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Knowledge Management in Organizations

13th International Conference, KMO 2018
Žilina, Slovakia, August 6–10, 2018
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Preface

Welcome to the proceedings of the 13th International Conference on Knowledge Management in Organizations, held at the University of Zilina, Slovakia, during August 6–10, 2018. The theme of this year's conference was "Emerging Research for Knowledge Management in Organizations."

In today's intensely connected global economy, knowledge management (KM) in organizations is an important business imperative. KM involves the people, content, processes, culture, and enabling technologies necessary to capture, share, manage, and find information. To effectively manage knowledge in organizations, there are many challenges that need to be addressed.

According to Albert Einstein, "Information is not knowledge. The only source of knowledge is experience." Knowledge is the most valuable asset in any organization today and it is advancing at a tremendous pace. There are many new trends in KM for organizations. One aspect of this is cognitive knowledge. Cognitive technologies have helped us to redefine knowledge solutions.

Besides cognitive knowledge there are many other new trends such as the use of social media for KM. KM systems are becoming more collaborative than ever before, as seen in social intranet software, allowing individuals to work on documents and communicate with each other in real time. Employees in organizations need access to the organization's KM system (KMS) while they are on the go. Consequently, mobile technology and KM software will soon be inseparable.

Organizations need to regularly generate new content to keep pace with increasing demands for information. KM software now allows us to tag, share, and organize content as soon as we create it. Today, KM software allows for segmentation of information into multiple community spaces so that employees do not have to be overwhelmed with documentation that pertains to accounting or tech support.

It is important for KM to have a well-designed user interface that allows users to leverage the system properly. KM systems should allow for external integration so that internal and external parties can share information more easily. Customization is essential to the success of KM systems. KM should become more customizable, allowing organizations to scale their solution to the organization's growth.

In an economy based on highly specialized knowledge, collaboration is essential. What is critical now is a focus on fostering collaboration between individuals, teams, divisions, and organizations. Organizations must develop the skills and culture that enable high-value collaboration.

Collaboration alone is not adequate. Trust is the most important determinant of knowledge sharing and transfer. There are many issues that must be addressed to enable trust and knowledge sharing. Culture has been identified as one of the most important factors that enables or impedes knowledge sharing and transfer. Other issues include: organizational structure; social relations; rewards and motivation; emotion;

information technology; communication; top management support; social media and leadership etc.

KM is also facing a challenging time with the advance of big data and the Internet of Things (IOT) as well as cognitive learning. There is the issue of between innovation, technology, and KM. It is not only limited to technology, but it is the integration of business strategy and process, organizational community and culture, expertise and technology. To do this requires us to look into the emerging discipline of service science, especially service dominant logic. Co-creation of value is essential to offer services and products that will provide value to users.

As we can see, effective implementation of KM in organizations is challenging. There are still many research issues that need to be addressed. KMO 2018 aimed to bring together leading academic researchers and research scholars to exchange and share their experiences and research from all aspects of KM challenges. It also provided an interdisciplinary platform for researchers, practitioners, and educators to present and discuss their most recent work, trends, innovation, and concerns as well as practical challenges encountered and solutions adopted in the field of KM in organizations.

The conference welcomes contributions from researchers and scholars on original and unpublished results of conceptual, constructive, empirical, experimental, or theoretical work in all areas of KM in organizations. The conference solicits contributions of full papers that address themes and topics of the conference. We are also interested in case studies that demonstrate how KM research strategies have been applied and the lessons learned. Case studies and work-in-progress/posters are welcomed. PhD research, proposals for roundtable discussions, non-academic contributions, and product demonstrations based on the main themes are also invited.

Research contributions on the aforementioned aspects can enlighten industry on how to handle the various organizational and technical opportunities and challenges in KM. KMO 2018 aimed to encourage research into the various aspects of KM so as to address many of the challenges facing organizations. The intent is to create a better understanding of knowledge management practices, research, and practical applications.

This year, we had 60 papers. All published papers underwent a rigorous review process involving at least four reviewers. Authors of these papers come from 24 countries including Austria, Brazil, Chile, China, Colombia, Czech Republic, Finland, Hong Kong, India, Indonesia, Italy, Japan, Malaysia, New Zealand, Oman, Poland, Russia, Slovakia, Slovenia, Spain, Taiwan, Tunisia, UAE, and UK.

The papers are organized into 12 thematic sections as:

- Knowledge Management Models and Analysis
- Knowledge Sharing
- Knowledge Transfer and Learning
- Knowledge and Service Innovation
- Knowledge Creation
- Knowledge and Organization
- Information Systems and Information Science
- Knowledge and Technology Management
- Data Mining and Intelligent Science

- Business and Customer Relationship Management
- Big Data and IOT
- New Trends in IT

Besides the papers, we also had invited keynotes and four tutorials.

We would like to thank our authors, reviewers, and Program Committee for their contributions and the University of Zilina, Slovakia, for hosting the conference. Special thanks to the authors and participants at the conference. Without their efforts, there would be no conference or proceedings.

We hope that these proceedings will be beneficial for your reference and that the information in this volume will be useful for further advancements in both research and industry in the area of KM.

June 2018

Lorna Uden
Branislav Hadzima
I-Hsien Ting

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SOON: Supporting the Evaluation of Researchers' Profiles

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Abstract. Find Your Doctor (FYD) is the first Job-placement agency in Italy dedicated to PhDs who are leaving the Academia to continue their professional path in companies and organizations. The mission of FYD is to outline the value of the research background as an asset for the development of companies and society as a whole. For this reason we started a research project aimed at building SOON, Skills Out Of Narrative, a HR supporting tool able to extract from the text provided by a person telling his/her experience a set of well defined skills, both soft and hard, creating a profile. The final aim of the project is to produce a list of candidates ranked on the basis of the degree of similarity of their profile w.r.t. the profile required for a certain job position or activity. This paper describes the full architecture of SOON and the idea at the basis of the FYD mission.

Keywords: Soft skills · Text extraction · Knowledge management

1 Introduction

In the last few years there have been several debates about what types of occupations PhD graduates find after the end of their studies. Several recent studies, mostly commissioned by the European Union, confirm that most of the PhDs, who graduate across Europe, are not going to find long-term occupation in the Academia, but will eventually migrate towards both private and public companies and organizations [1].

Far from considering this effort as a waste of educational resources, the European institutions strongly recommend this flow of competences outwards Universities as a crucial carrier for the economic growth of countries. As instance, [2] states that *"The proportion of researchers employed in the business sector is insufficient to sustain Europe's position as a global economic leader."*

However, while in some countries the value of a PhD is widely recognized and several support programs do exist to guide and optimize the transition of Doctors outside the academic research, other states, especially in the Mediterranean area, are far less accustomed to exploit this professional background. In

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Italy, in particular, the majority of job-placement agencies hardly even handle PhD profiles: Universities do not yet provide structured support and Doctors leaving the Academy are mostly left on their own, facing the difficult task to gain visibility towards Human Resources (HR) offices and employers, who have little idea on how PhDs' experiences and curriculum vitae may be employed and enhanced in companies.

In this context, the Find Your Doctor project aims at becoming the first Job-placement agency in Italy dedicated to PhDs who are undergoing the transition outside Academia, with the mission of outlining the value of the research background as an asset for the development of companies and society as a whole.

For this reason, within the FYD project we are developing a job-matching semi-automatic tool based on a *narrative* approach for the soft skills: we start with a questionnaire of open questions, a semi-structured interview that leads the candidate to reason on a given number of macro-skills usually considered important by employers, such as communication, relation, rigor, ability to face uncertainty and more (see Sect. 4). The focus is on the so-called soft skills [1,3] in particular, because the words used to express comparable content may vary more across contexts than for technical expertise. The questionnaire is designed to promote the candidate to first describe the meaning that he/she attributes to a given skill and only then to self-evaluate with respect to it, possibly grounding this evaluation in an actual experience.

By the analysis of the text is than possible to infer a-posteriori a taxonomy that covers the possible meanings attributed to a certain skill by the respondent. Each response will thus be associated to a set of univocally defined labels: a "hidden vocabulary" that can be used for both the analysis of the job requirements and that of the candidate's profile, matching the two based on some shared metric purged by interpretation asymmetries on the two sides.

Such a matching tool is, of course, as limited as the ability of the software to reliably infer from the text the proper meaning that the respondent is attributing to the investigated competence area within the defined taxonomy. This in not trivial even for humans, but a pre-filtering tool may facilitate the task.

The aim of this paper is to present an approach aimed at building a decision-support, pre-filtering tool able to shift the focus from the ability of a person to tell their experience with the proper words to the content of his/her expertise, both in terms of technical and transversal skills, providing as output a list of candidates ranked w.r.t. their degree of ownership of each skill in a pre-defined taxonomy. The tool is named SOON, *Skills Out Of Narrative*, from the approach we adopt as basis of the soft skills evaluation process.

The remaining of the paper is organized as follows. After an initial presentation in Sect. 2 of the Find Your Doctor (FYD) project and aims, Sect. 3 reviews some of the most relevant approaches already presented in the literature. The taxonomy of the researcher's soft skills is then reported in Sect. 4. Section 5 presents the overall architecture of this tool, while Sect. 6 describes the two approaches that are under study for the text preprocessing and the skill extraction phases, together with a first group of experiments carried out in this research project. Conclusions and final remarks are reported in Sect. 7.

2 The Find Your Doctor Project

Born in 2014 and recently formalized as an innovative start-up, FYD represents a first attempt in Italy to systematically tackle the issue of researchers' employment in enterprises, by the not-for-profit consortium of companies C2T-Consortium for Technology Transfer. FYD operates through orientation and education for PhDs on the one hand, and through job-matching services and scientific consultancy for companies on the other.

