whatever the applied collaborative workflows are (i.e. the “what actually happened” situation at time t). It is obtained by updating the initial model with events coming from the field.
- At any time t, a measure of the divergence ∂ is made between the expected model and the field model.

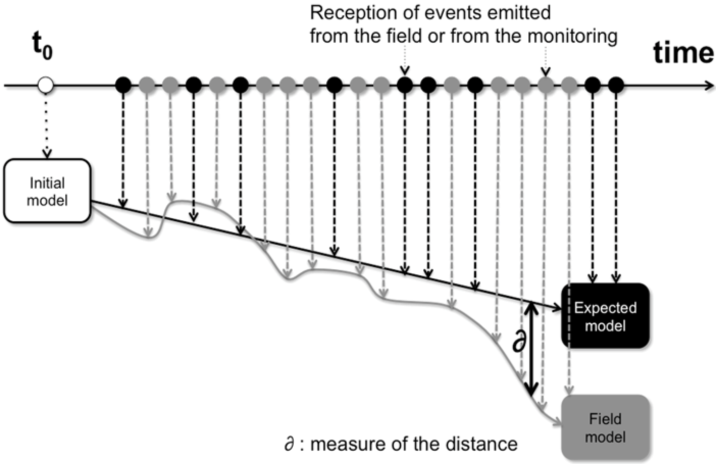

Fig. 2. Principles of detection of the divergence

The measure of ∂ is given by the following formula:

$$\partial = \sum_{i=0}^{n} w_i \partial_i \tag{2}$$

Where:

- ∂_i is a difference identified between the expected model and the field model. E.g.: a partner is not available, a new risk has appeared, a resource is free,
- w_i is the weight applied to ∂_i according the type of element concerned by the identified difference (e.g. partner, risk, resource, activity, etc.) and the kind of difference, called operation here (added, deleted, updated). This weight is used to qualify each detected difference, as each difference has not the same impact on the relevancy of the processes. For example, the addition of an order (the deletion of a partner) has more negative impact on the processes than the deletion of an order (the addition of a new partner) (see Table 1).

The matrix {element type × operation} is a parameter defined by the partners of the collaboration among the execution of the Agility Service. Among the difference detection, a threshold (named $\partial_{\text{threshold}}$) is also defined by the partners. If the calculated ∂ is equal or over this threshold, the Agility Service will execute the adaptation step.

Table 1. Sample of an element types × operation matrix

Element	Added	Deleted	Updated
Partner	1	3	2
Traffic Jam Constraint	4	3	2
Order	2	1	1

3.2 Adaptation

We propose combining two kinds of system adaptations (to the most appropriate conformation): (i) the ability to evolve in a predetermined closed geometry and/or (ii) the ability to redesign a new structure fitting the situation.

The first point refers more to a “Design-time” agility, based, for instance, on risk studies and leading to the building of models including a number of conditional branches to optimize coverage of the possibilities. The second point refers more to a “Run-time” agility where the (re)building of the best possible conformation has to be improvised, at the convenient moment.

To decide what kind of adaptation should be proposed to the user, the adaptation part is based on the study of the difference details gathered by the ∂ calculus in the detection step. First of all, we defined a set of business rules describing how the adaptation step can advice users on the loop to choose (partial or total redefinition, etc.), based on the details of each detected difference and on the weight of each concept participating into the calculated ∂.

Then, when all theses rules are run, the Agility Service is able to indicate the best solution(s) for adaptation to the users, considering all the detected differences. It is very important to note that the final choice is let to the users. The Agility Service is a decision support system in order to choose a relevant adaptation of the processes, not the system that takes the decision of the adaptation.

4 City Logistics and Transportation Use-Case

Our use-case is based on the process of French drug deliveries to pharmacies. It is inspired by the one described in [11]. In France, drugs and Over-the-counter (OTC) medicines are produced by various pharmaceutical manufacturers and mainly distributed through a two-levels network composed of wholesalers and pharmacies (about 80% of the national sales of drugs and OTC medicines [12]) as shown on Figure 3.

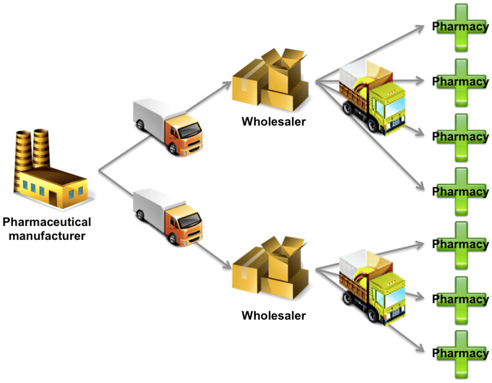

Fig. 3. French drugs and OTC medicines distribution network (according [11])

As the French law requires wholesalers to have a minimum stock of each product in their warehouses, it is considered in this use-case that there is no shortage at wholesaler level. The focus is put on the products distributed from wholesalers to pharmacies. A wholesaler supplies several pharmacies, contained in a given geographical area, about three to four times per day (in average) [12]. The average delay between the reception of the order by the wholesaler, and the delivery to the pharmacy is 2h15. Usually, the deliveries are organized as a set of scheduled rounds.

Considering the fact that the deliveries are dependent on traffic conditions, lorries conditions and availability, weather conditions, it is crucial to (i) gather relevant information in real time and (ii) to manage it very quickly. Thus any changes, any evolution, any information that could challenge the rounds and the quality of service of the delivery process have to be managed in order to be able to adapt the routes of the wholesaler's lorries in real time. According to [4], [13] and [14], these elements that happened and that embedded data can be considered and managed as events.

We have listed four macro types of events covering the whole kinds of events that can happen in various contexts as delivery management, as shown in Table 2. These events help us to gather knowledge about the evolution of the situation (i.e. process execution and environment of execution).

Table 2. Macro event types

Event type	Description
Situational	Used for information about the situation (e.g. information coming from sensors or human made description)
Consequence	Used to transmit the result of one activity/a sequence of activities
Activity	Used to give information about the state of a service: waiting, work in progress, done, failed
Resource	Used for information about the resources (i.e. information such as reports, or objects or human means)

In the context of the delivery use-case, these events can embed at least (i) the traffic information provided by the city hall to assess the traffic situation and potential new routes (situational event), (ii) the pharmacies' stock to assess the priorities in terms of supply (resource event), (iii) the patients' urgent orders to assess the emergencies in term of demand (consequence event), (iv) the ongoing preparations at wholesaler's warehouse to adapt the time delivery schedule (activities event), etc.

Based on these events, we defined some business rules in order to be able to adapt the behavior of the delivery system within the SocEDA platform. Below is a sample of the rules used in this use-case:

- **If** there is an important traffic jam 1 km around $pharmacy_N$ **then** go to $pharmacy_{N+1}$,
- **If** the planned route is modified **then** inform all the remaining pharmacies for the delay,
- **If** there is an urgent request for a specific drug **then** proceed to the delivery of this drug first.

The considered scenario concerns one vehicle, which has to deliver five pharmacies (P) located in various places of a given area. The scheduled round is:

1. Start from wholesaler's warehouse at 8:30 am,
2. Arrive to P#53 at 8:45 am and leave at 8:55 am,
3. Arrive to P#22 at 9:15 am and leave at 9:25 am,
4. Arrive to P#34 at 9:30 am and leave at 9:40 am,
5. Arrive to P#11 at 10:00 am and leave at 10:10 am,
6. Arrive to P#14 at 10:20 am and leave at 10:30 am,
7. Go back to warehouse at 10:50 am.

The wholesaler has chosen a $\partial_{\text{threshold}}$ equals to 2.

At 8:25 am the vehicle is ready to start. Its round begins at 8:30 am. At 8:43 am, the driver arrives to P#53 and leaves at 8:51 am.

While he is driving to P#22, he received an alert about a traffic jam due to a street protest in the street just near P#22. **The Agility Service of the SocEDA platform adds a *Traffic Jam Constraint* element into the field situation model (and nothing into the expected situation model). According the matrix {element type × operation}, $\partial = 4$ and $\partial > \partial_{\text{threshold}}$.** So the Agility Service of the SocEDA platform modifies its round schedule and proposes an adapted route to the driver, in order to avoid the traffic jam and to deliver P#34 instead of P#22. The SocEDA platform also informs P#22 that the delivery should be effective around 10:45 am. Finally, he arrives at P#34 at 9:18 am and leaves at 9:28 am.

The new schedule indicates to the driver the route to go to P#11. While he is driving to P#11, he receives an alert about an urgent demand received by P#14 and for which the medicines are in the delivery order he is transporting. **The Agility Service of the SocEDA platform adds an *Order* element into the field situation model (and nothing into the expected situation model). According the matrix {element type × operation}, $\partial = 2$ and $\partial = \partial_{\text{threshold}}$.** Consequently, the platform suggests him to change his route to deliver first P#14 instead P#11. And the pharmacist of P#11 receives a notification from the platform at 9:38 am about the move of its delivery (from 11:00 am to 10:25 am). Finally the driver reaches P#14 at 9:58 am and leaves at 10:13 am. The medicine is delivered without any delay to the patient. The driver continues his route normally and arrives à P#11 at 10:24 am and leaves at 10:35 am.

The driver goes to P#22 following the route proposed by the platform: he reaches P#22 at 10:45 am and leaves at 10:55 am.

Finally the driver goes back to the wholesaler's warehouse at 11:05 am, with only a delay of 15 min on the planned schedule. This example shows how the SocEDA platform allows detecting, analyzing and reacting on events and can help people avoiding losing time and means by adapting processes.

5 Conclusion

The SocEDA platform provides an environment to manage processes in an event-driven perspective, allowing the users to be dynamically connected to events coming from the environment and the processes themselves. Events are gathered through a publish-subscribe mechanism based on topic and content subscription. This kind of subscriptions is very interesting because it allows the user to get the relevant information at the right time, without any necessity of knowing all the event sources providing this information. Events gathered by the SocEDA platform are filtered and aggregated to detect interesting situations and, through the SocEDA's Agility Service, to propose relevant changes to existing and running processes and services.

Regarding the overall proposition, two reproaches might be done: (i) what about the robustness of such a system? And (ii) how to deal with access to events and unreliable data?

Concerning the first point, it is clear that as we are based on organizations' Information Systems, we are thus technically dependent on the network. If the network goes down, a part or, in the worst case, the entire system fails too. Hardware security measures should be taken to protect the physical network, in addition to the security measures taken to protect the data network against acts of piracy.

Concerning the second point, we agree on that events can only be used if they are trustable: a possible solution to tackle this point may be the definition of a social filter to evaluate the event providers and the events themselves [15] [16]. This social filter operates on a social network of services to compute the strength of the relationships between them through a trust interference algorithm. The social filter is one of the components of the SocEDA platform and will be integrated on the CEP. Another complementary solution could be the use of a governance tool to manage subscriptions to event types.

Acknowledgments. This work has been partially funded by the French Research Agency (ANR) regarding the research project SocEDA (SOCial Event Driven Architecture) (Grant ANR-10-SEGI-013). This project aims to provide dynamic and adaptive workflows to collaborative situations through EDA and CEP. The authors would like to thank the project partners for their advices and comments regarding this work.

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Collaborative Process Flexibility Using Multi-Criteria Decision Making

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Abstract. The ability to deal with both foreseen and unforeseen changes in a collaborative process (also known as Collaborative Process flexibility) is considered critical for the business process management systems. In this paper, we present an approach that uses a modeling framework and engine called Situation Action Network (SAN), along with multi-criteria decision making methods and techniques (MCDM). Such combination introduces event-driven flexibility in collaborative processes. We discuss and implement appropriate notions and mechanisms in order to alleviate a part of the modeler's effort during the design of hierarchical rules (i.e. SAN trees). This increases their run time flexibility and support the adaptation of collaborative business processes. We validate our approach using an illustrative scenario taken from the nuclear crisis management domain.

Keywords: Collaborative Processes, Flexibility, Adaptation, MCDM, SANs.

1 Introduction

In today's agile business environment, information systems should be able to model business needs in a flexible manner in order to be effective. It must allow domain experts to model business systems with means that are intuitively comprehensible using concepts that are familiar to them, such as goals and actions for achieving them. Goal-orientation is based on separating the declarative statements and defining desired system behavior, thus hiding from business users the low-level system details [1]. This flexibility is even more imperative when business information systems should deal with and support collaborative processes. Collaborative Process flexibility can be seen as the ability to deal with both foreseen and unforeseen changes in a collaborative process, by varying or adapting promptly those parts that are affected.

Situation Action Networks (SANs) is a modeling framework that can be used for defining business systems' reactions to significant situations with the purpose of

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 691–698, 2013.

fulfilling or satisfying a goal [2]. SANs are hierarchical goal-directed models that comprise nodes with specific semantics, presenting possible decomposition paths from goals into subgoals and primitive actions. Goals are related to situations that trigger their activation and reactions that should be performed towards achieving these goals when certain conditions are met (Fig. 1). SANs are modeled and executed by the SAN editor and SAN engine, respectively. SAN engine can enable automatic search for new goals when specific circumstances, i.e. situational and contextual settings, arise and recommend actions in order to satisfy the currently active goals.

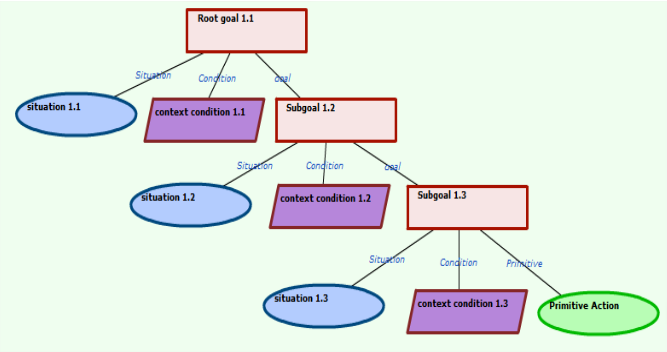


Fig. 1. Basic Modeling Primitives of SANs

The SAN framework has been coupled with an aspect-oriented extension of BPMN2.0 in order to enable the execution of BPMN2.0 processes and support business process adaptation [3]. In that work, SANs are used to monitor the process execution environment and describe meaningful reactions to problems. Based on these monitoring capabilities, SANs are able to detect process execution problems (e.g. violation on quality “threshold”) and trigger lookup for suitable adaptation actions by using a reasoning mechanism. The implementation of the recommended adaptation is based on aspect-oriented programming (AOP) techniques [4]. We note that the actual SAN modeling is not considered trivial and dictates for an editor that is domain expert and is capable for conceptually validating the outcome.

Despite the intuitiveness of goal-orientation for business users, modelling a goal-oriented business process to its full detail can be tedious and time-consuming. Furthermore, not all process parameters may be known a priori, or large numbers of alternative goal decompositions are possible, thus making the development of a detailed model impractical or even impossible. In order to remedy these issues, process modeling flexibility with SANs can be improved with techniques that enable them to dynamically “choose” the required or desired detailed goal decompositions.

In this paper, our research objective is to extend the SAN modeling framework with the appropriate constructs and corresponding methods in order to alleviate a part of the modeler’s effort during the design of BPMN2.0 processes and increase their run time flexibility.