In fact, the majority of job-matching portals available online used by large companies HR offices and recruitment agencies are systems where researchers are mostly in disadvantage compared to people with previous experience in business. Automatic matching, indeed, is usually performed by searching keywords in a candidate's CV, but the taxonomy used in job-ads is set on the language of the employers and usually does not match the words that a researcher would use to describe his/her experience. Many researchers and HR managers report that PhDs often score well in job-interviews, but are mostly cut out from the selection at an earlier stage, due to low-level keywords filtering.

Moreover, while for the hard (i.e., technical) skills several taxonomies have been presented, as for instance the ESCO taxonomy[1] by the European Community, at present no fully established classification system has been presented for the soft (i.e., transversal) skills. Even the soft skill extension of ESCO is still preliminary and not yet complete. One possible way to help researchers consists in suggesting keywords (as LinkedIn does, e.g.) that can be meaningful for the employers. However, this approach has the downside that the employer and the candidate may not agree on the meaning of the words they are matched by, especially when they come from such different referring cultures as in our case study. In many cases, a researcher may not even recognize at first that a certain term does apply to his/her experience, which he/she is used to describe with a different vocabulary.

For this reason, within the FYD project we adopt a questionnaire of open questions, a semi-structured interview that leads the candidate to reason on a given number of macro-skills usually considered important by employers, such as communication, relation, rigor, ability to face uncertainty and more (see Sect. 4).

The questionnaire is designed to promote the candidate to first describe the meaning that he/she attributes to a given skill and only then to self-evaluate with respect to it, possibly grounding this evaluation in an actual experience.

3 Related Work

In the literature, the automatic extraction of meaningful information from unstructured texts has been already used to identify the most suitable candidate

[1] https://ec.europa.eu/esco/portal/home.

for an open position from a set of applicants or to help a job seeker in identifying the most suitable open positions. For example, the work described in [4] proposes a system that aims to analyze candidate profiles for jobs, by extracting information from unstructured resumes through the use of probabilistic information extraction techniques. Another work described in [5] illustrates the use of supervised and unsupervised classifiers to match candidates to job vacancies suggesting a ranked list of vacancies to job seekers. Information extraction is also used for processing job vacancies sent by e-mail. For example, in [6], an information extraction system has been designed in order to alleviate the workload of an agency specialized in e-recruiting.

Extracting knowledge with text classification has proven to give good results for many real-life web-based data such as, for instance, those gathered by institutional scientific information platforms [7], or micro-blogs and other social media platforms [8], in many different research areas such as opinion spam detection [9] and sentiment analysis [10].

4 A Taxonomy of the Researcher's Soft Skills

In our approach, we take into consideration a large number of proposals in which the problem of evaluating job candidates' soft skills was investigated. In literature there have been a strong interest in finding ways to recognize, evaluate and in case enhance soft skills in employees (see for instance [11,12]). In fact, it is becoming increasingly important to build 'transferable skills' for people future employability, adaptability and occupational mobility. The amount of economic restructuring presently underway in the world will require a far more flexible workforce in the future that needs to have a wide range of transferable skills.

Released in late September 2011 there has been a timely report for the European Commission as part of the Social agenda for modernizing Europe entitled "Transferability of Skills across Economic Sectors"[2]. This report analyses the role of soft skills in career pathways and the labour market, and levels of skill transferability across different sectors in the current context and during the years leading up to 2020. It also looks at the roles of actors involved in promoting transferability and methods for enhancing job mobility. In Find Your Doctor we focus on the issue of employing researchers in companies, and therefore on identifying the skills, both hard and soft, that can be transferred from Academy to companies.

Multiple attempts have been made to define the key competences for knowledge-based economies (e.g., the European ESCO project). The outcomes are usually lists of abstract and "universal" skills that completely loose the relational nature of competences. These are developed in specific contexts, sharing professional activities with others and in a continuous learning process. In order to respect these features we employ a narrative methodology [13] particularly useful to keep the complexity of a human resource and not reducing it only into

[2] http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=6070&type=2&furtherPubs=no.

categories. Narratives, in this sense, could represent a complex pattern connecting knowledge in action and values, and are particularly useful to "make visible" individuals' self-representation of their expertise in real contexts. Narratives are already used for PhD profiling: see, for example, the project managed by ABG France: www.mydocpro.org offers a detailed list of transversal competencies that web pages subscribers can select and frame within their own experiences, by adding specific professional events that can help to outline a particular skill. Differently from our approach, in this website competencies are already settled and the personal profile is quite standardized: experiences are only used in an illustrative way.

There is a lack of consistent theory for defining and classifying various skills, and there is no generally accepted soft skills taxonomy. Soft skills are characterized by high transferability across sectors and occupations and can be identified as transversal skills. Focusing on researchers our attention was centered on capturing the soft skills within transversal skills that support the innovation activity.

Within the European report the team has identified 22 soft skills within 5 clusters (see Fig. 1).

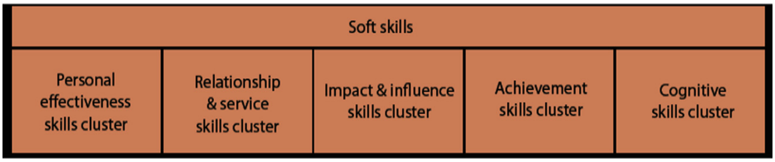

Fig. 1. The soft skill cluster in the European report

Transversal skills that range from problem solving to interpersonal skills are considered as important for innovation. Having these skills, which can be transferred from one context to another, is a good basis for accumulation of specific skills required by a given job expected in managing a robust innovation pipeline and portfolio to deliver new growth opportunities.

In order to collect contextualized experiences, we have selected a set of areas that are often associated to the development of transversal skills in higher education [14], such as creativity and innovation, rigor, managing risk and uncertainty, communication and networking. Then, for each area, we defined a questionnaire inviting researchers to think about their professional experiences and describe those that may be connected to that specific area of competence.

Inspired by the European project work, we started to analyse these narratives in order to identify a set of categories for each competence area that could be useful to map researchers' learning experiences. This might be viewed as reversing the typical paradigm that forces individuals to reduce their professional experiences in a predefined set of categories. In contrast to this option, those who subscribe the FYD website are invited to freely answer open questions and their descriptions of their work experience will be then organized into the categories emerging from our research. We plan to build this set of categories a-posteriori, following the methods of "constructivist" Grounded Theory [15].

Therefore, our approach classifies the researcher soft skills into 6 categories, as detailed in the following:

1. *carefulness*, i.e., the candidate is careful to look at or consider every aspect of a given task to make certain it is correct or safe;
2. *creativity*, i.e., the ability to produce original and unusual ideas, or to make something new or imaginative;
3. *unexpected/emergency* i.e., the ability to deal in an effective way with something that happens suddenly or unexpectedly and needs fast action in order to avoid harmful results;
4. *uncertainty*, i.e., the ability to deal with a situation in which something is not known, or with something that is not known or certain;
5. *communication*, i.e., the ability to communicate with people;
6. *networking*, i.e., the process of meeting and talking to a lot of people, esp. in order to get information that can help you.

Each skills area is divided into several classes, each class representing a particular soft skill. For instance, the *communication* area contains the following skills:

1. *effectiveness*, i.e., the candidate must be able to transfer meaningful information in a way clear and easy for the receiver;
2. *dissemination*, i.e., the candidate must be able to transfer technical information in a peer-to-peer context;
3. *teaching*, i.e., teaching experience in Academy or school;
4. *operative communication* i.e., the candidate must be careful in transferring operative informations, for instance mails flow;
5. *verbal communication* i.e., the candidate must be at easy and effective in public talking;
6. *written communication* i.e., the candidate must be at effective and clear when writing documents;
7. *internationality*, i.e., the ability to communicate in an international context;
8. *self-learning*, i.e., the ability to transform a communication task in a learning experience;
9. *fair measure*, i.e., the ability to find the right equilibrium between talking and listening;

A detailed description of the taxonomy is available in [16].

5 The Approach

In this section we present the architecture of SOON as shown in Fig. 2. The whole approach is divided into two phases, one offline that aims at gathering the researchers data and creating the profiles, the second online active when a new job offer arrives from a company.

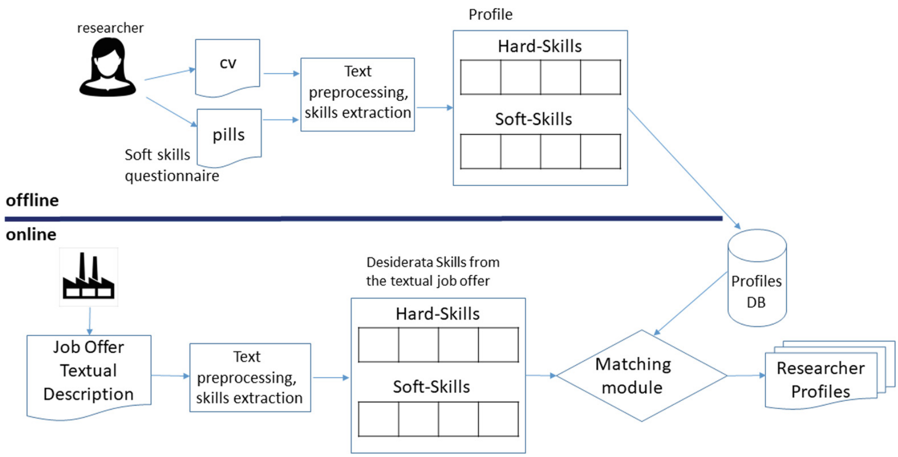

Fig. 2. The architecture of the tool SOON.

5.1 The Offline Phase: Creating the Researchers Profiles

In this phase the researcher provides two textual descriptions of her experience, the *curriculum vitae (CV)* and a questionnaire composed by 13 free text questions called *experience pills*, or simply *pills*. The *Text Preprocessing and Skills Extraction* module extracts the skills from the text provided by cv and pills and creates a formal representation of the researcher, the profile. There are several techniques that can be applied to create the researcher profile, at present we are investigating the vector based representation developed by the Information Retrieval researchers to represent documents. In the vector based model a document D is represented as an *m-dimensional* vector, where each dimension corresponds to a distinct term and m is the total number of terms used in the collection of documents. From this basis, in our approach a profile P is composed by two vectors, $P = (H, S)$ where H is the vector representing the hard skills of the researcher, while S represents her soft skills. The hard skills vector H is written as $(w_1, ..., w_m)$, where w_i is the weight of skill h_i that indicates its importance, while m is the number of skills defined in the ESCO taxonomy. The soft skills vector S is written as $(x_1, ..., x_n)$, where x_j is the weight of skill s_j and n is the number of skills defined in the taxonomy described in Sect. 4. If the profile P does not contain a skill s_j or h_i then the corresponding weight is zero. The vector H is extracted from the researcher cv text, while the vector S is created extracting the skills information from the pills questionnaire. After a preprocessing phase in which the raw text is divided into sentences each sentence is analyzed to extract the skills. At the moment we are developing and testing two different solutions: the first proposal is based on machine learning techniques and it has been presented in [17]. The second solution is based on Language Models and is an on-going research. At the end of this phase the researcher's profile P is stored in the *Profile DB*.

5.2 The Online Phase: Finding the Best Researcher Profile for a Given Job Offer

The online phase occurs when a company requires the job agency services of Find Your Doctor. In this case the HR team of Find Your Doctor receives a job offer description as a textual document. The *Text Preprocessing and Skills Extraction* module extracts the hard and soft skills required by the company for the given position, and creates a *desiderata profile DP*. At this point the *Matching module* computes the distance between the profile DP and the profiles stored in the database. At present the distance between a profile P and a desiderata profile DP is simply computed by using the cosine similarity as follows:

$$sim(DP, P) = \left(\frac{H_{DP} * H_P}{\|H_{DP}\| \|H_P\|}, \frac{S_{DP} * S_P}{\|S_{DP}\| \|S_P\|}\right) \tag{1}$$

The two values are both kept and the profiles are ranked w.r.t. their hard skills or their soft skills similarity value. In the next future several aggregation solutions will be evaluated to compute a unique ranking value.

6 The Text Preprocessing and Skill Extraction Module

As already reported, the *Text Preprocessing and Skills Extraction* module is in charge of extracting the vector H from the researcher cv text, while the vector S is created by extracting the skills information from the pills questionnaire. Actually we are developing and testing two different solutions: one based on machine learning techniques, and one based on Language Models.

6.1 The Machine Learning Approach

Figure 3 depicts the system architecture and the data pipeline. The *Paragraph identification* module analyses the questionnaire answer (called "experience pill" or simply "pill") by dividing its text into paragraphs (based on punctuation). In the design phase of a text classifier, one of the most critical issues regards the definition of the best formal representation suitable as input to a machine learning system. Moreover, the formal representation considerably affects the quality of the classification [18]. The literature provides several techniques used to create the formal representation of a document, as for instance Bag of Words (BoW) or Word2Vec[3]. Most techniques include pre-filtering steps as *Word parsing and tokenization*, *Stop-words removal*, *Lemmatization and stemming*, and *Term selection/feature extraction*. The approach presented in this paper adopts Word2Vec. Then, the *Feature Selection* module finds the optimal set of features to be input to the machine learning classifier. It is based on the evolutionary paradigm where a population of solutions (in this case the tokens acquired after the preprocessing phase) is repeatedly evaluated and updated, by replacing some attributes with new potentially better ones.

[3] Introduction to Information Retrieval https://nlp.stanford.edu/IR-book/.

In our approach, an initial set of tokens defines the training sample obtained by the preprocessing phase. These tokens constitute the initial population of features. The feature ranking values coming from the feature selection filters provide a measure for the importance of the features in the classification task and will be used as the "fitness" measure for determining the features in the evolving population. First of all, an initial pool of features is produced by parsing the training sample for all basic words. These words constitute the initial population. Then the feature set will be iterated through the evaluation, analysis and reproduction process. During the iteration, the feature pool is used to train a classifier which provides an evaluation for the performance of the individual features. The set will be iterated through the Fitness Evaluation, Selection and Replacement blocks.

The outcomes of the classification step are then stored in a database, ready to be used to create the soft skills researcher's profile.

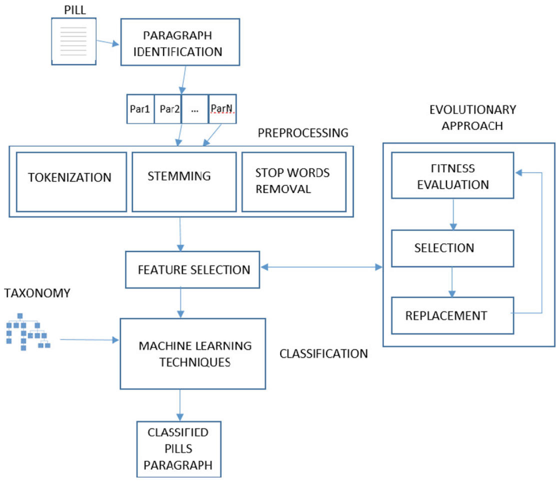

Fig. 3. The overall architecture representation.

A benchmark dataset was prepared by analyzing about 600 questionnaires gathered by the Find Your Doctor (FYD) HR team, by dividing each questionnaire answer in sentences, and by labeling each sentence with the most appropriate soft skill. This analysis step gathered around 15,000 labeled sentences. Unfortunately not all the soft skills categories detailed in the taxonomy presented in Sect. 4 were populated enough to perform a classifier training task. The most populated category was "communication" with around 5000 sentences randomly partitioned in the 9 soft skills belonging to this area, and stating the classes of the ML classifiers. For this reason we decided to perform a preliminary evaluation only on this area, with the aim to assess the benefits of using machine learning in this context. The benchmark creation activity is currently an ongoing work, with the aim to complete the labeling of all questionnaires available now in the FYD collection.

In this first prototype 5 different machine learning techniques (see Table 1) have been selected and applied for a comparative evaluation in the task of soft skills classification. During these preliminary experiments in the "communication" area, only six out of 9 soft skills had enough instances to perform the training phase of the classifiers. These soft skills were, respectively *effectiveness*, *dissemination*, *teaching*, *written communication*, *verbal communication* and *internationality*, for a total of 4389 sentences.

The labeled sentences were randomly partitioned into training and test sets (75% and 25%) for the first *Percentage Split* experiments set. The obtained results are validated by applying the *10 Fold Cross Validation* approach over the same dataset. The results are reported in Table 1.

Table 1. Preliminary results.

Classifier	Percentage Split			10 Fold Cross Validation		
	75% train - 25% test					
	Precision 0–1	Recall 0–1	Accuracy %	Precision 0–1	Recall 0–1	Accuracy %
Naive Bayes	0.808	0.723	72.3343	0.7713	0.698	69.7624
K-Nearest Neighbor						
K = 1	0.638	0.628	62.8212	0.599	0.595	59.5392
K = 5	0.683	0.654	65.4179	0.683	0.658	65.8027
K = 9	0.742	0.666	66.5706	0.721	0.669	66.8826
Support Vector Machine	0.731	0.726	**72.6225**	0.721	0.717	**71.7163**
Decision Tree	0.746	0.741	74.0638	0.705	0.706	70.5544
Random Forest	0.694	0.674	67.4352	0.648	0.635	63.4989

From the first set of experiments carried out in this work the best results were obtained by using the Support Vector Machine. The Naive Bayes approach also obtained interesting results over the dataset, even if they appear performing only for the Percentage Split experiments, while not for the validating phase. Similar results were obtained by the Decision Tree, while KNN and Random Forest were not able to reach interesting results in these first experimental session.

6.2 A Language Model Based Approach

Differently from the machine learning based approach, Language Models (LMs) belong to the class of probabilistic models. They offer a formal representation of a document by considering probabilistic distributions of words in a language, and by computing the probability to generate the text of a document related to a specific pill sentence (query) from the language model representing a certain skill.

The simplest LM is based on single words probabilities, the *unigram model*, in which the probability that a given word is descriptive for a document is computed. Differently, in the *n-gram model* the probability of each word depends on the previous words, where the n-gram probability is defined on the probability of the $n-1$ previous words.

In our ongoing research, after an initial pre-processing over the pills (stop-word removal and Pos-Tagging application [19]) a *bigrams* based model is defined [20] for each area/competence. In fact, from a preliminary analysis phase, the *bigrams* approach gets, on average, better results than a test solution developed by using simple unigrams. Then, we use the *add-k smoothing* algorithm [21] for the smoothing methodology, since, on a computational level, it proved to be the most appropriate solution among those available in the literature, by showing good results in terms of effectiveness. The LM creation for each of the areas/competences coded by the Find Your Doctor experts should allow the recognition of those document sentences whose text is defined by the generated LMs.

For this reason, the proposed approach should be able to discriminate the pills sentences related to a defined area/competence by associating, to each text, a list of soft skills.

7 Conclusion and Future Work

In the context of the Find Your Doctor project, this paper presents the architecture and the design of a tool aimed at supporting the HR resources in the evaluation of researchers profiles. At the basis lays an automatic classification process of the researchers cv and pills questionnaires w.r.t. pre-defined soft and hard skills taxonomies. The approach evaluates sentence by sentence the questionnaire and the cv of the candidate, by classifying each sentence w.r.t. the proper taxonomy.

Future work involves the complete development of the *Text Preprocessing and Skill Extraction Module* in order to finalize and evaluate the HR support tool able to search the profiles collection and to provide lists of researchers ranked on the basis of one or more skills. Moreover different similarity coefficients, beyond cosine similarity, will be tested (e.g., Jaccard, Anderberg...).