Different kinds of flexibility are needed during the life cycle of a business process. There have been numerous studies of flexibility in business processes oriented systems, both in terms of the factors which motivate it and the ways in which it can be achieved. The following papers cover extensively the literature on both the notion of process flexibility as well as design and evaluation approaches of flexible process-aware systems [5], [6], [7], [8], [9], [10]. Our approach focuses on relieving the modeler from having to a priori map situations to specific actions that should be enacted when the situations occur. Instead, a pool of primitive actions or even linked SANs can be mapped at design time with situations. These pools may be dynamically updated at run time. The framework extension involves the capability to automatically select appropriate primitive actions based on real time evaluated criteria using Multi-Criteria Decision Making (MCDM) methods. We formally present this extension, we discuss the necessary SAN engine extensions and we conclude with an illustrative scenario that exhibits the flexibility improvements.

2 Flexibility Approach

We introduce two new node types in the SAN formalism, named Abstract Action and Action Pool that enable dynamic (at runtime) "choice" over the required or desired goal decompositions. This dynamic behaviour of SANs along with the use of AO4BPMN2.0 (aspect-oriented extension of BPMN2.0, presented in [3]), induces flexibility in collaborative business processes.

Abstract actions are leaf nodes in SANs that when visited (during SAN traversal), they determine on-the-fly the tasks they should be performed, selecting them from a repository of alternative actions, called Action Pool. For that purpose search and selection multi-criteria decision making methods (MCDM) are specified beforehand. In our implementation we have used the Linguistic Ordered Weighted Average (LOWA) [11] method that acts on linguistic variables, such as words or sentences in a natural language, and produces (linguistic) ranking. The tasks can range from primitive actions up to whole SANs. Abstract action nodes replace themselves with the task(s) that are automatically selected from an associated action pool, based on the search and selection method and resolution policy used. Abstract Action nodes must be annotated with metadata providing the necessary configuration for the search and selection methods. These metadata specify the criteria that will be used along with their weights. Additional metadata control the ordering, the size of results list and filtering ("LOWA Criteria", "Ascending Order", "Results Count", Allowed Values", "Results Filter", "Mapping"). All the annotations needed both in abstract actions nodes and in action pools are inserted through the SAN editor.

An Action Pool contains several possible alternative decompositions for an abstract action. Normally the contained items should all provide decompositions for the same purpose or goal. An action pool can be used by more than one abstract action, possibly in different SANs. It's worth noting that Action Pools can either be predefined sets of decompositions, or they can be retrieved / generated at runtime from an online service, for instance databases or web services. Action Pools must be annotated firstly with criteria parameters. Any metadata defined for annotating an Action Pool actually denote mandatory metadata that should also appear in the action pool items. Some or all of the action pool metadata can be used as search and selection criteria in LOWA method or any other MCDM methods that might be defined in the future. All action pool Items must be annotated with values, pertaining to the criteria defined in action pool. These values are used to calculate the average scores of action pool items using LOWA. The values can either be linguistic terms, numeric or text values. In case of linguistic terms a mapping parameter is used for specifying how the linguistic terms map to actual criteria values.

A Search and Selection Method is responsible to scan all action pool items, examine their properties and figure out which of them fit the specific purpose of the abstract action node. When more than one action pool items fit the purpose, it is again the responsibility of search and selection method to pick the best one. In some cases, however, it is acceptable (or even desired) to select the top N best items or all matching items. In such cases an ordering is required. We used the multi-criteria decision making method LOWA for performing this ranking of the action pools items.

A Resolution Policy is needed when the search and selection method returns more than one items. It is responsible to make the final selection of the item that will be used to replace the abstract action node. It is allowed to select more than one item, in which case it must define the way the items should be combined. For the time being five resolution policies have been defined: i) use the item at the 1st place (best ranked item) in the results list, ii) select an item from the results list randomly, iii) combine all matching items into a "Parallel Any" action, iv) combine all matching items into a "Parallel All" action, v) combine all matching items into a "Parallel Timeout" action.

2.1 Algorithm and Implementation

LOWA has been used as MCDM method to select and rank the action pool items, using linguistic terms. This method accepts the following input arguments from SAN engine core: i) reference to the "owner" abstract action, ii) reference to the specified action pool, iii) reference to the local context. These are references to various SAN model entities that contain configuration data that the method needs in order to work appropriately. Configuration data are stored as metadata annotations on the arguments passed to SAN model entities. Using the above input, the following algorithm (Table 1) is implemented by our system in order to properly use the abstract action capabilities of SAN formalism.

Table 1. SAN Search & Selection

```
Algorithm SAN Search & Selection
Require: self reference to abstract action node
items ← get_action_pool_items( get_action_pool(self) )
criteria ← get_criteria(self)
allowed_values ← get_allowed_values(self)
mapping ← get_mapping(self)
weights ← get_criteria_weights(self, criteria)
for each item I in items do
    values ← empty list
    for each criterion C in criteria do
        item_value ← get_item_value(I, C)
        if mapping $\neq \emptyset$ then
            item_value ← translate_value(mapping of C, item_value)
```

```
            end if
            add item_value to values
        end for
        lowa_value ← calculate_lowa(values,weights,#criteria,allowed_values)
        IT.lowa_score ← lowa_value
    end for
    remove elements of list 'items' with 'lowa_score $\neq$ filter'
    order elements of list 'items' based on 'lowa_scores' with direction 'order'
    remove elements of list 'items' after position 'count'
```

The dynamic decomposition functionality described has been incorporated in the reference SAN engine by extending its base API and implementing extensions at the traversal engine and SAN repository (Fig. 2). All components along with their extensions were coded using Java programming language. The Adaptation Manager component handles the coupling of SAN engine with the aspect-oriented extension of BPMN2.0 (presented in [3]) in order to enable the execution of BPMN2.0 processes and support business process adaptation. Its primary role is to closely monitor the execution of process instances and activate the corresponding advices based on SAN traversal (further details can be found in [3]).

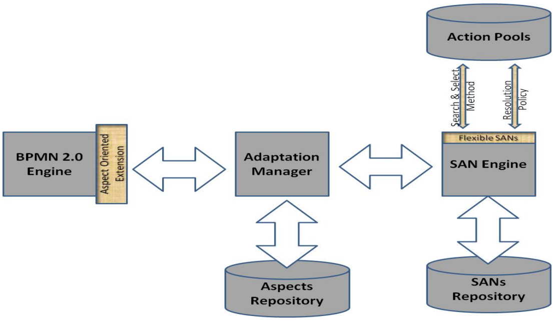


Fig. 2. Conceptual Architecture

3 Illustrative Scenario

We use the nuclear crisis management scenario[3], where a large quantity of radioactive substance is accidentally released in the atmosphere. A number of mitigating actions take place based on a predefined collaborative process that involves several different actors, authorities and services (e.g. police, military, fire brigade, national institute for radioprotection and nuclear safety, representatives of national authority etc.). In this scenario instead of pre-modeling (in one SAN) all possible adaptation actions, we use the notion of abstract action and action pool in order to be able to select adaptation advices at run time based on the current context.

The SAN (Fig. 3) designed, takes advantage of an action pool and instead of having a pre-designed recommendation process of generating advices, when "Study Advice" gets delayed, the abstract action "Recommend of weaving a Wf Advice" is used. This abstract action is associated with a number of alternative advices that could be suggested, based on the current context information. In this scenario Radiation Level and Weather Conditions are used as selection criteria for the search and selection method. The contextual values of these two criteria are derived from the field and meteorological event streams, and they are expressed as linguistic terms taking one of the values: Normal, Notify, Alert, Dangerous and Critical. The SAN Designer can set the weights for these criteria (e.g. 70% Radiation Level, 30% Weather Conditions). We use an Action pool that includes items that generate adaptation advices (i.e. recommendations):

1. *Advice 2 without interrupt* (Radiation Level: ALERT, Weather Conditions: ALERT). Since a dangerous or critical situation has not been detected yet, the involved actors can afford to wait for this study to be finished before the Representative of the National Authority asking for additional clarifications. When both the "study advice" and "study clarifications" tasks finish, the normal workflow execution can proceed. The Advice 2 involves the weaving after the "study advice" task the following sequential ones: "Ask for clarifications", "Wait and receive clarifications", "Study clarifications".

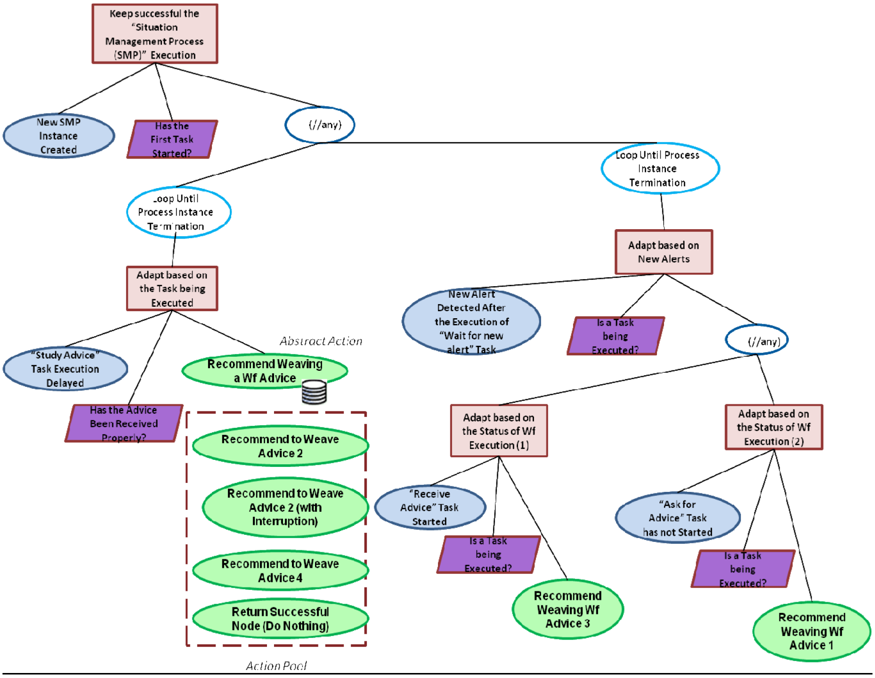


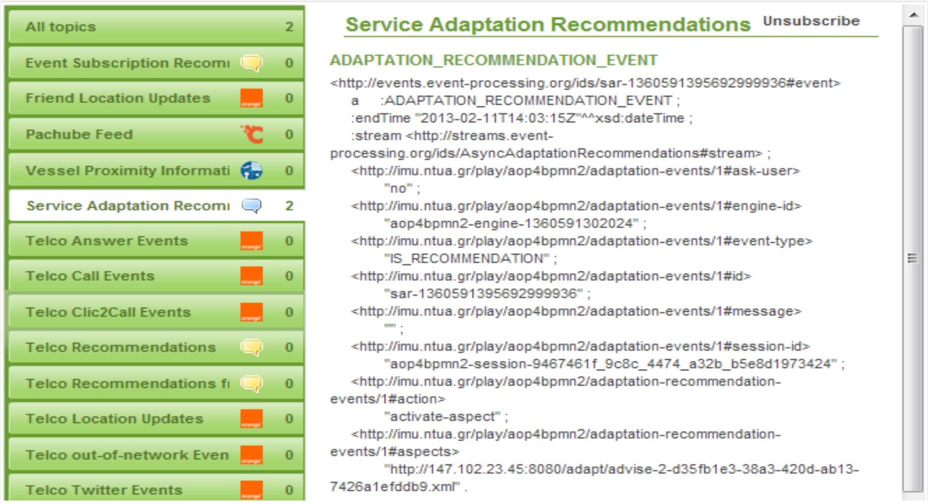
Fig. 3. SAN deployed for Collaborative Process Flexibility

2. Advice 2 with task interruption (Radiation Level: CRITICAL, Weather Conditions: DANGEROUS). In this case the reactions should be accelerated, so the task "Study Advice" is interrupted and the advice 2 is weaved.

3. Advice 4 (Radiation Level: DANGEROUS, Weather Conditions: NORMAL). Although, a dangerous situation has been detected, there is some time (since weather conditions are normal) to consider carefully the proper reactions. The important thing in such situation is to take the best possible decision that is why advice 4 is weaved after the “Study Advice” task has been completed with a delay (no interruption this time). The Advice 4 involves the weaving after the “study advice” task the following sequential ones: “Ask for activity report”, “Wait and receive activity report”, “study activity report”.

4. Do Nothing - normal workflow execution (Radiation Level: NOTIFY, Weather Conditions: NORMAL). Although SAN has detected a significant delay in the “Study Advice” task, it is not meaningful to weave any adaptation action since the weather conditions are normal, thus the radiation cloud will not move fast. This means the there is the necessary time for the involved actors to take the correct decisions.

The following figure presents recommendations generated by our system, and published as events, using the aforementioned setup.



ADAPTATION_RECOMMENDATION_EVENT

```
<http://events.event-processing.org/ids/sar-1360591395692999936#event>
    a    :ADAPTATION_RECOMMENDATION_EVENT ;
    :endTime "2013-02-11T14:03:15Z"^^xsd:dateTime ;
    :stream <http://streams.event-
processing.org/ids/AsyncAdaptationRecommendations#stream> ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-events/1#ask-user>
          "no" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-events/1#engine-id>
          "aop4bpmn2-engine-1360591302024" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-events/1#event-type>
          "IS_RECOMMENDATION" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-events/1#id>
          "sar-1360591395692999936" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-events/1#message>
          "" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-events/1#session-id>
          "aop4bpmn2-session-9467461f_9c8c_4474_a32b_b5e8d1973424" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-recommendation-
events/1#action>
          "activate-aspect" ;
    <http://imu.ntua.gr/play/aop4bpmn2/adaptation-recommendation-
events/1#aspects>
          "http://147.102.23.45:8080/adapt/advise-2-d35fb1e3-38a3-420d-ab13-
7426a1efddb9.xml" .
```

Fig. 4. Recommendation to weave Advice 2

4 Conclusions

In this paper, we presented an extension of the Situation Action Network (SAN) modelling framework in order to introduce run-time flexibility in collaborative processes. The extension enables dynamic decomposition of SANs allowing for abstract definition of SANs at design time. Dynamic decomposition enables more flexible and modular modelling, since the decomposition details can be modelled separately from the main problem. This separation facilitates SANs’ reuse and improves the usefulness and applicability of each main model. On the other hand, the decomposed models (contained in Action Pools) can be treated as runtime libraries and also be re-used. Further, our approach implements an abstraction layer over the main modelling process by removing the decomposition search, selection and execution method details. Finally, decompositions for various purposes, in the form of action pools, can be developed and provided by third parties, or collaboratively be built from a group of designers. Continuing this work on flexible SANs, we plan for an extensive evaluation of our approach where any lag or limitations in terms of recommendations speed, will be measured.

Acknowledgments. This work has been partially funded by the European Commission under project PLAY (Grant FP7-258659). The authors would like to thank the project partners for their advices and comments regarding this work.

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PLAY: Semantics-Based Event Marketplace

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Abstract. In this paper we present PLAY Platform, a Web-oriented distributed semantic middleware that serves as an Event Marketplace: the place where heterogeneous events can be integrated and combined. The purpose of the platform is to derive useful information from diverse real-time sources such as collaborative processes. The platform provides technology where instant results are needed or where heterogeneous data must be integrated on the fly or where the data arrive fast enough to require the stream processing nature of our approach. The main advantages of the platforms are its scalability (cloud-based nature) and the expressivity of the event combinations that can be defined (using both real-time and historical data). The platform has been applied in a use case about Personal data management. In this paper we present some results from the validation, focusing on smartphone and social media integration.

Keywords: Mobile Data, Linked Data, Personal Data, Real-time Web, Event Marketplace, Complex Event Processing, Semantic Streams.

1 Introduction

Recently, there has been a significant paradigm shift towards real-time computing. Previously, requests for Web sites just like queries against databases were concerned with looking at what happened in the past. On the other hand, complex event processing (CEP) is a technology concerned with processing real-time events, i.e., CEP is concerned with what has just happened. An event is something that has happened, or is contemplated as having happened [8]. For example, an event may signify a sensor reading, and so forth. Using complex event processing this paper wants to outline a framework for dynamic and complex, event-driven interaction for the Web. This infrastructure leads to the concept of the **Event Marketplace** (similar to a service marketplace) where events coming from different event producers (as illustrated above) can be arbitrary combined by different event consumers. The most important requirement is to build the Marketplace upon widely-accepted open standards that enable different components of the event processing architecture to be plugged into an event-processing "fabric" with minimal effort, allowing the development of

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 699–707, 2013.

time-driven, event-based, global applications. This “on-the-fly-adaptive” nature of the Marketplace will enable the dynamic definition of situations of interest (complex event patterns) and ad-hoc generation of timely reactions to new situations. In this paper we present the concept and the architecture of a platform/middleware that can satisfy some of these requirements today. We argue that the proposed solution can scale regarding the distribution of services (sources) and the throughput of interesting information that can be exchanged and can be easily extended with new services (openness).

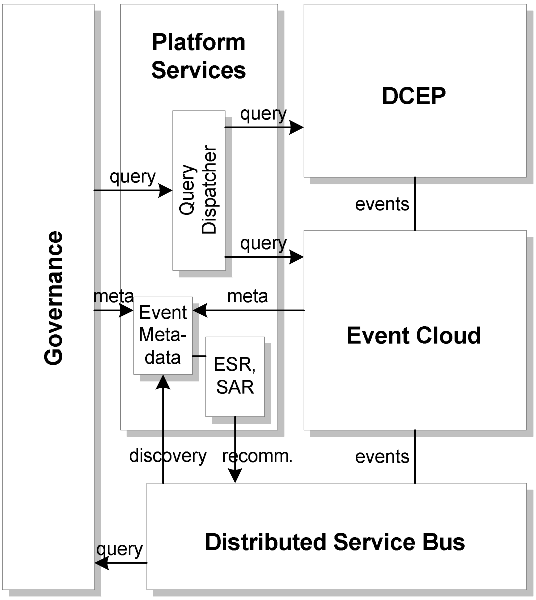

Fig. 1. Conceptual Architecture

2 Platform

The conceptual architecture for our platform is depicted in Figure 1. We introduce the components briefly. The **Distributed Service Bus** (DSB) at bottom right of the figure provides the SOA and EDA (Event Driven Architecture) infrastructure for components and end user services. The **Governance** component allows users to get information about services and events. The **Event Cloud** provides storage and forwarding of events. Its role is manipulating events, real-time or historic. Real-time subscriptions may use a simple set of operators such as conjunctive queries to filter out an interesting event. More complex queries are executed in the DCEP component. The **DCEP** component (Distributed Complex Event Processing) has the role of detecting complex events by means of event patterns. To detect complex events, DCEP gets simple events from then Event Cloud as defined in the event patterns. The pattern language is BDPL which we introduce below. The **Platform Services** incorporate several additions to the platform. The Query Dispatcher has the role of decomposing and deploying patterns in

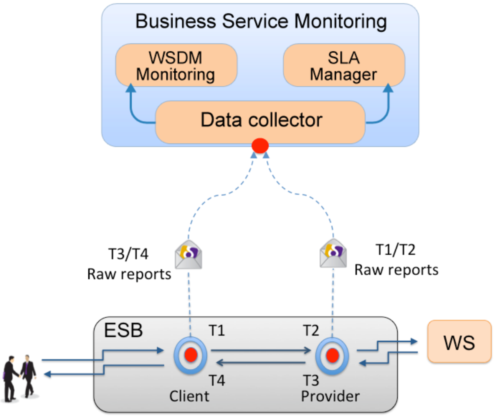

Fig. 2. Raw Reports time stamps illustration

the Event Cloud and DCEP. The Event Metadata component enables the discovery of relevant events for a consumer and provides data to the subscription recommender. The recommenders Event Subscription Recommender (ESR) and Service Adaptation Recommender (SAR) are discussed below.

2.1 Governance and Monitoring

The Business Service Monitoring Architecture is an implementation that is called EasierBSM[1]. It enables the monitoring of the Distributed Service Bus (DSB) middleware: services that are deployed on bus as well as external applications. The mechanism is event-driven, monitoring exclusively receives data from the bus as notifications. Components generate and send 'reports' about their activity.

Raw Reports Events. Raw reports (Figure 2) are sent by interceptors (located around services of the business node). They are based on a model defined by Linagora[2]. T1/T2 report is sent, giving the status of the exchange (i) before the client request is sent to the provider and (ii) after the provider receives the client request. A T3/T4 report is sent, giving the status of the exchange (iii) before the provider sends the response to the client and (iv) after the client receives the response. Several experiments have led to an optimal configuration of 2 events per exchange. Actually, reports are sent on T2 and (potentially if the exchange pattern is In-Out) T4. This choice minimizes the number of non-functional events while sustaining an efficient monitoring. Indeed, it would be possible to send only one Raw Report containing the 4 time stamps, but in this case, the EasierBSM would not be able to manage non-responding services.

Service Level Agreement Events. The Service Level Monitoring is dedicated to the technical aspects and is the lowest kind of event EasierBSM is able to send. For that purpose, EasierBSM contains two components (see Figure 2) implementing respectively the WSDM [20] (WSDM Monitoring component) and WS-Agreement[3] (SLA Manager component). Both of them use the Raw Reports events as data input. Once QoS are computed, it is possible to build and negotiate agreements at a governance level between service consumer and provider. Negotiated Service Level Agreements are loaded in the SLA component. It receives also the Raw Reports from the DataCollector and checks if a particular exchange is violating an agreement. Then, an SLA alert is potentially sent as an upper level monitoring notification using the Common Alerting Protocol (CAP[4]) standard.

2.2 Event Cloud

The EventCloud [21] is a distributed datastore that allows to store quadruples (RDF triples with context) and to manage events represented as quadruples or set of quadruples (a.k.a., event). To scale, the architecture is based on a structured Peer-to-Peer (P2P) network named Content Addressable Network (CAN) [22]. A CAN is a

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[1] `http://research.linagora.com/display/easierbsm`

[2] `http://research.linagora.com/display/esstar/Es-RawReport`

[3] `http://schemas.ggf.org/graap/2007/03/ws-agreement`

[4] `http://docs.oasis-open.org/emergency/cap/v1.2/`

structured P2P network (structured in opposition to unstructured, another category of P2P networks better suited to high peer churn) based on a d-dimensional Cartesian coordinate space labeled *D*. This space is dynamically partitioned among all peers in the system such that each node is responsible for indexing and storing data in a zone of *D* thanks to a traditional RDF datastore such as Jena. According to our data model, we use a 4-dimensional CAN in order to associate each RDF term of a quadruple to a dimension of the CAN network. Thus, a quadruple to index is a point in a 4-dimensional space.

Retrieval Model. At the EventCloud level, an API is provided according to a retrieval model based on *pull* and *push* mechanisms. The *pull* or *put/get* mode refers to one-time queries; an application formulates a query to retrieve data which have been already stored. In contrast, the *push* or *pub/sub* mode is used to notify applications which register long standing queries and push back a notification each time an event that matches them occurs. Both retrieval modes have their filter model based on SPARQL. We allow the SELECT query form and a pattern applies to one graph value at a time. As such SPARQL provides us the ability to formulate a subscription by associating several filter constraints to a quadruple, but also to a set of quadruples that belong to the same event. This means that several quadruples of an event that are published asynchronously at different times may participate in the matching of a subscription by using their common constraints. Also, due to the distributed nature of the EventCloud, each quadruple is possibly stored in different peers. It is important to understand that our push retrieval mode is not supposed to act as a CEP engine correlating several events from several streams.

2.3 Big Data Processing Language

To combine real-time data and contextual (historic) data we propose a language called Big Data Processing Language (BDPL). The language is suited to be deployed in a distributed setting. We modelled BDPL as close to SPARQL 1.1 as possible. Bound variables in the query are allowed to join events based on values from the individual event instances. From the SPARQL 1.1 language we use the following subset: CONSTRUCT queries without operators UNION and subqueries[5], OPTIONAL or LIMIT[6] clauses. We distinguish graph patterns (using syntax EVENT and GRAPH) into real-time data and historic data respectively. The real-time parts may be combined with temporal operators such as time windows from [10] to enable temporal processing. Intuitively, a query is fulfilled if there is a mapping [13] for all variables from the real-time parts and a *compatible* mapping for the historic data at the time of the real-time answer. Operationally this means that the real-time part is applied to the streams. When there is a result the variable mapping will be checked for compatibility with all historic parts in the query.

The model for the query language also requires a model for the data to be queried i.e., the events. The Linked Data principles [14] are a methodology of publishing structured data and to interlink the data to make them more useful. These principles

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[5] These operators can be emulated using two or more separate queries.

[6] These operators do not make sense on streams i.e., potentially unbounded datasets.

apply to event modelling. We use an event schema from which the event types are inherited. The schema [15] makes use of related work by reusing the class "Event" from Dolce Ultralight based on DOLCE [4]. We are developing this event model to satisfy requirements of an open platform addressing *variety* in big data. As such, data from the Web must be reused and be extensible for broader participation.

2.4 ESR and SAR Recommenders

In this section, we focus on ESR and SAR Recommenders that are included in the platform services conceptual component (Figure 1). We aimed to support dynamic recommendations of new event streams to which a service should subscribe for a meaningful period of time, in order to take advantage of situational information, expressed as simple or complex events. We developed ESR that exploits real-time event streams in order to dynamically produce new event subscriptions. This component provides added value assistance to services and users that will have the choice to be subscribed to the "right" event streams at the "right time" and for the "proper period of time". Thus, ESR improves subscription efficiency and prevents from unnecessary network traffic and additional workload on the subscriber's side. SAR is the second recommender. It addresses the issue of business process adaptation. For SAR we enhanced aspect-oriented business process management [17] with event-driven capabilities for discovering situations requiring adaptations. To this end, we developed an aspect-oriented extension to BPMN2.0 similar to AO4BPMN [18]. In order to cope with the advanced event-driven and situational processing related needs of both these recommenders, we developed a goal-driven, ECA-based hierarchical framework, called Situation-Action-Network (SAN) as background mechanism. It is a modeling framework that can be used for defining systems' reactions to significant situations with the purpose of fulfilling or satisfying a goal. Recently, the SAN modeling framework has been extended in order to alleviate a part of the modeler's effort during the design of SAN trees and increase their run-time flexibility [23].

3 Missed Calls Manager Use Case

The *Missed Calls Manager* (shortened hereafter to MCM) shows the event handling as a service in the Android Platform, sensing local telco and social events and acting as a joining link between users and the PLAY Platform that will "mix" events of different natures.

3.1 Use Case Scenario and Design

"After 3 out/ingoing missed calls to/from the same callee/er in the last 3 minutes, send a recommendation suggesting the user to contact his friend in a different way".

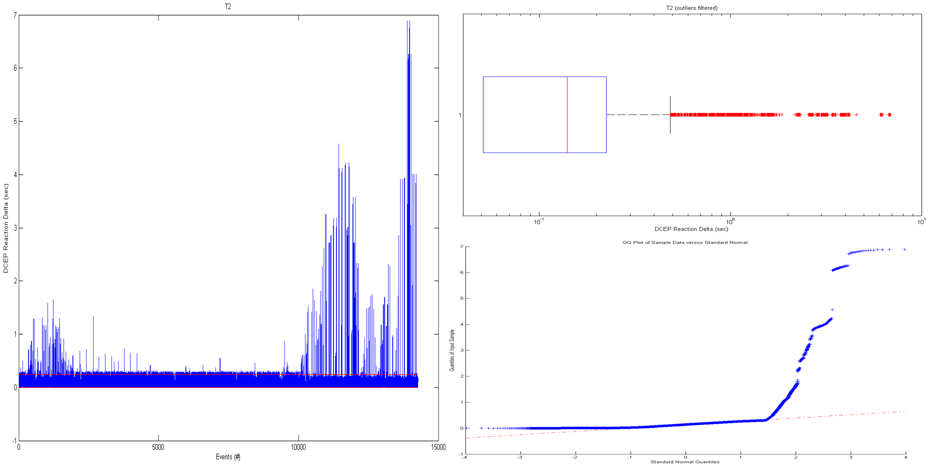


Fig. 3. Normal, box and QQ plots for the KPI T2

In this scenario, for each detected missed call, the MCM App sends to the PLAY DSB a simple event. Each event is delivered through the EventCloud to DCEP, which processes all of them for checking if a sequence of 3 call events with equal caller, callee and direction is occurring. The body of the event processing implementation in BDPL looks as follows, cf. Listing 1. Every time the pattern is detected, the `CONSTRUCT` defines a new complex event: `Recommendation`, pushed back to the Android Device, containing the wished suggestion. This closes the "event loop" for the user, who can decide whether to follow such a suggestion or not.

```
CONSTRUCT {
    :e rdf:type :Recommendation .
    :e :stream <http://...TaxiUCESRRecomDcep#stream>.
    :e :message "Missed 3 calls, try to contact the
        callee in another way"^^xsd:string .
    :e :members ?e1, ?e2, ?e3 .
    :e uctelco:callerPhoneNumber ?alice .
    :e uctelco:calleePhoneNumber ?bob .
    :e uctelco:answerRequired "true"^^xsd:boolean .
    :e uctelco:action <blank://action1> .
    <blank://action1> rdf:type uctelco:OpenTwitter .
    <blank://action1> :screenName ?screenName .
} WHERE {
    WINDOW {
        EVENT ?id1 {
            ?e1 rdf:type :UcTelcoCall .
            ?e1 :stream <http://...TaxiUCCall#stream> .
            ?e1 uctelco:callerPhoneNumber ?alice .
            ?e1 uctelco:calleePhoneNumber ?bob .
            ?e1 uctelco:direction ?direction .
            ?e1 :screenName ?screenName .
        } SEQ EVENT ?id2 {
            ?e2 rdf:type :UcTelcoCall .
            ?e2 :stream <http://...TaxiUCCall#stream> .
            ?e2 uctelco:callerPhoneNumber ?alice .
            ?e2 uctelco:calleePhoneNumber ?bob .
            ?e2 uctelco:direction ?direction .
        } SEQ EVENT ?id3 {
            ?e3 rdf:type :UcTelcoCall .
            ?e3 :stream <http://...TaxiUCCall#stream> .
            ?e3 uctelco:callerPhoneNumber ?alice .
            ?e3 uctelco:calleePhoneNumber ?bob .
            ?e3 uctelco:direction ?direction .
        }
    } ("PT1M"^^xsd:duration, sliding)
}
```