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Using Knowledge Management in Scientific Work - Time Analysis

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Abstract. Knowledge management is currently a commonly used term not only in the academic environment but also in the environment of organizations. There is no doubt about the benefits of Knowledge Management for practice. Many researchers have been involved in and dealing with knowledge management issues in organizations. The question is in which scientific area is knowledge management most frequently used? The aim of the paper is to present the main scientific areas of the use of Knowledge Management based on the available data from the Scopus database. The paper also addresses the increasing interest in knowledge management in research work, which is based on a time analysis. The results are presented in the form of clear graphs. The main aim of the paper is to provide a clear set of facts related to Knowledge Management with an emphasis on its present and future use not only in the professional work of researchers but also in business practice. The paper defines the key areas of Knowledge Management, but also the areas that still present new challenges for researchers.

Keywords: Knowledge management · Knowledge
Concepts of knowledge management · Knowledge base of the organization

1 Introduction

In recent years, the character of today's society has changed significantly. The changes that occur are often clear and tangible, but we also feel that less clear changes have occurred as well. A lot of people do not notice them at all, and they perceive them more implicitly. Changes in information and knowledge society have brought both. Most of us realize and perceive the changes caused by massive computerization, only some implicitly perceive the need to change the competences of each of us who wants to work actively in the information society [9]. Even less clear are the changes brought by the knowledge society [21]. Acquirements, findings, knowledge has not got to the center of attention of most workers and creative people yet. The society, however, is

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already moving towards it and it is good to know the changes that this approach will cause, at least partly to imagine them.

These changes and trends encourage a growing interest in the field of knowledge, namely knowledge management. Trying to understand and work with something as incomprehensible as knowledge is very interesting. The problem, however, remains to change society characterized by materialism and individualism and direct it towards non-material values and cooperation [7, 14].

The knowledge-oriented world, which is unlimited because of the inexhaustibility of its possibilities, becomes more and more important. It also concerns small and medium-sized enterprises and their management, who also have to learn other approaches concerning management of their businesses - in terms of knowledge and management of knowledge. It is no longer possible to promote the idea of the past that capital in connection with work creates value [25]. The reality is that people are the basic source of value creation [2].

When defining the concept of knowledge, we encounter different approaches to the term knowledge in the literature. Many authors define knowledge based on the hierarchical sequence of data - information - knowledge [1]. Knowledge is defined as valuable information from the human mind [3, 16], tested, evaluated information in the context [4], derived from information using a certain sequence of formal rules (comparison, sorting, analytical-synthetic evaluation, verification, etc.) [27].

The role of knowledge management in knowledge organizations was also defined by Peter Drucker, and in the 50 s the definition was changed to a claim that the manager is responsible for the performance of people [5]. This too narrow definition can be extended by claiming that the manager is responsible for knowledge application. And these statements can be extended by the term knowledge capital, which in connection with the work creates values [2]. The view into the past confirms the essence and truth of this claim. In the period of the English Industrial Revolution, which thanks to introduction of machine manufacture, brought a massive increase in the performance of the people, which was up to five times over a hundred years. Thanks to machines, work has become simpler and more efficient (which has had direct impacts even today), but the machines have begun to replace people directly. At present, however, such a seemingly ideal situation, is a big problem and a solution to unemployment is not a cheap labor force. Powerful and cheap work machines can still be placed anywhere. However, the volume of production can be increased even with capital cuts. So, when less and less capital is enough to generate profits, how businesses should create the added value? The answer is knowledge and knowledge management. Knowledge capital goes hand in hand with technological advances. Sure, assuming that we are now thinking about the development of much more advanced machines, i.e. high-technologies. They are the result of many laboratory experiments and scientific research, thus bringing together qualified professionals, but at the same time an economical and effective management of natural resources is supposed.

And who presents the knowledge capital? At present, there is no problem with a health handicap - it is possible to produce something without a hand or without a foot. But nothing can be done without a head and mind. So we can talk about a new type of workers - a new worker [12]. Under the term of a new worker, however, it is possible to include also the representatives of the enterprises and organizations that hold their interests and supported by their practice, as well as acquired knowledge and experience, create the added value. On the other hand, however, there is one more group of workers - those who have the ambition to become brains, the capital for the enterprise, and they are just preparing for this task. Both groups of workers, although having different requirements they have to meet, have a common active ability to work with information. At the top of the process is a worker who can add value to the business. This relationship is expressed in Fig. 1.

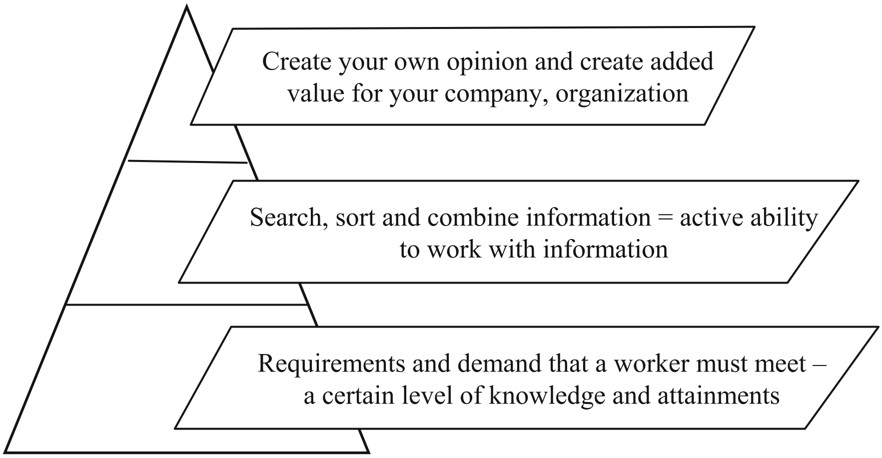

Fig. 1. Pyramid of value creation processes in the enterprise

There is no universal solution for how to properly implement knowledge management in every business. Therefore, it is necessary to determine which knowledge processes a particular company needs and wants to develop.

This paper aims to create a comprehensive overview of the use of knowledge management in scientific work and the need to create knowledge base in organizations. One part of the paper is to perform a time analysis using the available data from the Scopus database, which will demonstrate an increasing interest in knowledge orientation at present.

2 Knowledge Base of the Organization

At present, in the period of knowledge or information society it is an urgent challenge for organizations to create and evaluate their knowledge base effectively. The purpose of this effort is to improve the competitive position of organizations significantly and to ensure a long-term competitive advantage. Issues to improve the knowledge base of organizations' staff are dealt with in three main concepts [8]:

- "*Learning Organization*" concept [6], which is mainly associated with names such as P. M. Senge, Ch. Roberts, B. J. Smith, G. Roth, R. L. Flood,

- "*Knowledge-Creating Company*" concept [19], with which the names of I. Nonaky, H. Takeuchi are associated,
- "*Intellectual Capital*" concept [22], with which the names of L. Edvinson, M. S. Malone, J. Roose, G. Roose, N. C. Dragonetti are associated.

However, these concepts enter a broader framework, collectively referred to as "Knowledge Management". This term is often sought after and used in professional works, but it does not have a uniform definition or a defined field of research and application. However, it is true that this discipline has deeper roots, wider scope and earlier beginnings as the three above-mentioned concepts of improving the knowledge base of the organization and is partly overlapping them. Problems of knowledge management are dealt with by authors such as K. M. Wig, K. Sveyby, L. Liebowitz, T. H. Davenport and T. J. Beckman [26].

An important role in formulating procedures to deal with the growing role of data, information and knowledge in organizations has been played by the work of Professor Peter M. Senge, American Professor, in the 1990s "The Fifth Discipline. The Art and Practise of the Learning Organization". Senge defines a learning organization as an organization where people are constantly expanding their ability to achieve the desired results, supporting new and creative ways of thinking, where space for collective aspirations is created, and where people are learning how to learn together [11].

This definition can be generalized by saying that organizations should learn faster and better than their competitors. In addition, it is possible to create a long-term competitive advantage for small and medium-sized enterprises.

Senge also assumes that five factors that are mutually integrated and interconnected contribute to the process innovation of the learning organization. These are "component technologies" [17, 23], which are also referred to as learning organization disciplines. These are comprehensive techniques and theories that must be studied, learned and applied in the organization [10]. Thus, they gradually become a solid foundation for the next process of mastering the necessary knowledge. The above mentioned component technologies are:

- "Systems Thinking",
- "Personal Mastery",
- "Mental Models",
- "Building Shared Vision",
- "Team Learning".

The Knowledge-Creating Company concept is based primarily on "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovations" by Professors of Hitotsubashi University, Ikujiro Nonaka, and Hirotaki Takeuchi. This work primarily reflects the practical experience of utilizing knowledge in the economic, social and cultural environment of Japanese management, such as Honda, Canon and others. Among other things, the authors defined two types of knowledge:

- explicit knowledge, which is largely captured in the data sources of the organization, it is the knowledge that is codified, respectively structured, and can be easily expressed in letters, words, characters [19]. Nonaka and Takeuchi indicate that explicit knowledge can be expressed in a formal language, including grammatical or mathematical expressions, specifications, and manuals. They can therefore be stored in document management systems, library systems, marketing information systems, etc.

- implicit knowledge, resp. tacit knowledge, that is subjective and hidden in the minds or subconscious of co-workers [19]. Tacit Knowledge is still an unspoken knowledge gained through education or training. Thus, tacit knowledge is a hidden kind of knowledge that we commonly acquire through socialization with the environment, and the existence of which we often do not even know [13]. Nonaka and Takeuchi, however, report experiences and recommendations on how to do the conversion = externalization, respectively articulation, of these latent knowledge to explicit knowledge, which are clearly formulated and purposeful, for example, in the innovation of products, processes or services.

The concept of Intellectual Capital is a good illustration of the works of the co-authors of this concept. The first is the work of L. Edvinson, M. S. Malone, entitled "Intellectual Capital Realizing Your Company's True Value by Finding Its Hidden Roots." The second is the work of J. Roos, G. Roos, N. C. Dragonetti, L. Edvinson entitled "Intellectual Capital. Navigating the New Business Landscape". Under intellectual capital, it is possible to understand the language of thinking, speaking, and dealing with people about the motive power of the future revenue of the organization [18]. This concept provides a number of techniques that enable managers to manage better - including relationships with customers, partners, innovations, overall organizational infrastructure, as well as knowledge and skills of its staff [24]. The concept of intellectual capital is actually trying to estimate, respectively to appreciate the intangible wealth of the organization that it has in knowledge and then to focus on ways to use this wealth.

After a brief explanation of the basic concepts of knowledge management, it is worth mentioning the work of Davenport and Prusak entitled "Working Knowledge. How Organizations Manage What They Know" [4]. Authors very systematically and with orientation for practical use explain the essence, meaning and possibilities of developing and using knowledge in organizations. It can be said that this is a synthesis of notes and opinions from the previously published works on knowledge or knowledge management.

3 The Results of the Scopus Database Time Analysis

The submitted paper is analytical. The main aim of the paper is to introduce the main scientific areas of using the principles of knowledge management. This intent also corresponds to the way and the sequence of data analysis, which can be divided into 3 stages. In all three stages of the work, the available data were searched through the Scopus bibliographic, abstract and citation databases.

In the first stage, historical data was searched for in the database, which made it possible to create an exact timeline and to illustrate the development of the number of expert knowledge in the area of "Knowledge Management". These data were searched in the database without a time limit. When searching, the entered collocation of words "Knowledge Management" was searched for in the Article Title. Among the results, the documents issued in 2018 were excluded, so only the data documenting the number of documents issued by 2017 were used. The historically oldest document was registered in the database in 1977. Approximately until the mid-1990s, the number of published professional works in the database did not exceed 10 documents per year. From a historical point of view, the attention in the developed world around the same time has become more and more focused on the building of the information society in various forms. The theme of information society development has become a major element of public policy especially after the G7 Ministerial Conference (Germany, Canada, Great Britain, France, Italy, Japan and the United States) in February 1995, which promoted the role of the "Global Information Society" to an international role of primary importance [20].

The theme of development of information society, and later the so-called knowledge society, has gradually become the focus of both political and scientific interest at the end of the 20th and at the beginning of the 21st centuries, as evidenced by the growing number of recorded professional works in the database during this period. On the basis of the data found, it can be stated that in terms of the number of registered documents in the Scopus database, the most documents were registered in 2010, when 1005 documents dealing with Knowledge Management were added to the database. In other years, the number of registered documents in the Scopus database ranges from approximately 500 to 800 documents per year. The total number of registered documents in the Scopus database and a gradual increase in the number of documents is shown in Fig. 2.

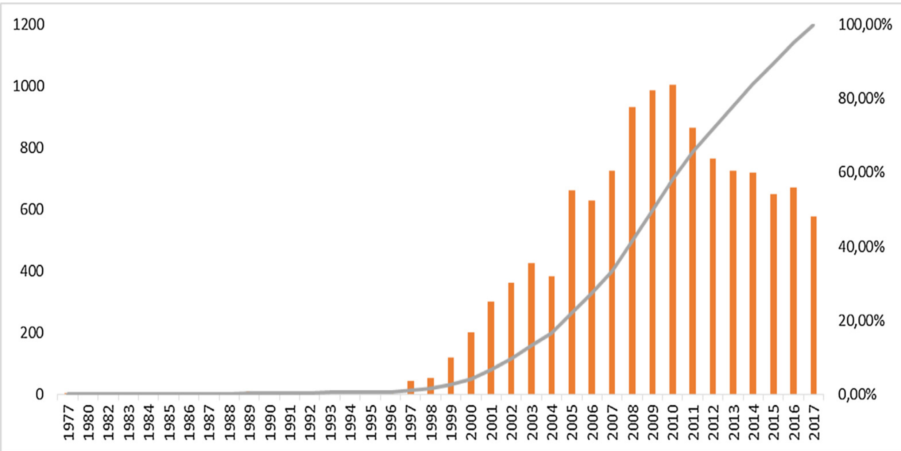

Fig. 2. Growth of the number of documents registered in the Scopus database

In the second phase, the "Knowledge Management" documents were searched in a database filtered according to the "Subject Area" criterion. Pareto Analysis was used to further data analysis, by which from a total of 28 categories 5 so-called key areas of knowledge management were selected:

1. Computer Science,
2. Business, Management and Accounting,
3. Engineering,
4. Social Sciences,
5. Decision Sciences.

Percentage of registered documents from these five areas is approximately 82.2% of all documents related to the Knowledge Management problem. By contrast, the areas where Scopus documents do not exceed more than 1% are Physics and Astronomy, Pharmacology, Toxicology and Pharmaceutics, Nursing, Chemistry, Neuroscience, Immunology and Microbiology, Dentistry, Veterinary. The results of Pareto Analysis are displayed in Fig. 3.

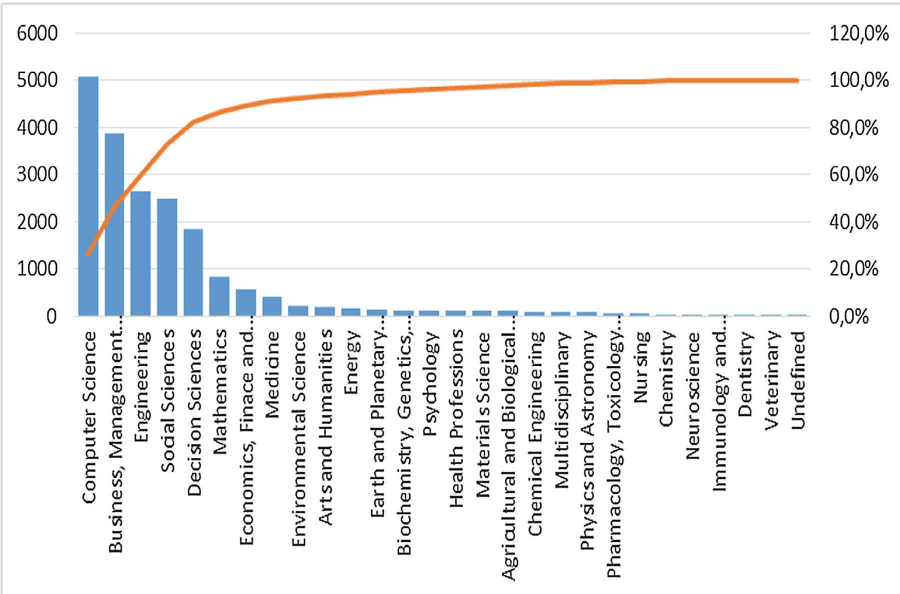

Fig. 3. Pareto analysis

In a more detailed search for documents in the Scopus database, a total of 28 areas were found in which individual documents were classified. Therefore, Pareto Analysis was used to select only 5 areas that make up the largest percentage. The results of the analysis show the main areas of management knowledge interest. The most represented area is Computer Science. While information management is important and the need to manage digital information is greater than ever before, information management is only one part of knowledge management. In addition to information and explicit knowledge, knowledge management must be able to “manage” knowledge of know-how, know-how and, above all, tacit knowledge. While know-how knowledge can be captured and documented as information, tacit knowledge can only be transmitted through socialization and interaction. Information, databases, patents, technology procedures, know-how are the property of an organization, but the knowledge is yet owned only by a person. Knowledge management is therefore mainly driven by the optimization of the management of people who possess this knowledge. Thus, logically, areas such as Social Sciences, Psychology, Cognitive Sciences, and so on become more and more imortant.

In the third phase, 5 so-called key areas of knowledge management were selected and further analyzed in terms of the number of documents in each area over the entire available Scopus database period. The development of the number of documents in selected five key areas is shown in Fig. 4.

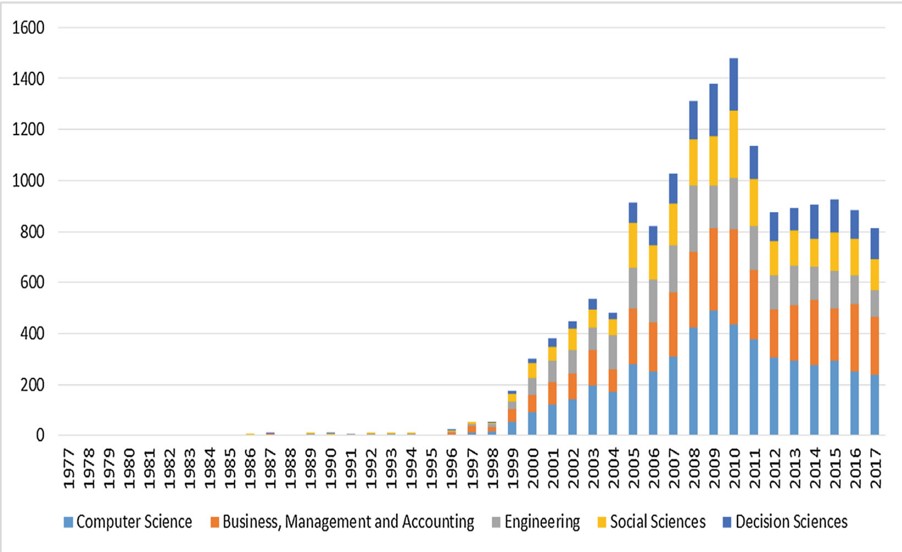

Fig. 4. Development of the number of documents in selected areas of Knowledge Management for the available time period

For the entire available time period, the highest number of recorded documents was integrated into the Subject Area "Computer Science". These results are logical because, with the arrival of an information and knowledge society, Computer Science is precisely the area that supports the development of knowledge management worldwide.