Listing 1. BDPL Event Pattern

3.2 Evaluation and Performance

In order to evaluate the DCEP performance, the following KPI has been defined and measured in a scenario simulating 41 users randomly generating events and triggering the described pattern. The KPI characterizes the speed

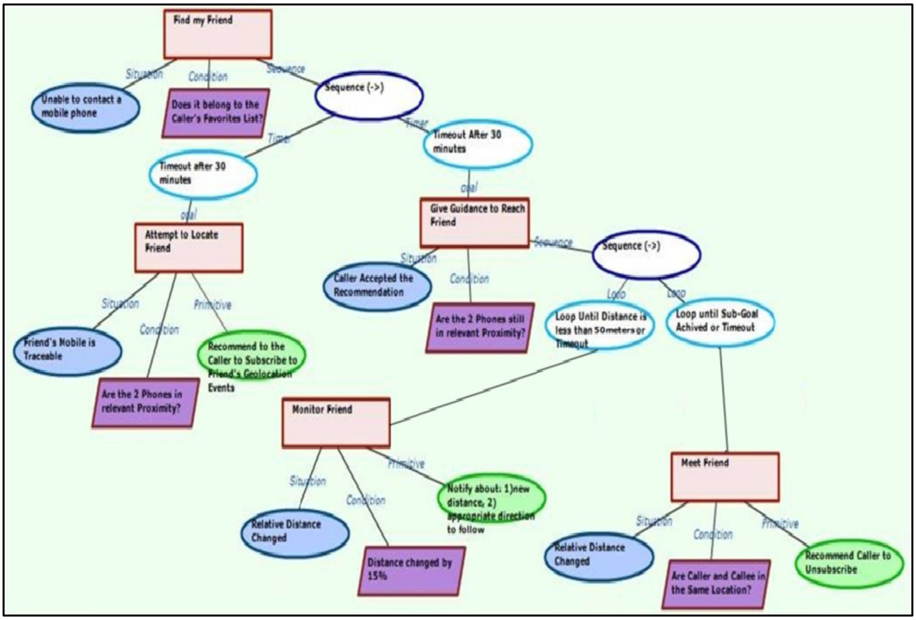


Fig. 4. "Find my Friend" SAN

of DCEP as the delta between when the last simple event entering the DCEP and when the DCEP build and emits a complex event. The diagrams in Figure 3 show this KPI with linear normal plot, the logarithmic box plot and the QQ plot, as a function of the cardinality of the events sent. The linear plot shows that the processing speed has initial spikes. These are due to some lazy processing e.g., DCEP is only connecting to its output streams after a respective event was detected for the first time. The spikes to the right of the plot are due to current event input slowdowns which influence DCEP performance. We are working to correct these in our middleware.

3.3 ESR in Smartphone Scenario

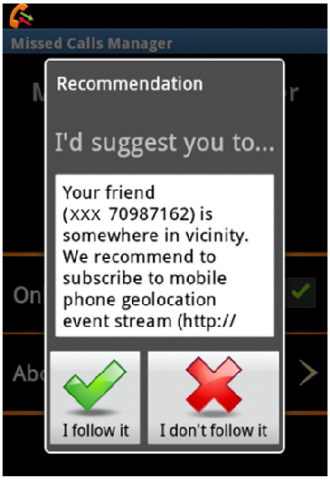
This scenario also involves events transmitted to our platform from the MCM App. This time ESR was introduced for recommending to a user that is unable to contact her friend (e.g. she is in a crowded place, doesn't answer her phone while they have scheduled to meet), the most efficient way to physically meet her. This involves: i) the subscription at the appropriate time to his friend's geolocation events; ii) the calculation of the appropriate duration of this subscription; and iii) the transmission of notifications that can guide the user.

In Figure 4, the SAN is presented as designed using a dedicated SAN editor. The SAN engine starts the tree traversal when the situation "Unable to contact a mobile phone" is detected (i.e. 3 missed calls events in the last 3 minutes) by our platform. Since the two users are in vicinity (i.e. less than 5 km), ESR recommends the subscription to friend's geolocation events (Figure 5). The unsubscription takes place once the two users meet.

4 Related Work

Some attempts were made to define a universal vocabulary for events which extends structs of primitive types. One notable approach is the XML format of AMIT presented in [2] providing more detailed temporal semantics and modelling not only events but their generalization, specialization and other relationships between events which can be used in processing. We support such relationships in our system. While designing an event-based system at Internet-scale, we employed widely available Semantic Web technologies to model events as proposed by Sen et al. [3]. There are models for events such as E* [7], F [5] and LODE [6], all of which rely on the DOLCE [4] top-level ontology as we do. However, they do not seem to be tailored to real-time processing because a lot of (e.g. temporal) expressivity such as relative and vague time is not supported by the state of the art in real-time processing engines.

C-SPARQL is a language and a system to process streaming RDF data incrementally [11]. RDF triples are events. Timestamps are attached to the triples implicitly when the events enter the system. Sets of events are matched in windows. This means that the approach has a *set-at-a-time* semantics. EP-SPARQL [9] is built on top of the Prolog-based event processing engine ETALIS [10] like our work. EP-SPARQL supports more event processing operators than C-SPARQL including *event-at-a-time* operators like the sequence of two events which require no mandatory window definition and are thus more declarative. Like C-SPARQL, however, this approach considers events as triples not as objects with further structure. This means that e.g. time is a second-class citizen and not part of the event to be transmitted across distributed systems. BDPL works with structured events consisting of many RDF triples per event as opposed to one triple per event. In addition to real-time data both C-SPARQL and EP-SPARQL can combine stream results with background knowledge. However, they do not propose a distributed system like EventCloud to address the *volume* of data.



Your friend (xxx 70987162) is somewhere in vicinity. We recommend to subscribe to mobile phone geolocation event stream (http://

Fig. 5. ESR Recommendation on User's Smartphone

5 Conclusion

We presented a novel approach for real-time querying enabling the expression of complex situations to be notified to the user instantaneously. Main novelty in the approach is the combination of real-time and distributed historical data in the system. The query engine is realized in a distributed manner using event processing and semantic technologies. This work is part of the development of an Event Marketplace, a scalable infrastructure for exchanging and processing heterogeneous events. We argue that approaches like this will change searching on the Web in real-time, opening possibilities for new scenarios such as acting ahead of time leading to proactivity.

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Building the Social Semantic Enterprise

Real-Time Data Aggregation in Distributed Enterprise Social Platforms

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Abstract. The widespread use of social platforms in contemporary organizations leads to the generation of large amount of content shared through various social tools. This information is distributed and often unstructured, making it difficult to fully exploit its value in enterprise context. While Semantic Web technologies allow for publishing meaningful and structured data, major challenges include: (1) real-time integration of distributed social data, and (2) content personalization to identify relevant pieces of information and present them to users to limit the information overload. This research in progress paper draws from an enterprise use case and discussed practices in real-time integration of social data in distributed social platforms. We propose to combine Semantic Web technologies with standardized transport protocols to provide efficient and open source layer for aggregation of distributed social data in an enterprise. We also show how our component can facilitate development of personalised social platforms.

Keywords: Enterprise Social Networks, Real-time systems, Personalization.

1 Introduction

The employees of contemporary enterprises are often distributed across departments and geographical locations, use different information systems, and offer a wide variety of skills and expertise to the organisation. In such environment, efficient delivery of relevant information to interested peers can be challenging. To help alleviate this problem, Semantic Web technologies [1] have gained popularity in the corporate world, enabling transparent provision of structured and meaningful data with the use of lightweight and standardized vocabularies such as FOAF[1] or SIOC[2], allowing to model enterprise data in RDF[3]. The combination of Semantic Web technologies with social platforms in organisations led to the "Social Semantic Enterprise" [13] that can profit from these trends by efficient, close to real-time aggregation of structured and meaningful data.

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[1] `http://foaf-project.org/`

[2] `http://sioc-project.org/`

[3] Resource Description Framework: `http://www.w3.org/RDF/`

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 711–718, 2013.

Social platforms that enable personalized information access in an enterprise environment require an infrastructure and algorithms that address many complex challenges: (1) aggregation and integration of data from different information systems/social platforms in the IT landscape of the enterprise is required, (2) provision of new algorithms that are independent of the domain and/or the source of the data to allow efficient personalization, (3) effective presentation and feedback mechanism to improve acceptance and quality of delivered information. This paper focuses mainly on the first challenge, and discusses how the contribution presented here can facilitate solutions to the second and third problems. We argue that while Semantic Web technologies provide rich data integration capabilities [18], there is a need to ensure that the integration of information from the vital sources available in an organization can be performed in, or close to, real-time. This is especially relevant in large organizations, where social platforms can be deployed in different geographical localisations nevertheless they need to interact instantaneously. Current approaches may not only delay the information flow but also negatively impact overall efficiency in many scenarios.

This paper gives an overview of work focused on enabling real-time aggregation and integration of social content published through distributed social platforms across and beyond an organization. We discuss how Semantic Web technologies and real-time instant messaging protocols can be used for efficient and quick aggregation of content between distributed social platforms according to corporate information management policies and with the use of existing real-time communication protocols.

2 Distributed Social Platforms

Organizations build and maintain many information systems to manage large volume of content published and consumed by knowledge-intensive workers [8]. Such environments involve many actors sharing and consuming information within a large network that is often distributed across various departments (see Figure 1) or even geographically. This shift requires new approaches for delivery of timely and relevant information in a close-to-real-time manner across such peer-to-peer [12] networks. Many initiatives [24,5,11] focus on building collaborative tools (e.g. wikis) that combine the benefits of mass collaboration with the intrinsic qualities of peer-to-peer networks, such as scalability or fault-tolerance. Although knowledge workers utilize many collaboration tools (e.g. blogs, wikis), crucial information is often not managed effectively [16] what affects efficiency and generates additional spending. To address this concern, organizations attempt to sustain information exchange through utilization of social networking tools both internally and externally. Once the social platform is operational and social connections are established, it is important to gather and reuse information available in this network. Thus, a distributed social network requires efficient information aggregation and delivery tools to allow for timely updates and retrieval of relevant content [21]. To address this challenge, the Semantic Web practitioners propose to use RDF to capture social data [20] and integrate RDF content across the organization. This is possible thanks to tools that provide means for building scalable distributed RDF repositories based on P2P networks, for example RDFPeers [3]. Indeed, the growing amount of information available in the form of

RDF that needs to be accessible by distributed peers in an organizational network requires mechanism for distributed querying [15] or replication [17]. Consequently, there is a need to tackle many aspects related to the dynamism of RDF data ("dataset dynamics" [23]), including change management. These issues are addressed in approaches for synchronization of RDF data (e.g. RDFSync [22]) that model and distribute changes in RDF models to the peers in large networks.

Distributed social platforms pose challenges related to efficient aggregation and delivery of information to relevant employees. The generic categorizations of models for communication and content/event exchange in a distributed environment differentiates pull and push approaches. The pull model involves an initial request from the (active) client that is responded by a (passive) server and is one of the most commonly used communication patterns in distributed networks. Polling is a mechanism related to pull model, which relies on clients actively sampling the server status through repetitive requests. Polling is considered resource expensive and scales poorly [6] as frequent polling may lead to inefficient usage of resources, but infrequent requests "may result in delayed responses to critical situations" [6]. Further, many scenarios require asynchronous delivery of events for better performance and scalability. Long Polling, introduced to address these limitations, is an approach based on the request-response model in which the server holds the request open until the response is available (or when the set timeout is reached) [9]. In contrast to the pull approach, the push model assumes a passive client that is notified of the occurrence of specific events upon a subscription to the server. The publish/subscribe (PubSub) interaction paradigm exploits the push model as it enables agents to subscribe to a particular event (e.g. content update), and to receive asynchronous notifications from the server/publisher when the event occurs [7]. The advantages of the PubSub paradigm over the Polling approach lie in the optimization of the number of request, the required network traffic, and in the full decoupling in "time, space, and synchronization between publishers and subscribers" [7]. Although the push approaches are gaining more popularity, the tools built using the pull paradigm are prevalent (see [2] for a detailed discussion). However, with the expansion of the Semantic Web technologies, more focus is put on applications implementing the push interaction model.

The task of real-time synchronization of RDF data requires both protocols and RDF description formats that allow concise data modelling and generate minimum amount of network traffic. In the next section, we present the scenario based on the problems faced by organizations with distributed social platforms and the generic requirements for integration of semantic social content and discuss these formats.

2.1 Use Case

Real-time aggregation of information published through various social platforms and collaboration tools in an organization lead to a number of problems and technological challenges. This is resembled in the use case described in this article (see Figure 1). Andrew, Bob and Cecilia are knowledge workers employed by a large organisation, however they work in different departments (CTO, IT, and marketing respectively) and use different social tools and platforms. In the current environment, they often must follow updates through various collaboration tools (e.g. wikis, confluence, enterprise microblogging) and corporate blogs of other co-workers to access content relevant to a given topic of their interest. While the use of RSS in this scenario is possible it implies regular querying of the information sources for updates, this approach does not allow for efficient integration of data across separated sub-divisional networks with restricted access policies. Finally, modifications of content that has already been distributed are not possible.

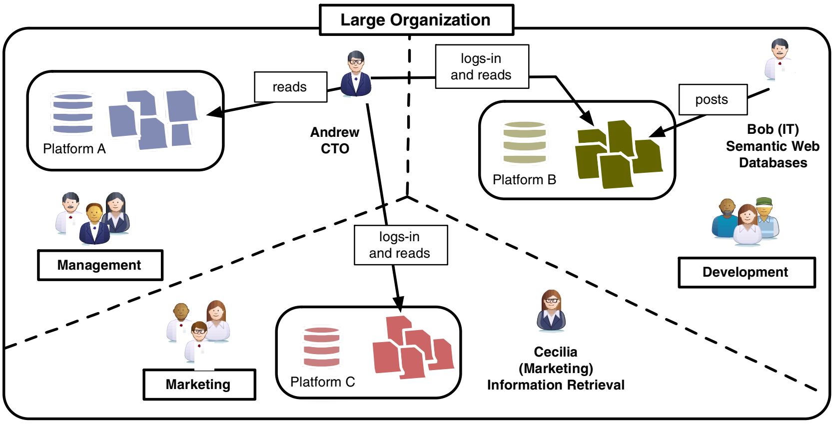

Fig. 1. Users publish large volumes of information through disconnected enterprise social platforms. This valuable information may be hard to discover by other users lowering the value of knowledge capital in an organization.

This example highlights the need for techniques enabling aggregation of social data with operations on data with fine granularity. Therefore, we argue that operations on data such as *Create*, *Read*, *Update*, or *Delete* (CRUD) [10] should be possible to execute not only on the document, but as well on the single-statement level. The support for, and efficiency of, the execution of these operations form the basic requirements for social platforms aggregating data across distributed organizations in real-time. Further, social platforms should be capable of delivery of content to interested users independently of the platform they are using, as well as limit the content delivery to only subscribed users as well as through filtering. In the next section we give an overview of the existing RDF update formats.