The second largest area is Business, Management and Accounting. Equally, this area is very important in the development of principles and concepts in organization, and at the same time it is an area that includes the application part. Within this area it is possible to look for and find professional works not only theoretical but also practical. They can help researchers, but also business practitioners in their future work. High percentage representation in this area also suggests that there is a fairly high interest from either the researcher or the entrepreneurial practice of applying knowledge management principles to business or management in general. As already mentioned in the paper by application of knowledge management, organizations can gain long-term sustainable competitive advantages.

And other major areas - Engineering, Social Sciences and Decision Sciences can be characterized as those in which work with knowledge is their essential part.

In summary, however, we can say that space for the use of knowledge management is across different scientific disciplines and it is a truly multidisciplinary scientific area.

Percentage of documents in a database in selected areas for the entire available time period is shown in Fig. 5.

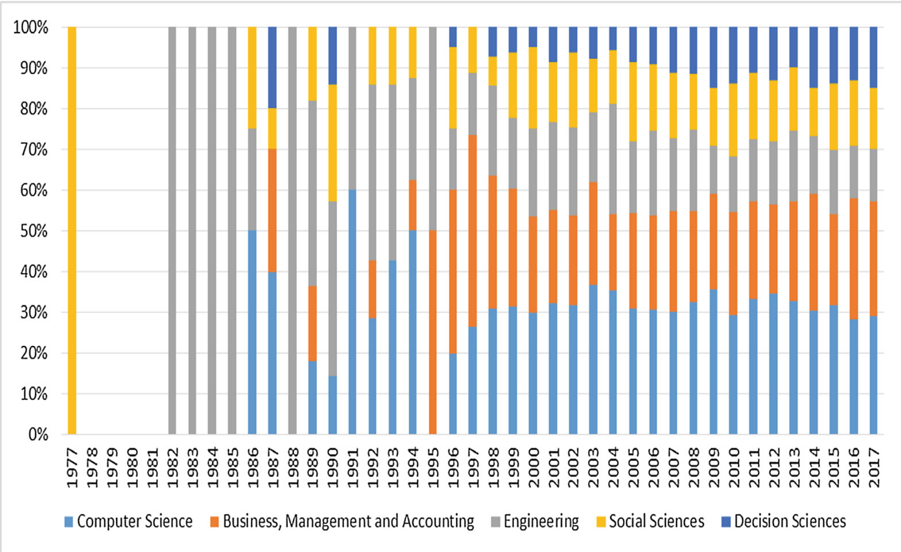

Fig. 5. Percentage of documents in selected areas of Knowledge Management

4 Discussion and Conclusions

The concepts of using knowledge management are currently considered very useful and actual. Their implementation in practice, however, is a long-term and demanding process that requires conceptual management dependent on business strategy and also synchronization with other critical factors of the organization's success [15]. When introducing any changes and therefore also changes related to the implementation of the organization's principles of management, the main problem is the resistance to change. This is an attempt to stabilize movement to the original state, respectively apparent or hidden efforts to maintain the "status quo". Success is often dependent on the art of managerial personnel and their leadership.

Organizations are trying to be competitive and knowledge management as a tool for making existing and creating new knowledge capital available can help them. Organizations should try to develop the overall competence of individuals in the organization, to implement and promote quality education of employees at every level, to support the culture of knowledge sharing in the organization. Even on the basis of the findings, it can be argued that knowledge management can be the driving force of organizations at present, in multidisciplinary fields. The results clearly demonstrate a wide range of areas of interest and use of knowledge management. At the same time, based on the results obtained, we can observe the new trend of knowledge management interest, namely the development of tacit knowledge.

To implement concepts and principles of knowledge management in organizations successfully, it is very important to overcome the tendency to address the symptoms of deficiencies in favor of seeking and addressing their real causes and the resulting procedures for systematic creation a knowledge base for the organization's competitive ability.

The main aim of the paper was to highlight the key importance of purposeful creation and proactive use of essential knowledge in organizations, which should ultimately ensure stable prosperity or long-term competitive advantages for organizations.

At the end of the paper, we can say that Knowledge Management and its various partial concepts have become highly actual issues. It reflects the need to know to create the organization's knowledge base systematically. Professional literature and information resources offer an increasing number of professional works focused on this problem. From the point of view of application practice, it is a huge tool for organizations because they can use the theoretical or practical information, data, advice and experience of researchers or other organizations who have published their knowledge - whether through the Scopus database or other publicly available search databases. The authors of the paper believe that the submitted paper may serve as an example of a proved increase in the impact of knowledge management over the last decades, and will help raise further interest in this scientific area.

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A Model for Data Analysis in SMEs Based on Process Importance

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Abstract. Data analysis technology enables businesses to enrich their business value creation by extracting knowledge. This knowledge extraction is done by knowledge workers. Businesses are seldom able to analyse all their data because the workload for the responsible persons would be too high. So the question which most of the businesses have to deal with is: "Where to start the data analysis" with the fundamental view of increasing the quality of business decisions and process stability. Therefore, the authors conducted a qualitative study based on expert interviews (n = 12) to select the important business processes in a company to start with data analysis enabling efficient business decisions. The result of the study is a set of factors which allows knowledge workers to filter the important knowledge intensive business processes to focus on.

Keywords: Process management · Knowledge workers
Knowledge intensive business processes · Data analysis
Small and medium sized enterprises

1 Introduction

In most of current business processes abstract knowledge is used to maintain quality and efficiency, which is often held by knowledge workers (KW) in the organization [1], whose daily business is strongly influenced by the used information systems [2]. With the rise of digital aids, like e.g. Business Intelligence (BI), companies have the ability to understand their business better and increase the quality of their business decisions within stable processes [3]. A data driven approach can help to gain knowledge with major shortcuts in the process [4]. To take these shortcuts, knowledge workers need to have the capabilities to perform data analysis. As the number of data, which can be used for data analysis, is typically very large, they also need a clear-cut problem that helps to focus their analysis.

Core processes are the business processes that create a business's competitive advantage [5]. Often, these processes are also knowledge intensive [6], wherefore they can benefit from data-driven decision support [3]. Although core processes are important for business, especially small companies are often not aware of their own

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ones [7]. This work shows up a model for classification of the existing business processes and for selecting the knowledge intensive ones. This gives SMEs the opportunity to start with the business processes first, which have higher impact on the business value than others. The efficiency in use of restricted resources can be increased by this process selection for data analysis. One option to filter the important processes for adding business value is by describing the factors which can be used as indicators for knowledge intensive business processes. The knowledge intensive business processes are often the same as the key processes but many small and medium sized enterprises (SME) which do not deal with any quality norm like ISO 9001, ISO 14385 or similar ones are not aware of. For all these companies, it is important to find out their business relevant processes - the knowledge intensive ones - all others can be seen as standard processes.

Based on these statements the research question is formulated as: Which factors can be used for the classification of knowledge intensive business processes to increase the efficiency in data analysis projects in SMEs?

After the introduction in Sect. 1, the authors show up the theoretical foundations in Sect. 2, focus on the study design and empirical data in Sect. 3. Section 4 explains the model for determination. In Sect. 5 the discussion is given. Limitations and ideas for future work are explained in Sect. 6.

2 Theoretical Foundations

Knowledge can be seen as one of the important factors a business has to look on to be able to succeed within a market against competitors [8]. The need for efficient knowledge work was already been mentioned by Wildemann [9] and is defined as one of the most important management tasks in organizations [10]. Knowledge management and digitalization often focus on big businesses with international orientation and more than 1000 employees [11]. Looking a bit deeper into European industries the biggest group in the market are the SMEs with less than 250 employees and a market share with more than 85% of all employees [12]. The active management of knowledge is an important topic for SMEs too [13], but the amount of resources and expertise is very limited. This limitation leads to the necessity of a filter possibility to focus on the right processes in a company.

Looking on the ideas of how knowledge workers everyday work can be better implemented in companies, Edwards and Kidd [7] mentioned four different strategies: (1) the knowledge world way, (2) the IT-driven way, (3) the functional way and the (4) business process way. Based on the supply chain ideas by Porter [14] the focus on the business processes is the way how the authors think about generating knowledge to increase the quality of business decisions. There are basic concepts on knowledge intensive business processes presented [6, 15], but they do not show up filter criteria for efficient process selection in SMEs.

In SMEs the ongoing digitalization demands the discovery of knowledge based on data in an efficient way to improve business and stabilize processes. Fayyad et al. [16] has given a model for knowledge discovery in five steps without any particular application or domain focus.

3 Study Design and Empirical Data

The study concentrated on Austrian SMEs. SMEs can be defined by (1) headcount (if smaller 250), (2) transaction volume (if less than 50 Mio. Euro) and (3) balance sheet total (less than 43 Mio Euro), which about 250.000 Austrian companies satisfy.

Based on a literature review [17] an overview of the topic was prepared and the qualitative analysis could be planned. Getting the data for the filtering of knowledge intensive processes, a qualitative study was set up based on the structured case approach by Caroll and Swatman [18] because of the theory building character of the research question. Based on the grounded theory the structured case approach by Carroll et al. [19] is a cyclic process to enrich the explored data over cycles without losing the application focus. These conceptual frameworks (CF) can be seen as "evolving models that are reviewed and defined over the life of the research project" [18]. Within a cycle the expert interviews are conducted with different experts from Austrian SMEs. The expert interviews were prepared as semi structured interviews based on the explorative character of the study [20].

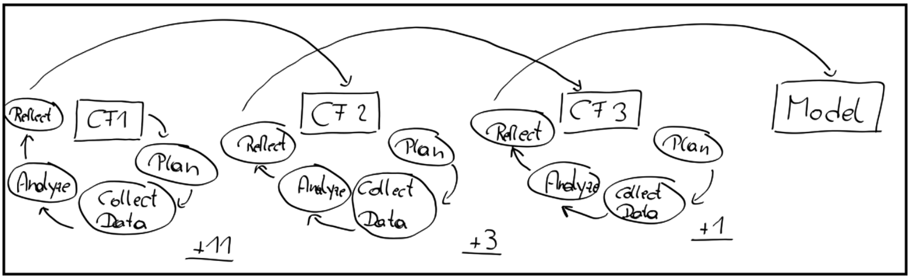

Fig. 1. Empirical design based on the structured case approach

The aim of the study was to find out by which factors the knowledge intensive business process can be determined. The generated factors can filter the processes which are later on interesting for data driven knowledge discovery.

Participants in the study are selected based on the theoretical sampling given by Glaser [21]. This means that the set of experts has developed based on the CF1 to CF3. As first experts have been three selected from practice and one out of the scientific environment. The same combination from practice and scientific was used for the second round and in the third round two form practice and 2 from science were selected based on the given criteria. It is important that the participants have a general idea about business processes to give a contribution to the main research question. Therefore, experts from SMEs and scientific experts were selected which are familiar with an international quality norm do ensure their knowledge on process management or have process topics in their own research area.

Before starting with the first cycle the initial conceptual framework 1 (CF1) had to be defined and the interview guideline was fixed. Basically, the CF1 can be described like a big cloud with the rough idea of some factors describing knowledge intensive business processes. This cloud should be filled with factors by the experts.

The guidelines for the semi-structured interviews were divided into five sections: (1) the aim of the interview, (2) giving an idea of knowledge intensive business processes, (3) show example process for discussion to the experts, (4) filtering of the knowledge intensive parts by the expert and (5) discussion about the factors describing the parts. The expert interviews are all digitally recorded, transcribed and coded with the software ATLAS.ti. The interviews were conducted in German and after coding was finished the factors have been translated to English.

After the first cycle with four expert interviews the following factors (Table 1) are named by the experts to determine the knowledge intensity for filtering processes. The first column shows the factor which is mentioned by an expert and the second column is the frequency of occurrence in the coding scheme based on qualitative research methods [21].

Table 1. Factors given in the first cycle based on CF1

Factor	Frequency
Standardization ability	25
Formalization ability	18
Complexity	16
Needed Information	15
Leeway in decision-making	14
Knowledge of employees	28
Expertise	21
Experience	14
Communication	26
Number of stakeholders	14
Adaptability	15

In the following paragraphs the factors are described to get a better understanding of what it means and what the intention of the experts was in combination with the recorded material.

The *standardization ability* is based on building up a process which can be repeated in absolute the same way again and again. So, the experts explained a negative impact on knowledge intensive processes. If there is adaptation in every case of the process this will not increase the standardization of the process and may be an indicator for knowledge intensity.

If there are complex process structures in place with lots of links to other processes, the test persons mentioned that than a formal description would be more complicated. The *formalization* in this case needs more trained people than for simple sequential processes and can be named as an indicator for the knowledge intensity which is necessary to run such a complicated process.

A nearly similar concept is the idea behind the *complexity*. If a process is defined by a small number of tasks and if they are not combined very tricky, then it can be seen as a simple - not complex - process. Experts suggest that such processes do not need much knowledge to go through the process. High complexity can be named as an indicator for high knowledge intensity in a process.

Lots of different documents and information systems are used to go through one process – this looks like lots of *information* is needed to perform a correct run of the process. Influenced by any of the given information, the process needs to be handled. In case that process users need the information of external sources for completing the process the experts argued that it is an indicator for high knowledge intensity.

The *leeway in decision-taking* is described as the selection of one alternative out of many. If the process user is able to select one of the alternatives during the process flow, a high leeway in decision-taking is given. The experts rank this as a positive factor on knowledge intensity because for handling the process, the process user has to have deep knowledge about the decision process itself and the evaluation of the alternatives.

Lots of experts mentioned the implicit part of the *knowledge* as a relevant factor for the filter model. Explicit knowledge they often paired with information. Nevertheless, it stands for the combination of people and process which is needed for a proper process run. Experts thought that processes which need a high knowledge to run through, are the knowledge intensive ones.

Expertise in a certain domain can be reached by training and experience in this domain. If there are processes in a company, which can only be executed by people working in this process for a long time, they are more likely knowledge intensive processes than others which can be performed by everyone without expertise.

Knowledge which can only be achieved by *experience* is the so-called experience by experts. It is not possible to get this knowledge without performing the process. This knowledge has to be increased with the time and repetition of the process run through. This knowledge is in direct relationship to the people running the process. It is relevant for filtering knowledge intensive processes as it has a positive impact on the filter model.

Communication can exist between people, creatures and machines. Is there a lot of communication with different communication endpoint necessary for a process run, than this can be an identifier for a knowledge intensive business process. Is a process run possible without any communication, the process is less knowledge intensive.

Stakeholders are represented by any involved or informed people in a process. They can have active or inactive parts and can be counted. When a process has more stakeholders than others they all have to be integrated and therefore the knowledge intensity is higher than in processes with only a small number of stakeholders.

Adapting a process by running through the process is an ability which makes it much harder to perform a process in the right way or the way it adds a business value. Process users need a lot of knowledge in the process to go for the right tasks which are not fixed. *Adaptability* is seen by the experts as an indicator to see if a process is more knowledge intensive.

After the first cycle a set of 11 factors (see Table 1) was defined, it sharped the picture of the cloud from CF1. The factors were integrated in the second version of the conceptual framework 2 (CF2). The interview structure was adapted by the generated knowledge and the second cycle in the structured case approach with again four experts was conducted. So the very rough idea of the CF1 could have been improved and specified in more detail. The factors from CF1 were presented during all interviews in the cycle 2 based on the CF2.

After the interviews in cycle 2 again all data were digital recorded, transcribed and coded afterwards. The following factors were additionally mentioned to the existing factors from cycle one. The factors shown in Table 2 are the new ones with the corresponding number of frequency. They are explained in the next paragraphs.

Table 2. Factors given in the second cycle based on CF2

Factor	Frequency
Malfunction	25
Degree of structuring	18
Interfaces	16

The *malfunction* of a process is an indicator for divergent values reached in the process - others than described in the standard. The experts interpreted this malfunction as the consequence on next tasks or linked processes. This malfunction in a process has to be determined by a process expert and is relevant when one malfunction leads to dramatic complications in the subsequent tasks. This is seen as an indicator for high knowledge intensity within a process.

A high *degree of structure* is given when relevant process parameters are described at a meta-level and the process user can easily run through the process without detailed knowledge. A low degree of structure is seen as an indicator for knowledge intensive processes by the experts.

The connection with different other processes or different people is the transfer of information and can be implemented digital or analog. The so-called *interfaces* can be triggered manual or automatic. The number of interfaces can be seen as an indicator for knowledge intensive processes based on the assumption that interfaces are more than communication.

As mentioned in Fig. 1 there was a third adapted cycle for expert-interviews. Again, the adaptions based on the learnings from CF1 and CF2 are implemented for the questionnaires in CF3 and four experts were contacted. The picture about the factors which are descriptive for knowledge intensive business processes gets sharper with the cycles CF1 and CF2. The factors from CF1 and CF2 were presented during all interviews in the cycle 3 based on the CF3 (Table 3).

Table 3. Factors given in the third cycle based on CF3

Factor	Frequency
Flexibility	6

Flexibility was named as the only one additional factor in cycle 3. This can be seen as an indicator for the reliability of the factors generated during the three cycles. Most of the experts are using the term similar to adaptability which is described by Heinrich et al. [22]. Flexibility is described by the experts as: the timeframe which a process needs to be adapted. Processes which need lot of time to run through are not as flexible as processes which can run through during a smaller amount of time. The needed time for adaptations is much longer. Flexible processes can be identified as knowledge intensive processes with a positive influence.

The overall picture about the factors which are interesting to identify knowledge important business processes is sharp enough to build up a model for identifying them in the next chapter. The increase of factors is the indicator for the number of additional CFs. The increase in the first round was 11 factors, in the second round 3 factors and in round 3 only 1 factor. This was the reason for ending up after CF3 and not go for a CF4.

4 The Model for Determination

After the closure of the third cycle there are 15 factors defined by the experts to describe knowledge intensive business processes. The idea of the model is not to calculate any dedicated value for every process, but at least it is a possible method to indicate if some processes in the reviewed business can be ranked as more knowledge intensive than other ones. The factors can be aggregated in four main areas of interest. Three of the main areas are deviated by the fundamental model of IS which is based on the attributes (1) people, (2) technology and (3) tasks [22] – for this model technology is seen in the processes itself. Additionally, based on the given factors by the experts the category of (4) interdependencies is formed. The allocation of the factors to the categories is explained as shown:

- *Category process*: (1) standardization ability, (2) formalization ability, (3) complexity, (4) needed Information, (5) leeway in decision-making, (6) malfunction and (7) degree of structuring
- *Category people*: (8) knowledge of employees, (9) expertise, (10) experience
- *Category task*: (11) adaptivity, (12) flexibility
- *Category interdependencies*: (13) communication, (14) number of stakeholders, (15) interfaces.

The processes determined by the factors are the processes where data analysis should focus first. With the factor model given in Fig. 2 it is possible to select knowledge intensive business processes where it is promising to add some additional data or have at least a deeper look by "letting the data speak". Based on the restricted knowledge worker resources in SMEs for BI initiatives, this model is able to set up a quick decision support for generating a ranking of the processes.