3 Approach

3.1 Describing Social Data with Semantic Web

For some applications (e.g. social content), in particular when aggregation from various sources is required, content update can be represented as streams of RDF triples [19]. Many applications in the Enterprise 2.0 are more stateful (e.g. presence management), thus require not only addition of the new content but also deletion/editing of existing information. Thus, RDF data integration techniques deployed in Enterprise 2.0 platforms should support not only addition, but also deletion and editing of existing content. Further, it is essential that the update operations should be done on the lowest possible level that is triple-level. Hence, we investigate a number of formats that provide social data modelling capabilities and fine-grained CRUD. Here we compare variety of existing formats including: SPARQL Update[4], Talis Changeset, the Graph Update Ontology[5], Guaranteed RDF Update format[6], and Sesame RDF transactions.

The results of our previous work [4] indicate that Changeset and GUO consume significantly more network resources than the efficient formats (SPARQL Update and GRUF). Talis Changeset required roughly twice more resources (a 70% increase in case of GUO) to remove a tag from the description of an already distributed post. However, when more data is concerned in a single request (e.g. distribution of a newly published post), SPARQL Update provides the highest efficiency, followed closely by GUO and GRUF. Overall, the results indicate that, for the data provided, SPARQL Update combines many advantages with very low network usage and flexibility and as a W3C standard, SPARQL Update seems an appropriate format for describing RDF updates for real-time synchronization of distributed platforms.

Table 1. A comparison of the selected push protocols

Characteristics	Bayeux/Comet	Websockets	SLAP	SUP	XMPP PubSub	PUSH
Transport Layer	HTTP	HTTP	UDP	HTTP(S)	TCP/XMPP	HTTP(S)
Category	Both	Fat ping	Light ping	Light Ping	Fat ping	Fat ping
Interaction Style	Long Polling	Push	Ping/Poll	Poling	Push	Push
Latency	Low	Min.	Low	Low	Min.	Min.
Secure Notifications	Yes	Yes	Yes	Somewhat	Yes	Yes

3.2 Aggregating Social Data

The RDF update formats require a particular communication protocol [19] to deliver content to appropriate recipients. For example, SPARQL/Update utilizes the SPARQL 1.1 protocol[7] (with a HTTP binding) for managing RDF graphs, Changesets messages are distributed using a HTTP-based protocol[8], and Sparql-PuSH [14] uses the PubSubHubbub protocol[9] to notify subscribers about content updates using HTTP POST. Although some protocols enable maintenance of sessions between endpoints willing to exchange data (e.g. Session Initiation Protocol[10]), most are connectionless and based on HTTP, with exceptions such as XMPP PubSub that uses TCP connections maintained between the requests. These characteristics impact reliability of protocols and/or their ability to handle notifications to subscribers temporarily

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[4] `http://www.w3.org/TR/sparql11-update/`

[5] `http://webr3.org/specs/guo/`

[6] `http://websub.org/wiki/GRUF`

[7] `http://www.w3.org/TR/2009/WD-sparql11-protocol-20091022/`

[8] `http://n2.talis.com/wiki/Changeset_Protocol`

[9] `http://code.google.com/p/pubsubhubbub/`

[10] See RFC 3261 at `http://www.rfc-editor.org/rfc/rfc3261.txt`

offline or over unreliable networks. A detailed comparison of various features (see Table 1) suggests that reliability, efficiency, security and extensibility of XMPP PubSub combined with its adoption in contemporary enterprises make this protocol an ideal choice for aggregation of social content modelled in RDF. Thus, XMPP PubSub and SPARQL Update are selected as a solution to the above-mentioned problem.

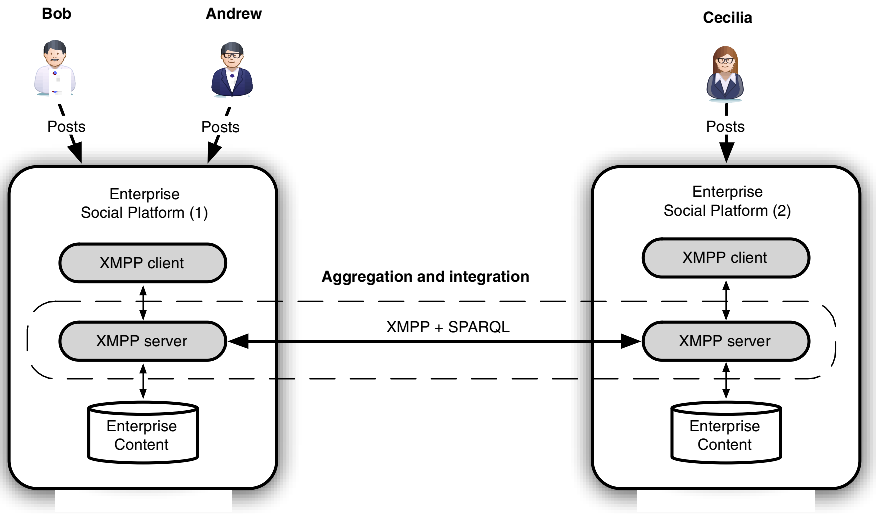

Fig. 2. Aggregation of content through distributed XMPP infrastructure

3.3 Proposed Solution

Based on the presented use case and the requirements we describe the architecture of the proposed solution. The XMPP server has the function of routing of the messages between the connected social platforms. In addition it provides an extensible platform that can process all information that it receives, for example to provide content personalisation through pluggable personalization components. As one or more platforms may be connected to a given XMPP server, the servers communicate with each other sending SPARQL Update messages embedded in XMPP PubSub stanzas. XMPP provides the infrastructure for connecting social platforms in a decentralised way and for sharing of knowledge between those social platforms. The server provides a central point for the connected social platforms to exchange XMPP messages. In case an existing XMPP server is used, it must implement the XMPP Publish-Subscribe extension (XEP-0060)[11], which allows XMPP clients to subscribe to updates. In order to publish and receive aggregated content social platforms need to connect to the XMPP server via the XMPP client, a task that can be accomplished using an open source component[12] that allows easy integration.

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[11] `http://xmpp.org/extensions/xep-0060.html`

[12] `https://github.com/derixmpppubsub/derixmpppubsub/`

3.4 Personalization

Our approach is designed having in mind the need for personalisation in enterprise social platforms. Being aware of the overwhelming amount of content published daily within the organization, users of social platforms require personalised access to information to limit the information overload. First the recommendation approach should take into account data from multiple sources. In addition, the approach should be applicable to any kind of social content: blog posts, microblog posts, wiki pages or even office documents could be recommendable items. The recommendation results should take relations between concepts/terms into account, so that slightly different views on the same concept can be handled. Further, the cold-start problem related to the initial lack of data for computation of recommendation should be avoided (e.g. in collaborative filtering, items which did not get any user ratings should be available as part of the recommendations). Such requirements make the selection of appropriate personalisation algorithm very difficult. The proposed solution allows for design and deployment of various personalization components that extend the XMPP server either through plugin mechanism, or using external components that process received messages. Our initial experiments (not in scope of this paper) prove that this approach is scalable, efficient and flexible enabling close to real-time personalised aggregation of social content from distributed social platforms.

4 Discussion

This article discussed challenges for efficient aggregation of cross-domain, multi source content in distributed enterprise social platforms. We argue that while Semantic Web technologies allow for publishing meaningful and structured data, major remaining challenges include: (1) real-time integration of distributed social data, and (2) content personalization to identify relevant pieces of information and present them to users to limit the information overload. This research in progress paper draws from an enterprise use case and discussed practices in real-time integration of social data in distributed social platform. We proposed to combine Semantic Web technologies and standard protocols already used in organisations to deploy instant messaging solutions to provide efficient and open source layer for aggregation of distributed social content. We also show how our component facilitates development of personalised social platforms.

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SEDA_Lab: Towards a Laboratory for Socio-Economic Data Analysis

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Abstract. In the paper we present an idea for a 'Laboratory for Socio-Economic Data Analysis' aiming to explore the use of extremely large amounts of socio-economic data from several sources of various degrees of heterogeneity. Based on these data, and on the state-of-the-art techniques in knowledge extraction and processing, we intend to deploy robust and high performance data analytics processes. Our goal is to enable the two data-bearing business partners Irish Times and Handelsblatt to use the data they have in conjunction with bigger data from external sources, to increase the value of their products and services offered and to reposition themselves in the market. We focus on two use cases that can produce tangible results in the analysis of socio-economic trends (e.g. unemployment, poverty) and socio-economic events (e.g. election tracking, bankruptcy) enabling better reporting, as well as timely decision support in crisis situations.

1 Basic Notions and the Background

The large volume of textual data available for exploitation by global user communities is growing daily. The current blogosphere hosts an average of 133 million blogs, with a daily publishing rate of 0.9 million blog posts, and with 346 million people (approx. 77% of the Internet users) reading them. The situation is analogous for many other types of resources and fields (e.g., financial data, news articles, patient records, business reports or patents).

Making the knowledge locked in these vast amounts of available texts fully accessible and interconnected is still a challenge for today's search engines and/or content management systems. The main reasons can be summarized as follows. Externalising the knowledge hidden in the individually authored texts (so that computers can efficiently process it and make it accessible) is virtually impossible when done manually. The automatic extraction of knowledge from texts has often too noisy and sparse results, which prevents their meaningful exploitation within the current knowledge representation frameworks. Hence, it is virtually impossible to integrate the results of

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automated knowledge extraction with legacy resources without significant (and expensive) human involvement and curation efforts.

We determine three broad types of data:

- Document corpora consisting of large amounts of structured information from metadata about the collections of documents, as well as large amounts of unstructured information represented by the textual contents of the documents themselves.
- Linked Open Data from the Web of Data - consisting of huge amounts of structured interconnected datasets, available online.
- Stream data - consisting also of online data, this time in unstructured form, captured from real-time information streams like Twitter, Facebook, blogs, news reporting agencies, stock market, financial services, etc. The data in this category is Big Data, through its volume, velocity and variety.

Based on these data, and on the state-of-the-art techniques in knowledge extraction and processing, we intend to deploy robust and high performance data analytics processes. Our goal is to enable the two data-bearing business partners Irish Times and Handelsblatt to use the data they have in conjunction with bigger data from external sources, to increase the value of their products and services offered and to reposition themselves in the market. We plan to deliver innovative and robust solutions for the representation, refinement and augmentation of the extracted knowledge, as well as for its integration. We will realise this goal through the development of novel methodologies for real-time processing, visualization and analytics over large volumes of socio-economic data (both structured and unstructured).

We focus on two use cases that can produce tangible results in the analysis of socio-economic trends (e.g. unemployment, poverty) and socio-economic events (e.g. election tracking, bankruptcy) enabling better reporting, as well as timely decision support in crisis situations.

1.1 The Adopted Approach

Our approach, in a nutshell, is to extract large amounts of knowledge from various resources and integrate it using lightweight and robust techniques with native support for data imprecision and uncertainty. These techniques will allow for storing of possibly conflicting information, resolving inconsistencies and lack of precision later on, either by means of empirical data-driven refinement, or by explicit ad-hoc interventions of users interacting via pro-active user interfaces.

More specifically, we will first deliver means for the integration and co-evolution of knowledge coming from resources of varying expressivity, noise level and relevance. In order to support that, we will build on an initial version of our novel lightweight, uncertainty-aware knowledge representation with simple similarity-based semantics easily extensible by intuitive rules. Based on these achievements, we will pursue three additional research threads:

1. Scalable multi-source knowledge extraction – Incremental knowledge extraction from textual resources and legacy terminological repositories (i.e., exist-

ing ontologies, thesauri or databases), and integration of the extracted content into continuously refined, emergent knowledge bases, which are in turn further augmented by means of lightweight inference and used in order to boost the initial extraction results.

2. Exploiting expert communities – In addition to large-scale automatic knowledge extraction from "inanimate" resources, we will also glean much more precise content from human expert communities, their actions and contributions, integrating the gleaned content into the emergent knowledge bases in order to improve them. The integrated knowledge will serve back to the domain experts, allowing for automated detection of possibly important hidden trends and other dynamic features.
3. Pro-active user interfaces – Participation of individuals in collaborative community efforts, exploitation of the extracted knowledge and explicit individual addition or curation of the emergent knowledge will be enabled by intelligent user interfaces. These will allow for searching, visualising, browsing, but also for proactive fetching of knowledge of interest, facilitated by profiles automatically created from the content particular users are working with. Apart from "reading" the content, the interfaces will also allow the users to "write" and thus augment that knowledge, i.e., to curate (modify) or add to the knowledge bases.

The output of the research threads described above will be implemented as an integral suite of services, accessible and interoperable. Thus we will ensure both coherence and modularity of the anticipated system, as well as easy re-use, extension for and adaptation to a large variety of use cases where textual information overload is occurs. The primary functionalities of the tool suite will be:

- search, browse and analyse knowledge extracted or inferred from textual resources of interest (either submitted manually to the system by users, or fetched automatically from external content repositories, like the information centre repositories, or the Irish Times service),
- retrieve the resources of interest based on knowledge either contained in, or pointing to them (apart from services extending the traditional key-word search),
- refine and augment the emergent knowledge bases either via one-click actions, or using intuitive machine-assisted input interfaces,
- exploit results of advanced social network analysis aimed at communities particular users are interested or directly active in.

To demonstrate and assess the applicability and usability of the results, we will be continually deploying them within two realistic complementary application scenarios in the socio-economic domain. This will be done in close cooperation with our business partners from the Irish Times and Handelsblatt, both information centres in control of huge datasets if publications in the chosen domains. The partners will continually express their case-specific requirements in an agile development process. They will also assist the technical partners and contribute with both empirical and user-based evaluation of the project deployment in the later stages.

The data that we will use in the realisation of the scenarios comes from several sources of various degrees of heterogeneity. The data is of three categories:

Document corpora - consisting of large amounts of structured information from metadata about the collections of documents, as well as large amounts of unstructured information represented by the textual contents of the documents themselves. The Irish Times and Handelsblatt provide a corpus of documents and the necessary metadata about them in the areas of the economy and the society.

This qualifies the data that we plan to use as big data as it definitely exceeds the processing capacity of conventional database systems; the data is too big, moves too fast, or doesn't fit the structures of your database architectures. To gain value from this data, there is need to choose an alternative way to process it.

1.2 SEDA_Lab Overview

The general structure of both pilot use cases is depicted in the Fig. 1. There is a distinction between the producers of data and the consumers of the output knowledge. However, the same entity can be at the same time a producer and a consumer. The producers of data can be of two types, centralised and distributed. Our two business partners The Irish Times and Handelsblatt are centralised producers of data. They provide more than just the document corpora, which are an important part, but also metadata about the documents, and other already extracted annotations. The directions for the use cases are complementary. One use case looks at determining long-term trends in the information processed, for example unemployment and poverty in the social domain, or stock trading values in the economic domain. The other use case aims to examine special events, which are time-critical, like bankruptcy announcements or election result tracking. The knowledge extracted, both in regards of long-term trends and time-critical events, will be used to augment the information provided by the two information centres to their users.

Apart from working towards the accomplishment of our research agenda, we intend to ensure maximum impact and sustainability of the results of the project, from the very beginning. The main means for achieving sustainability can be summarised as follows:

We will deliver a modular, open source and generally applicable framework for the extraction, integration, processing and delivery of knowledge coming from disparate textual or legacy resources. This will maximise the ease of deployment, re-use and extension of the researched technologies.

Building on the generally applicable framework, we will provide two specifically targeted pilot solutions. Although tailored to the requirements of two particular stakeholders, the solutions will still be transferable to many other subjects in the same areas. We will use the deployment at the major information centres, not only for mediating the respective publication knowledge to the pilot use case data consumers, but also to showcase the content delivery technologies to the customers, advertising the project's results to a potentially very large number of people.

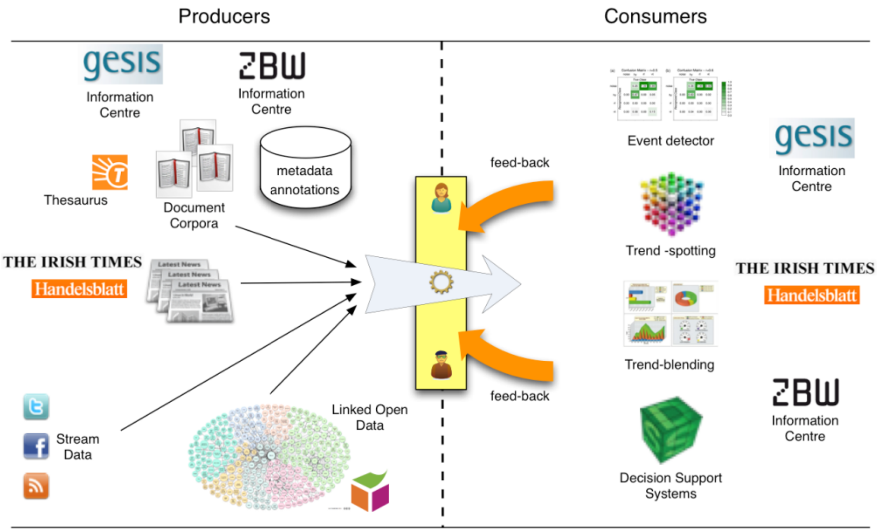

Fig. 1. Conceptual overview of the SEDA Lab interactions amongst producers and consumers

2 Contributions to the State-of-the-Art

SEDA Lab aims at the integral advancement of machine, as well as collective and individual human intelligence, by making knowledge locked in electronic textual resources more accessible and meaningful to users who seek it. Inherent to the overall goal, the project will make the knowledge being extracted and integrated from various disparate textual sources amenable not only to exploitation, by also to open-ended intuitive augmentation or curation by individual and collaborative actors. The particular research outputs delivered in order to accomplish the goals will be implemented as a generic modular tool suite with two specific social sciences and economics pilot applications.

Automated Knowledge Extraction. Automated knowledge extraction is typically performed on two layers of text analysis. The first one deals with finding named entities and normalizing them relative to their respective database identifiers. The second layer of text analysis is concerned with the extraction of relations between named entities. Many different approaches have already been tried, among them pattern-based ones, rule-based ones, and machine learning-based ones. In the case of social sciences, an added difficulty in the task of relationship ex.

Building on various text-mining (Feldman, 2006) approaches as those outlined above, ontology learning (Maedche, 2004, Buitelaar, 2008) currently presents the most advanced method for the extraction of expressive knowledge (in terms of formal statements about entities, i.e., concepts or individuals, and their mutual relations) from natural language texts. The ontology learning approaches have recently been extended by emergent semantics principles (Maedche, 2002, Ottens, 2007) in order to construct more expressive, representative and precise ontologies (or knowledge bases, in general) in a bottom-up manner.

In addition to the text analytics, we plan to extract expressive semantic structures from traditional databases by means of data mining techniques (Dzeroski, 2001, Hastie, 2001) wherever such datasets are available. W3C's RDB2RDF Working Group standardizes languages for mapping relational data and relational database schemas into RDF and OWL, through its two published candidate recommendations (Das, 2012, Arenas, 2012).

Emergent Knowledge Representation and Processing. Emergent knowledge is essentially dynamic and often vague or inconsistent. Approaches generalising classical formal logics have been proposed to tackle these features (Bobillo, 2008, Haase, 2005). However, the simple structure of the emergent knowledge does not allow for many non-trivial logical conclusions, rendering formal logical knowledge representations insufficient without significant human post-processing (Haase, 2005, Bechhofer, 2003). Also, even for relatively simple but large domains with many instances, logics-based querying may quickly become intractable (Hustadt, 2005). Thus, more lightweight approaches are appropriate for emergent knowledge.

Regarding Semantic Web research, numerous extensions of the basic RDF standard towards features of emergent knowledge have been investigated. Contextual features (e.g., provenance, certainty) are handled by (Schueler, 2008, Hartig, 2009). Similarity-based query post-processing with imprecision support is proposed in (Kiefer, 2007), while (Mazzieri, 2004) directly extends RDF semantics to support uncertainty (fuzzy degrees). Dynamic merging of RDF graphs is looked into by (Udrea, 2005). (Oren, 2008) researches robust approximate and scalable RDF query answering that can be used for practical exploitation of large emergent knowledge bases.

Big Data Processing. Big Data affects every sector and region of the economy and every aspect of society – providing insight into education (Dobbie, 2011), ecology (Economist, 2011) and financial risk management (Flood, 2011). It has the potential to create valuable new opportunities for individuals, communities, organisations and societies, but it also introduces new challenges (data capture, management, and analytics), and risks (privacy, security etc.). Big Data requires a new set of technologies order to transform raw data into valuable knowledge. The sheer scale of the data is an obvious challenge, however, other characteristics are equally important: the variety and velocity of the data (Russom, 2011). Variety means heterogeneity of data types, representation, and semantic interpretation. Velocity means both the rate at which data arrives and the time in which it must be acted upon.

Alternatively, (Jagadish, 2012) presents a generic pipe-line for Big Data processing, with multiple distinct phases, each important in the overall process, and each introducing new challenges: (i) acquisition, recording, (ii) extraction, cleaning, annotation, (iii) integration, aggregation, representation, (iv) analysis, modelling, (v) interpretation. Similar to this, (Fisher, 2012) describes a pipeline, focused on the architecture of the system used rather than on the process.

To tackle the challenges posed by each of the phases of the pipeline, we can make use of properties of the data, or of the characteristics of the process - the logical data independence of some databases or the inherent parallelism of some algorithms. A prominent example is Apache Mahout (mahout.apache.org) that provides implementations of a range of machine learning algorithms on Hadoop. Mahout has the drawback that it operates in batch mode and does not work effectively on stream data.

Twitter's Storm (storm-project.net) is one of a number of frameworks that has emerged for scalable analytics on real-time data.

Event and Trend Detection. There has been much research on data mining techniques for detecting interesting patterns in time series, one being event detection (a change in the values over time, which are considered quantitatively significant), but also repetitive patterns, or trends. In the statistics literature, the problem is known as "the change point detection problem" (Cherkassky, 1998) and can be treated in two ways: batch, or offline, where all the points are known and inspected together, or incremental or online, when the time points are processed one at a time (Keogh, 1997). However, in general, an event is not a single point, but a subgroup of points, which together represent the event.

Trend detection is complementary to event detection, as trends can lead to accurately predicting events even before they happen. In the project domain of socio-economic data, detecting trends like crime rates or accident hot-spots can, with the proper analysis tools, result in positive societal effects. While Twitter has been also a popular choice for trend detection (Mathioudakis, 2010, Castellanos, 2011), other equally rich sources are available to us.

3 Value Chain Thinking and the Underlying Business

Our idea for SEDA Lab builds on the principles of Value Chain Thinking (VCT) (Fearne, 2009) and reflects the natural flow of processes as these are found in the real world business environment and in a way that can support sustainable and organic growth of business ventures amongst members of the consortium. Our approach in using VCT for building the consortium and organising the workflows aims to understand stakeholders/experts attitude which after an extensive study of the field we now see that it is something not trivial at all, uncover hidden expert groups and identify hidden associations between different drivers based on the results of the above two.

As such, Value Chain Thinking is expected to help tailoring of the scenarios we deploy in the context of the project in a number of different (and with a high contextual variability) cases while still making use of the basic structure of the SEDA Lab infrastructure.

In the context of the above, SEDA Lab services can be regarded as knowledge-intensive interactions; we assume that knowledge is both the key resource for the service operations (especially as the services we deal with tend to be intangible) and a basic type of benefit/outcome received by the customer and used for the co-creation of value "in context" and "in use". In other words, we assume that the value co-creation is based on the knowledge provided by the customer (e.g. a reader of The Irish Times) to the provider (The Irish Times) and vice versa, together with the knowledge of the customer how to use in context the service in order to exploit and enhance its benefit potential.

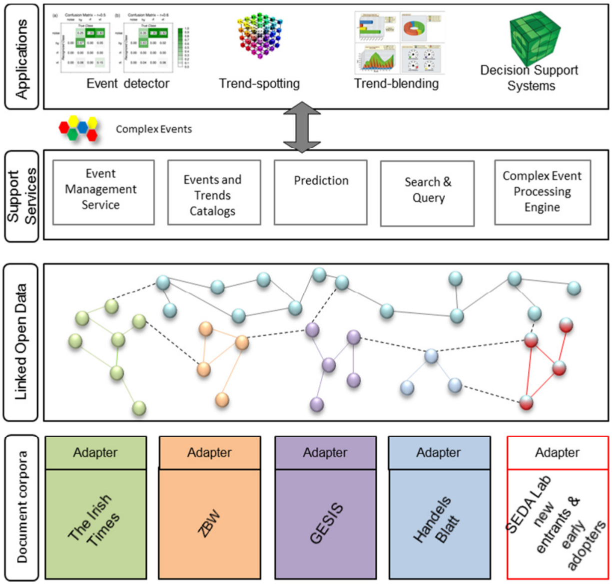

Fig. 2. Presentation of the four layers that SEDA Lab addresses. Links with other entities such as ZBW (www.zbw.eu) and GESIS (www.gesis.org) are included as well as for any new entrants in the SEDA Lab scheme.

In sum, the value of the service for the SEDA Lab customer is the result of a collaborative knowledge creation process between the customer and service providers, facilitated but not controlled or manipulated by our infrastructure. In this respect, the customer integrates all the benefits provided by the service provider, this incentivizing content owners and providers to invest from their side in building synergies amongst them and across all different steps of their data, information and knowledge value chains. In the picture above we try to visualise the layers that the adopted SEDA Lab Architecture affects:

Starting from the end user perspective, the upper layer is the one that s/he can have direct access to: these are the various Apps that a SEDA Lab user (actually: an Irish Times customer, or a Handelsblatt subscriber or registered user) may download to her/his smartphone or have access to from her/his computer at home or in office. Of course, access to these applications may happen through 3rd party applications or services through APIs. This layer is important for the project because it will be our front end to a general audience; the people will hate it or love it if the socio-economic trend-spotting, trend-blending or event detection Apps will be “cool” or have a “hot” interface.

One level down there are the Supporting services – without them no sense-making or useful App can be built. These services are built for the needs of the project by the consortium and while some of them are based on existing functionality, some others will be built for first time and will be critical for the success of the entire project. These are related to the management of socio-economic (S-E) trends and events.

The third layer deals with the Linked Open Data. Since their debut, the cloud of published data has grown considerably. Today there are 295 datasets in the form of a connected cloud, with about 31 billion RDF triples interlinked by around 504 million RDF links. Of this is only the "surfaced"/public data. More data will exists in intranets. Picking up on another example is the schema.org work. This activity from the major Web search operators will add further to the amount of machine processable.

Finally the fourth layer is the one that is provided by the Users and owners of big data in our consortium. With the trend of putting computing and networking capabilities into everyday objects and places, there are increasing numbers of data sources, producing increasing volumes of data that record what is happening in the world. Data is generated from everywhere: blogs, digital pictures, enterprise computing, feeds, social media (e.g. Twitter, Facebook), news streams and so on. This explosion of data is the result of many factors, increasing number of internet users, mobile phones, and increasing use of social networks and multimedia. Sectors such as news agencies, finance, social-economic tracking, and consumer-facing industries have also contributed significantly to the growth of Big Data.

4 Conclusions

Our idea for a laboratory for Socio-Economic Data Analysis builds on synergies with two established actors in the news publishing and news media world that will operate as big data owners and value added service providers involved in the dissemination, commercialisation and outreach activities.

SEDA Lab shall also offer a unique opportunity to both the Irish Times and Handelsblatt in terms of enabling both papers to offer a platform for comment in a variety of spheres including business, politics and public affairs, culture, the environment, health and education, to move from being newspapers of record to newspaper of reference.

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Semantic Social Networks for Integrated Healthcare

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Abstract. An important aspect of integrated care is the provision of personalized patient empowerment and decision support services, especially in case of the chronic patient with comorbidities. The paper discusses a blending of notions of social networks and semantic technologies in order to develop comprehensive personalized and dynamic models of the chronic comorbid patient, their environment and healthcare related issues, procedures, etc., so as to be able to support meaningful patient empowerment and decision support services.

Keywords: Social networking, Semantic technologies, Heterogeneous social Networks, UMLS, Healthcare integration, Actor network theory.

1 Introduction

The first decades of applications of information technology in medicine have targeted the health care enterprise and services provided therein. A major technological challenge has been the integration of various information systems and services to support the healthcare enterprise with emphasis on the tertiary level (e.g. hospitals). Towards this goal, a number of standards and standard communication protocols have been developed and implemented, with variable, rather questionable, success [1].

Along with this, the notion of integrated care has risen and now is a central issue in the domain of healthcare. Integrated care has many meanings [2]; the notion of "reunite parts of a whole" is an underlying commonality, whether integration refers to integration within different healthcare settings or in terms of integration of healthcare, social care, long-term and self-care or even integration of patient management for different conditions. In any case, a patient-centered bottom-up approach is favored [2],[3]. Closely related is the concept of patient empowerment, which has emerged as a new paradigm that can help improve medical outcomes while lowering costs of treatment by facilitating self-directed behavior change. The concept seems particularly promising in the management of chronic diseases [4],[5] and it is directly connected with personalized patient services and preventive measures. An important aspect of integrated care is the provision of personalized patient empowerment and decision support services, especially in case of the chronic patient with comorbidities. Comorbidity refers to the presence of one or more disorders in addition to a primary disease or disorder (either independently, or as a consequence of the primary condition or otherwise related) [6]. Comorbidity management is a hot topic in current medical literature [7], [8]. When addressing disease in the presence of comorbidities, each

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 729–736, 2013.

different medical condition the patient presents should not be viewed independently, but a “patient as a whole” view approach should be followed [9]. This places an emphasis on and extra burden of dealing successfully with all associations, interactions, co-dependencies, implications, adverse events, etc. that occur between different conditions co-presenting at the same patient at the same time, as well as between the different treatment regimens these conditions involve.

The goal of our work is to address integrated care for the chronic patient with comorbidities. Although a lot of work has been conducted towards a common understanding of the healthcare enterprise, even in the special case of the provision of home care for the chronic patient, e.g. [10], an analysis and definition of the personal environment of the healthy citizen and the patient is still missing. In our approach we propose the blending of notions of social networks and semantic technologies in order to develop comprehensive personalized and dynamic models of the chronic comorbid patient, their environment and healthcare related issues, procedures, etc., so as to be able to support meaningful patient empowerment and decision support services. Section 2 of this paper gives a brief overview of the current state of the art in social network technologies highlighting a novel approach adopted by our work. Section 3 discusses semantic tools and technologies in healthcare that can be invoked for building social network relationships. Section 4 presents the proposed model for the semantic social network and some preliminary implementation approaches while a discussion is given in Section 5.

2 Heterogeneous Social Networks

A conventional social network approach concentrates on the network of humans, presumably based on some common social or professional interest – any implied artefacts or concepts are of no interest and are not represented or accounted for in such networks. Here the focus is to establish relationships and connections among humans. These are based on some commonly shared interest, object and/or concept; however, this is only implied and not really accounted for in the network. Such an example from the (of the many) in the field of healthcare is the CarePages (http://www.carepages.com/) a social network of people collaborating together to share the challenges, hopes and victories of anyone facing a life-altering health event. Social networking in this sense is good at realizing and representing links between people, but it doesn’t explain what connects those particular people together and what connects those and not others [11].

One way to provide meaning to social networks is to establish relationships and promote self-organization into communities based on shared interests, and even more on specific items of interests. Recently the term ‘object-centered sociality’ was introduced [12] to describe the fact that strong social relationships are built mainly when individuals are grouped together around a shared object that mediates the ties between them. This can be achieved by organizing the network around the content people create together, comment on, link to, annotate similarly etc. [13]. In this case emphasis is placed on the connections between the humans and the objects and social interactions are basically established on the basis of commonly shared objects. This new approach to sociality has drawn attention, and current state-of-the-art research in the area involves various ways to exploit object-oriented sociality to the benefit of the community. An indicative example from the field of healthcare is the PatientsLikeMe site (http://www.patientslikeme.com/), which connects people based on their health issues and related shared experiences.

In either case, the focus is on trying to establish connections based on human action, agency and perception. A recent work, introduced the notion of heterogeneous social networks, where humans and social objects are uniformly treated as equal actors [14]. This paradigm follows the view and concepts of the actor-network theory (ANT). The basis of actor-network theory, a sociological theory developed in the 1980's [15], is the concept of the heterogeneous network, that is, a network containing many dissimilar elements, all treated as inseparable. This is the so-called principle of generalized symmetry, whereby human and non-human (e.g. artifacts, organization structures) are assigned equal amounts of agency. The basis of actor-network theory is the concept of the heterogeneous network, that is, a network containing many dissimilar elements, including both human and non-human entities. Using ANT one can show how things are attracted into or excluded from these networks, how some linkages work while others don't, and how connections are strengthened to make themselves stable and durable by linking to other networks and things. Some of these connections link together to form and identifiable entity of assemblage that can exert force – this is referred to as 'actor'.

3 Semantics for Building Social Network Connections

In implementing such a network, major challenges include a unified treatment and representation of all types of possible actors as well as the development of a social behavior for various nonhuman actors, and subsequently their own associations and networks. Both challenges can be addressed by concepts and technologies of the Semantic Web. In the conventional Web, a resource can be described via an XHTML/XML document, where various tags are used to annotate the document, mainly regarding its presentation, not conveying any semantics about the resource itself. In order to describe a resource the W3C Resource Description Framework (RDF) [16] is commonly used to represent metadata about a resource in the form of triples: subject, predicate, object. Generally, the subject can be the resource itself while the predicate can be any relationship as defined in any XML namespace published on the Web. The object can be an explicit value, but also a dereferencable URI. This way, an RDF triple can link the description of a resource with other sources of information on the Web, thus creating a worldwide graph-like linking of resources, what is currently termed Linked Open Data (LOD) cloud [17],[18].

The building blocks of the Semantic Web are considered to be ontologies, i.e. formal descriptions of parts of the world [19] that guide the specification and generation of the triplets. There are numerous ontologies that are specific to domain, resource type and objective (also known as application ontologies), but there are only a few general ones (known as upper or foundation ontologies) that are used frequently to build the former. One of the basic requirements is a unified and rich description of all actors to form as a basis for their social presence and their interactions within the social environment. This description includes two main aspects. The first is a domain specific description of the profile for both humans and nonhuman entities. Such a social profile can be described with a variety of domain specific schemata or even ontologies. For example, humans' profile can be based on the FOAF (Friend Of A Friend) (http://www.foaf-project.org/) ontology, mainly used to describe people, the links between them and the things they create and do.

In the healthcare domain there is a plentitude of formal controlled vocabularies and ontologies, for example see the NCBO BioPortal [20], [21] for an indicative list. Although a tremendous amount of effort has been devoted by the medical informatics community, a universal standard medical terminology and/or ontology has yet to be achieved [1]. Thus current state of the art presents a wealth of numerous diverse and often overlapping vocabularies, terminologies and ontologies, e.g. more than 340 available only in NCBO Bioportal. The ontologies used include amongst else for prominent medical ontologies such as SNOMED-CT (Systematized Nomenclature of Medicine – Clinical Terms), ICD9/10 (International Statistical Classification Diseases and Related Health Problems), Body System (body system terms used in ICD11), MeSH (Medical Subject Headings), NCI (Meta)Thesaurus, Galen (the high level ontology for the medical domain), HL7 (the Normative RIM model v2), Biomedical Resource Ontology (BRO, a controlled terminology of resources to improve sensitivity and specificity of Web searches).

Research efforts have focused on producing mappings between different terminologies, probably the most notable contribution is the UMLS mapping between more than 100 of the most commonly used controlled vocabularies in healthcare [22]. Indeed, UMLS (The Unified Medical Language System, http://www.nlm.nih.gov/research/umls/) also provides a semantic network of concepts via sets of semantic relationships. This network has 135 semantic types and 54 relationships, and covers with these effectively all concepts and connections in the healthcare domain.

4 Semantic Social Networks for Integrated Healthcare

A recent thorough treatment of the domain of chronic comorbid patient [23] suggests that one way to improve care is to cross reference evidence and guidelines for each condition with guidelines on comorbidities. As it has already been argued in literature [23], simple cross referencing of existing medical evidence and guidelines for all possible combinations of conditions would quickly make it unreadable and thus inefficient. Thus, the goal of our work is to follow a personalized and semantically enriched approach to create dynamic cross referencing of semantically related evidence data. The effort lies in semantic interlinking of three types of data (a) medical ground knowledge (b) up-to-date medical evidence and (c) personal patient data in order to create a personalized model of the disease and comorbidities progression pathways and trajectories (Fig. 1).

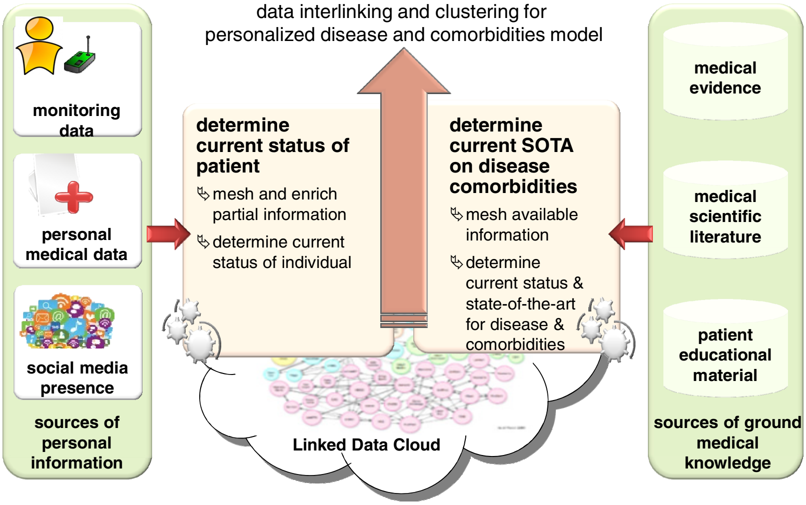

Fig. 1. Shifting focus towards personalized comorbidity management

Following the line of thought presented above, the health environment for the patient and/or the healthy citizen comprises of various coexisting and strongly interlinked entities: (a) individuals, including patients, healthy citizens and healthcare professionals; (b) organizations, including any institutional or organizational entity involved in any way in the healthcare process, e.g. healthcare providers, social services, health insurances, medical research institutions, research projects, pharmaceutical companies, well-being and fitness clubs, etc.; (c) health conditions, i.e. any health or medical condition; and (d) health interventions, including diet, life-style, therapy and drugs, supporting devices, etc. The UMLS semantic network [24] concepts and relationships have been used a basis for developing the proposed model shown (in a simplified, partial view) in Fig. 2.

All entities presented in this model can be viewed as symmetric actors within a heterogeneous social structure which represents the health and healthcare environment of the healthy citizen and patient, thus building and representing all interactions and effects amongst different concepts, objects and humans. A variety of ANT concepts and constructs can then be employed to support development of patient centered services for integrated care like symmetry, translation, black boxes, immutable mobiles and obligatory points of passage.

Symmetry: all things (humans and non-humans, concepts or real world) are treated in the same way, and are assumed to be capable of exerting force and joining together, changing and being changed by each other.

Translation: what happens when human and nonhuman entities come together and connect, changing one another to form links. At each such connection, one entity is working upon another to translate or change it to become part of a network of coordinated things and actions. In our approach, the concept of translation can be used to enhance inherently weak health relationships (such as a “may_cause disease”) via multiple connections especially based on evidence based medicine findings and published research papers (e.g. systematic reviews and meta-analyses).

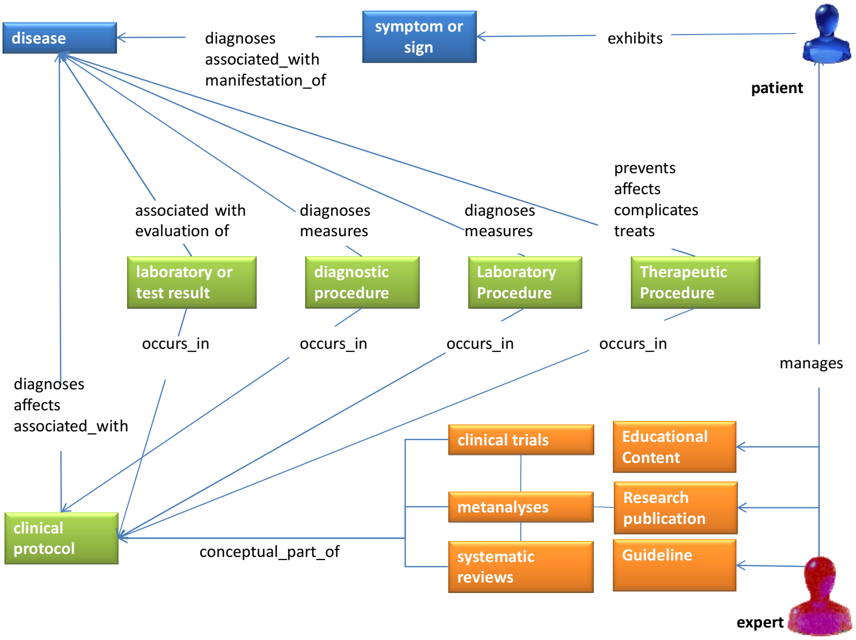

Fig. 2. A simplified partial view of the proposed model which is based on the UMLS semantic network

Black Boxes: Dynamics among actors to translate each other can become stabilized and the network can settle into a stable process or object that maintains itself. This can be viewed as a black-box, concealing all negotiations that brought it into existence. In our approach, a chronic condition (together with all its inflicting factors, treatments, monitoring, existing co-morbidities, etc.) well established in a patient could be treated as a black-box.

Immutable Mobiles: these are only visible within a particular framework of relations. They can be silent, ignored or overridden by other active objects, but they have developed enough solidity to move about and still hold their relations in place. For example, certain health and lifestyle behaviors, habits and/or conditions with solid relations to disease and risk of disease can eventually become immutable mobiles thus allowing a more generalized treatment of the pattern for groups of individuals/patients.

Obligatory Points of Passage: some immutable mobiles become obligatory points of passage, that is, central assemblages through which all relations in the network must flow at some time. This construct can be crucial for treating lifestyle and disease management, and more importantly for supporting clinical protocol alignment in cases of comorbidities.

In addition to this model and based on it we explore a system following the technologies and approaches described previously. More specifically, this work involves creating a subset of the UMLS Semantic Network and introducing some more fields specific to comorbidities, in order to address principles pertaining to clinical pathways, including temporal properties and organization of entities. The ultimate goal is the development of an ontology to describe the model of comorbidities and their management. This ontology will be the basis for creating the social semantic heterogeneous network discussed in the previous section. Entity interactions within this network can be presented using graph visualization tools enabling further analysis and user exploratory navigation through the graph.

The proposed approach due to its nature of handling detailed patient data and other "sensitive" information has to take consideration of the exposure risks and apply some kind of anonymity that is counter-intuitive to the social aspect of a patient empowerment network. In order to circumvent that an anonymity layer should be introduced protecting the real identity of patients but guaranteeing the validity of the medical data and allowing the social interactions to be formed. A simple approach to that could be a frontend-backend compartmentalization of patient data. In the backend the system knows everything about a patient and has all the data available for the expert in order to manage the patient but in the frontend the patient is known only as a unique ID provided by the system. This allows patients to interact with the network without revealing anything they don't intend to.

5 Discussion

The co-existence of multiple networks of individuals, organizations and health conditions/interventions can be exploited in order to create different views of the healthcare environment, thus creating variable impact. For example, an individual-centered linking visualization enhances integrated personal management of healthcare, collaboration and expert finding services. On the other hand, an organization-based linking visualization supports administrative, strategy and financial oriented goals, at an institutional, national and international level. Finally, resource oriented linking visualization/organization may serve a variety of goals. For example, visualization based on health conditions and interventions places focus on epidemiology and generation of new evidence on a large scale.

Following the approach of a heterogeneous network to organize information objects and humans alike and record their variable interactions one can further exploit notions and concepts of the actor-network theory to analyze the social structures and thus eventually gain more insights on the organization and communication of information.

Acknowledgments. This work has been funded in part by the Project HELCOHOP: Development of Electronic Clinical Protocols, 2012-2015, MIS 375876, co-funded by European and National funds.

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Financial Industry Ontologies for Risk and Regulation Data (FIORD) – A Position Paper

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Abstract. This paper presents a proposed approach to address risk and regulation management within the highly active and volatile financial domain by employing semantic based technologies within a collaborative networks environment. Firstly the problems and motivation are introduced, with accent on big data and high frequency trading issues that are creating major problems to the current software systems. Secondly the state of the art on Big Data, Regulation and Risk Management are presented. Next the FIORD platform architecture is detailed and the envisioned approach explained. Finally conclusions are presented where benefits for real time monitoring are emphasized so high frequency trading irregularities are detected in real time for the benefit of involved financial institutions.

Keywords: Big Data, High Frequency Trading, Collaborative Networks, Semantic Web, Ontologies, Reasoning, Risk, Regulation, Financial Industry.

1 Introduction

Gathering, querying and analysis of various types of data is an area that has developed in recent years as the volume and complexity of data has grown. This has led in turn to the concept of "Big Data" , that is strongly anchored within collaborative networks concept: without collaborative networks, Big Data would not have developed explosively in almost all domains of science, industry and life. In this respect, according to IBM, “2.5 quintillion bytes of data are created daily” [1]. The Financial

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 737–744, 2013.

Services sector is amongst the most data driven of industries. However, the industry has relied on older technologies to handle this ever-increasing data and analytics burden. The regulatory environment for this industry requires an understanding of multiple types of data including: order and trade execution data, market data for bids and offers, last sales and volume information, order book information, news and economic data, post trade data such as trade allocation information and payment and settlement instructions; corporate event notifications and data on financial products and financial market participants. This results in large volumes of data - billions of market related messages, industry related economic information and data on individual company and contract markets distributed globally in real time. As example, just the market data feeds expressing bids and offers distributed on just the below listed equity and options exchanges in the US on a most recent and typical day April 25, 2013 peaked at 5.51 million transactions a second. Historically, the peak rate was 6.8 million per second achieved on December 21, 2012 [2].

The changes in regulation, the increased interconnectedness of markets globally and the concomitant increases in financial data have resulted in a number of problems for financial participants and their regulators:

- The growing volume of order, cancellation and trade data
- The growing number of trading markets to be monitored,
- Non standardized data structures and overloaded middle ware techniques;
- Legacy technology solutions – both hardware and software;
- Lagging people and organisation skills in the technology, business and scientific communities necessary to understand Big Data, and,
- Finding the right data or combinations of data that will answer a business or scientific question from a very large volume of data in real-time.

Coupled with the above more generic big data challenges is the reluctance of financial services participants to move from their trusted existing IT infrastructure. Thus, an organisation such as a bank may have multiple parallel systems that have different internal data structures. Something different is required and this is what our research work is aiming towards. More specifically our aim is to allow for these existing platforms to be kept in place and it allow a common definition of the data within the systems to exist enabling a convenient and efficient way to access this data using new tools and methods. We refer to our approach as the Big GRC (Governance, Risk and Compliance) Data FIORD platform.

2 Motivations and Background for the Research

Our research work will look into understanding the causes that could generate unwanted market anomalies as the events that trigger financial market drops and then to prevent such drops reoccuring. As all financial markets are interconnected within massive collaborative networks, any anomaly can be propagated in seconds within multiple markets This was the case of the United States stock market crash on May 6th, 2010 (known as the ‘Flash Crash’) in which the Dow Jones Industrial Average (DJI) plunged by 1,000 points (about 9%) only to recover those losses in 20 minutes; and the twitter inspired precipitous drop in the Dow of 140 points on April 23, 2013 that recovered in a single minute. Our research work would contribute to the forensic review increasing the reliability, transparency and security of markets leading to heightened investor confidence and greater market liquidity. It should be able to anticipate and perhaps even protect the global economy from unexplained precipitous swings in market prices as was the case with the previously mentioned "Crash Flash" of 2010. [3]. In this later respect we envision providing semantically augmented technology solutions to market participants' infrastructure and regulators' monitoring capabilities which would gain and apply knowledge of the industry and the use of data there-in. This knowledge will be captured in open source versions of ontologies and semantic algorithms, which in turn will be put forth as draft standards for the financial services industry to upgrade and update the technology of this globally important but volatile industry. The core of our research (see Fig. 1) relates to the use of semantic technologies, ontologies and taxonomies. Industry-standard tagging of data are emerging as one of the technologies to enable the financial industry and its regulators to observe financial transactions by computer means through their ability to precisely define data content, facilitate classification, represent data rules and add dimensions of intelligence onto data structures more efficiently and at a lower cost than conventional technologies.

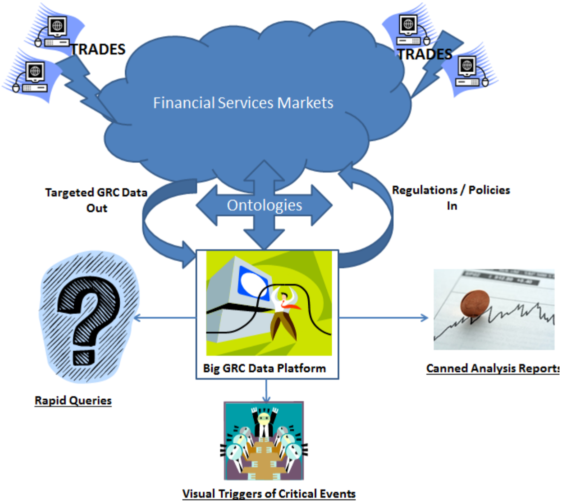


Fig. 1. FIORD High level View

Therefore, a regulator like the recently proposed EU Single Supervisory Mechanism or a large market participant would be able to:

- Perform complex and rapid queries on the large volume of trades that can be generated in just seconds;
- Use these queries to analyse market activity;and,
- Provide collated data to a suite of reporting tools that would allow rapid analysis and understanding of the changing position in the market.

3 State-of-the-Art

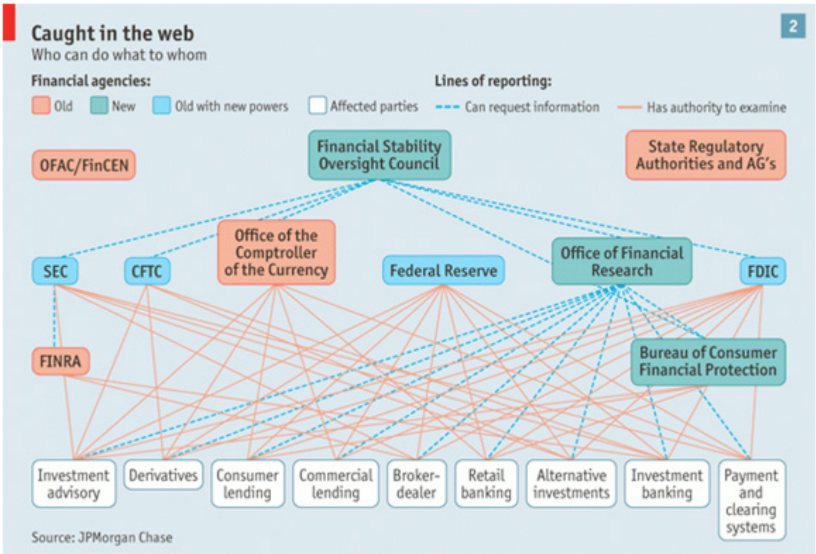
3.1 State-of-the-Art on Big Data and Collaborative Networks

Big Data is an emerging field where innovative technology offers alternatives to resolve the inherent problems that appear when working with huge amounts of data while providing new ways to reuse and extract value from information. All this is done mainly within collaborative networks environments as data is reused, improved and created only by cooperation and not in isolation. Big Data Public Private Forum (BIG) is working towards the definition and implementation of a clear strategy that tackles the necessary efforts in terms of research and innovation while providing a major boost for technology adoption and supporting actions for the successful implementation of the Big Data economy. **Volume, Velocity and Variety** were originally posited by *Gartner's Doug Laney* in a 2001 [4] research report that provides terms to describe some of the issues that affect big data. State of the art in these areas includes:

- **Volume:** Big data companies such as EMC can now offer storage solutions such as the 4 petabyte VMAX array. Meanwhile in the financial services domain, the world's financial markets and financial services companies generate and store petabytes of data on a daily basis. However financial services companies struggle to structure, query, analyse and act on this data mainly as it is stored in disparate data sets.
- **Variety (Big Data and Collaborative Networks):** Big data is any type of data - structured and unstructured data such as text, sensor data, audio, video, click streams, log files and more. New insights are found when analysing these data types together, acquired from multiple networks.
- **Velocity:** For time-sensitive processes such as catching fraud, big data must be used as it streams into the enterprise in order to maximize its value. High Frequency Trading (HFT) and real-time risk management are some of the most time sensitive data applications in financial services. In these strategies, computer scientists rely on speed to gain minuscule advantages in arbitraging price discrepancies in some particular security that is trading simultaneously on disparate markets.

3.2 State-of-the-Art on Regulation

Regulations in the financial services industry are becoming increasingly complex (Fig. 2) and can involve more than one regulator for a firm as well as different products, regulations and jurisdictions. However they play an important role in ensuring the stability of Europe's markets and economies and protect its citizens. Risk and controls for compliance are becoming more complex and more are needed in real time. Proposals have been made to use solutions that are based on semantic web technologies.



Source: JPMorgan Chase

Fig. 2. The complexity that is Financial Regulation – An Example from the United States

An initiative related to trading is the Financial Industry Business Ontology (FIBO) [6]. This is a collaborative effort engaging participants from the financial industry, the regulatory community, academic institutions and semantic technology vendors to model and build a set of open standard ontologies that will deliver transformational benefits to the financial system. The Enterprise Data Management Council (EDMC)[7] and the Object Management Group (OMG)[8] are partnering to lead this effort. Following the 2008 global financial crisis it became clear that the absence of certain data standards led to a lack of awareness of the magnitude of risk that the industry was exposed to. The goal of FIBO is to introduce semantic capabilities that will better enable: common terminology for business entities, financial contracts and instruments; improve data transparency; improve data integration and linkage; and improve financial reporting and analytics, so that greater "data" quality and health can be introduced into the financial system.

Other activities use collaborative groupings such as the Fix Protocol Ltd organization and the XBRL International Federation [9] to leverage eXtensible Mark-up Languages (XML) [10] and its offspring such as XBRL that tag data through standard protocols to identify data elements that computers can query and retrieve. Big GRC Data would take this collaborative approach and apply it to the space between regulators, market participants and data.

3.3 State-of-the-Art in Trading and Risk Management

Beginning in the early 1970's entrepreneurs and established exchanges began to introduce electronic trading systems, the CAT System of the Toronto Stock Exchange, private initiatives Instinet and Autex, and the Nasdaq market are from that era. In the 1980's trading centers became increasingly electronic with electronic futures markets such as Intex and the forerunner to CME's Globex arising, along with equity markets in the UK, such as SEAQ and SETS; and in Europe such as Xtra in Germany and the Paris Match system (see Past, Present and Future: The Evolution and Development of Electronic Financial Markets [11]. In the United States, National Market System I and then II and in Europe the Market in Financial Instruments Directives I and II furthered the development of electronic trading markets and precipitated high-speed trading. First, it was enough to simply get a trade done without human hands or voices being involved. Later, it became a matter of getting to the execution facility's order book before others. Direct market access to these executing facilities with limited credit limit checking became a way of eliminating delays in round-trip time. Latency busting co-location facilities, fiber networks and stream processing, all came together to process multiple data feeds in parallel in real-time streams, again to cut down on round-trip time. Further speed advantage was made possible by a new family of multi-core processors - symmetric multiprocessors making multiple central processing units (CPUs) available to complete individual processes simultaneously. Clusters of multiprocessors made massively parallel processing possible within a single machine or across multiple machines. Also becoming increasingly prevalent is asymmetrical processing, which uses separate specialized processors for specific tasks, like the Graphical Processing Unit (GPU) that moved from the video gaming to the financial district. Real-time trade risk management is becoming more of a possibility and a demand by regulators with the furtherance of a pervasive global network of almost unlimited bandwidth and with massively parallel, almost unlimited computing capabilities. This takes the form of shared facilities available on demand in the form of computational utilities provided as a service, referred to as cloud computing.

4 The proposed FIORD Architecture Platform

FIORD initiative (driven by an EU consortium made of the authors of this paper) will introduce an innovative approach, based on existing platform elements from the big data, semantic, and cloud areas as described in next Fig. 3.:

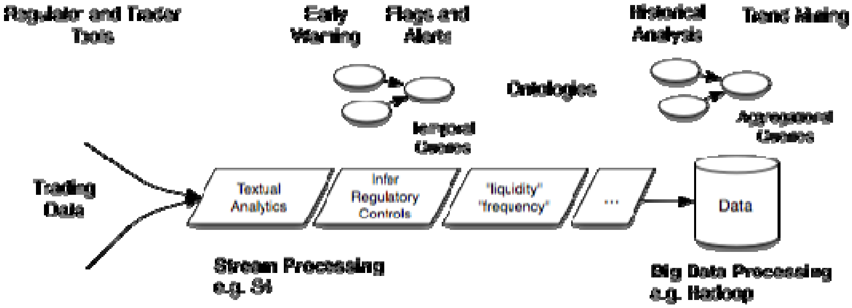


Fig. 3. FIORD Platform Architecture

The Big data elements will be required to store and analyze huge amounts of data. This will be done in three parts.

4.1 Stream Computing

This is a high-performance computer system that analyzes and collates multiple data streams from many sources. Industry users will then be able to use their existing data subscriptions in the final implementation of the platform. Where regulators can provide access to live real-time data we would avail ourselves of such; as well as internal feeds of data from the individual industry users. The Stream Computing elements of the platform would process the data using an inference engine [17] to find patterns in the data and stream it back out as a single flow. Stream computing uses software algorithms that analyze the data in real time as it streams in to increase speed and accuracy when dealing with data handling and analysis. Using this element of the platform FIORD would be able to uncover patterns of trading that will give regulators insight into triggers of systemic risk exposures (a suggested focus for the FIORD project is HFT systemic risk exposures), establish those triggers, or at least propose them, then install them in our designs.

4.2 Historical Analysis

In addition to processing data in real time, the streams will be stored in vast storage arrays to allow their review. For example, FIORD could take the triggers identified for systemic risk and see how they stand up to the historical data record as well as use them to proactively give signals of preventive measures. The addition platform element for this may include Data Storage. A potential solution may be EMC hardware, for example the Symmetrix VMAX, Teradata processors, SAPs in memory data bases, Kove's Dram accelerators, etc. It may be practical in today's technology environment that federated networks of servers across a vast globally interconnected network as envisioned by the LEI initiative of the G20's Financial Stability Board [12] which may provide possibilities to use hundreds of servers as a clustered virtual computing environment.

4.3 Semantic Platform

The above approach will require a web semantic platform to allow the platform to link data from diverse sources together, reason over it, federate it, and query it. The key platform capabilities may include such techniques as :

- Querying: SPARQL[13] is an RDF [14] query language, that is, a query language for databases, able to retrieve and manipulate data stored in Resource Description Framework format.
- Ontologies: OWL[15] or the Web Ontology Language, a language for describing and sharing ontologies on the World Wide Web. This will allow the ontologies developed as part of FIORD to be authored and distributed.
- Rules: RIF[16] is the W3C Rule Interchange Format. It's an XML language for expressing rules which computers can execute.
- Taxonomies: RDF is a set of classes with certain properties using the RDF extensible knowledge representation language, providing basic elements for the description of ontologies, otherwise called RDF vocabularies. These resources can be saved in a triplestore to reach them with the query language SPARQL.

- Reasoner: This is a piece of software able to infer logical consequences from a set of asserted facts or axioms. There are various options available for this element of the platform and the most appropriate will be investigated.

5 Conclusions

FIORD aims to provide tools and methods, and a pilot of both, for detecting systemic risk. It will leverage existing programs that are already moving forward in both the public and private sectors. For example systemic risk analysis will require an external globally unique identification system for all financial market participants and the products they trade, own and/or process. It will also require standardized data tags to surround the analyzed data in order to enable efficient computer query and analysis.

Benefits are expected to be significant as real-time monitoring by regulatory supervisors will enable stress events such as a High Frequency Trader algorithms going rouge to be easier and much earlier detected. FIORD would also contribute to systemic risk analysis across multiple financial institutions. Here a cascading trigger event could potentially be detected due to concentration and liquidity risk exposures observed across the interconnected financial system. Increased safety and security of markets would result leading to heightened investor confidence in those markets and in financial institutions in general

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