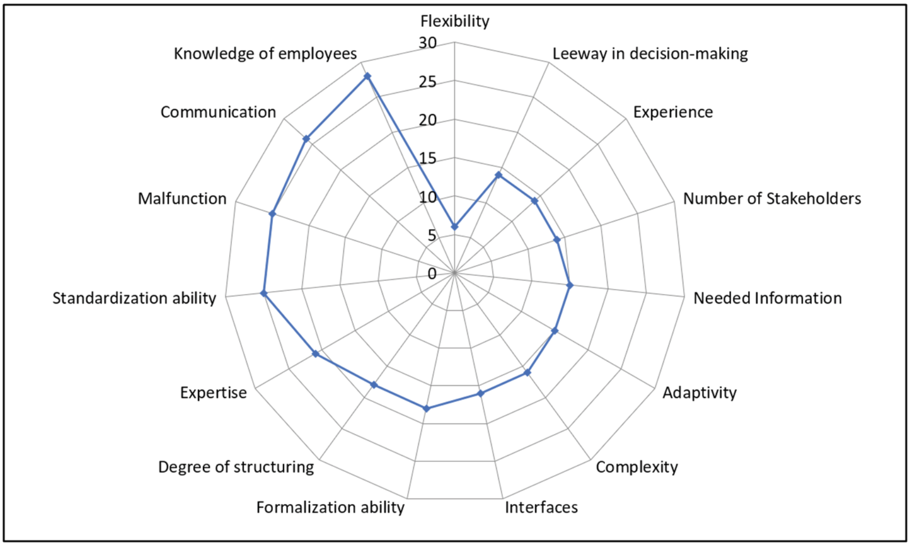

Fig. 2. Factor model for determination of the knowledge intensive business processes

There are models presented how to develop BI initiatives [16] and how the process has to be structured. An additional model is given in [authors et al., 2018] which shows, how to ensure the implications after BI has been done and how this can lead to more stable processes and better business decisions.

5 Discussion of Results

As shown in models for data driven knowledge discovery, it is important to get up with a first idea to start the process of analyzing data. Based on resource restrictions and effectiveness reasons in SMEs, companies need a way to find an efficient starting point for their BI activities. The developed model for the filtering of knowledge intensive business processes (Fig. 2) shows a possible way to find these starting points by looking on the data of knowledge intensive business processes before to look on the data of less important processes. The research question can be answered with the built model.

In most companies, the knowledge intensive business processes will be similar with key processes based on a classical split given by quality management norms like the ISO 9000 series in (1) Management Processes (2) Supporting Processes and (3) Key Processes. Therefore, good trained knowledge workers get a tool to focus on processes they count for the business value before exploring the data of less important processes. This also allows companies to think about a deeper integration of data technologies for continuous process improvement as this is one of the requirements from every quality management norm and an essential criterion for an integrated quality management system.

6 Limitations and Future Work

As the model for the factor based filtering of the knowledge intensive processes is only based on three cycles in the Structured Case Approach this has to be expanded by further studies to ensure the completeness of the factors and additionally develop a measurement model for calculation of the process order based on the knowledge intensity.

The next step will be the application of the developed model in some real-world cases to get feedback on the quality and the usability of the model and the completeness of the described factors. Based on these cases further implementations and additional adaptions in the model will be done.

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Critical Issues of Comprehensive Performance Measurement and Management Process

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Abstract. An effectively functioning performance management process has become the key to success in today's tough competitive environment. It is necessary to have comprehensive knowledge of new approaches to performance measurement in order to create and implement such a process. The main aim of this paper is to contribute toward building on such knowledge by designing a performance measurement and management process diagram. To fulfill this goal, the features of a performance measurement system have been determined based on research in the literature; additionally, key elements that are necessary for a comprehensive process of performance management have been defined using case study analysis. The diagram also identifies critical elements of contemporary performance management process related to the provision of balanced performance indicators and their subsequent incorporation in strategic planning. The findings show that competitive-related performance aspects such as innovation, core competencies, and employee engagement are not sufficiently integrated in performance measurement.

Keywords: Performance · Management · Measurement · Process Indicators

1 Introduction

With the advent of new management practices such as total quality management and lean management as well as new competitive challenges such as flexibility and a rapid response to customer expectations, many have argued that accounting-based performance measurement systems are no longer sufficient [10].

Performance measurement systems play a key role in implementing strategy, evaluating and understanding the achievement of a company's objectives, and rewarding employees. Many managers and academicians soon recognized that traditional financial indicators are not adequate to fulfill these functions, because they promote short-termism leading to a lack of strategic focus and failure to provide data on quality [13, 22, 31]. On the basis of these findings, a wide variety of performance

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measurement and management systems were developed and implemented. All of them were designed to provide an integrated and balanced overview of a company's performance. This can be considered a key transformation of the period up to 2000. Although much is being written about non-financial performance measures, there is still very little known about actual current practices.

The integration of a multistakeholder perspective and system dynamics is typical in the second decade of the 21st century [32]. The most recent literature highlights that it is necessary to approach performance management from a more open systems perspective [8]. Intellectual capital and innovation are becoming the foundation for creating competitive advantage. Therefore, at this time, we can see a distinct effort to integrate certain new leading performance indicators, such as leadership, training, education, innovation, capabilities, knowledge, and personal improvement into performance measurement systems. However, the focus is mainly on what should be measured today rather than what should be measured in the future [14].

To be able to respond to above-mentioned changes, managers need comprehensive knowledge of new approaches in performance management and measurement. The main aim of this paper is to contribute toward building on such knowledge by designing a comprehensive process for performance measurement and management. The particular steps of this process are defined on the basis of an extensive review of the literature and a series of research studies carried out during the years 2011–2014 aimed at identifying the key elements of effective performance measurement and management systems [26, 27]. Using the results obtained, the critical element of performance measurement process development was determined, i.e., the choice and implementation of indicators that reflect all aspects of performance. An even more important aspect is utilizing the important information that has been acquired by measuring in the strategic planning process. Therefore, we decided to explore the extent to which financial and non-financial indicators are used, the degree to which top managers identify particular performance indicators as significant, and whether the information obtained from these measurements are used in the strategic planning process.

2 Trends in Performance Measurement and Management System

A contemporary performance measurement system must find a balance between indicators that are financial/non-financial, short-term/long-term, backward-looking/forward-looking, shareholder-oriented/stakeholder-oriented, and leading/lagging [15, 19]. This can cause practical problems, because companies often use too many poorly selected indicators (that do not drive performance and are poorly defined (open to manipulation), poorly measured (collected and analyzed incorrectly), and poorly applied (collected but not integrated into strategic decision-making) [12, 21].

At first, a strong critique of traditional performance measurement systems and managers' confidence in financial indicators led to greater emphasis being placed on "modern" financial indicators based on value management. However, as stated by [30] more than 10 years later, this scenario seems to have paradoxically changed only a little. International evidence as well as our surveys [26, 27] indicate that managers remain anchored to traditional financial measures, while other measures, such as EVA, are used rarely. This unchanged approach to financial performance measurement was also confirmed by a recent study conducted by the U.S. National Association of Corporate Directors, which determined that only 16% of managers use measures of economic value as financial metrics in compensation plans [6].

Next, through use of the balanced scorecard and EFQM frameworks, non-financial indicators are increasing and the literature has begun to stress their utility. Most research surveys reveal that non-financial indicators are more closely aligned to strategic initiatives, and can help employees focus on customer performance. Therefore represent the drivers of financial performance [7]. Performance measurement literature also assumes that the integration of non-financial indicators allows managers to better understand the relationships among various strategic objectives, communicate the association between employees' action and strategic goals, and set priorities based on those objectives [23]. It is also important to recognize that non-financial indicators are not free of limitations. As Chow and Van der Stede [10] stated, some non-financial performance indicators may be difficult to measure accurately, efficiently, or in a timely fashion. Other limitations are that they may be biased or ambiguous, easier to manipulate, measured in many ways that may change over time, time-consuming, and expensive [11]. Moreover, they often differ between companies; for this reason, they are not suitable for benchmarking.

However, the question remains as to which performance indicators are optimal for measuring long-term corporate performance? In effective performance measurement systems, they must be based on organizational objectives, critical success factors, and customer needs – and they should change dynamically along with the strategy [18]. As recognition in the area of performance measurement grows, the researchers pose the question, "How can we best use the findings acquired by measuring performance for their management?" This could be seen as a current challenge for performance measurement and management.

In literature we can find a wide range of characteristics and features that must meet an effectively functioning performance measurement and management [4, 5, 12, 15, 29]. The relevant characteristics are summarized by [8] as follows:

- It must reflect relevant non-financial information based on key success factors of each business.
- It should be implemented as a means of translating strategy and monitoring business results.
- It must accordingly change dynamically with the strategy.
- It must meet the needs of specific situations in relevant manufacturing operations, and should be long-term oriented, as well as simple to understand and implement.
- It must make a link to the reward systems.
- It should stimulate the continuous improvement processes.
- It must be clearly defined and have a very explicit purpose.
- It should allow a fast and rigorous response to changes in the organizational environment.

All these requirements are reflected in the performance measurement and management process that has been designed as part of this research.

3 Objectives and Methodology of the Investigation

This research study is composed of a number of sections that are linked thematically. First, the features of an effective performance management and measurement system are defined using the literature. Next, we have defined the key elements that are necessary for a performance management process that corresponds to global trends. These elements have been defined using case study analyses conducted for 46 companies during 2011–2013. We limited our sample to medium (50–249 employees) and large (500 and more employees) manufacturing companies. The reason for this is that larger firms tend to measure more performance categories in comparison with smaller firms [2]. Hoque and James [9] also find a positive relationship between balanced scorecard measures and organization size. These findings indicate that large companies can be expected to have more sophisticated PMSes in comparison with SMEs. Second criterion for sample selection was the long-term experience (more than 5 years) with performance measurement and management, which was determined using previously conducted secondary analyses.

A case study method was chosen because guides the researcher to better explanations for the process and outcome of the situation under study by analyzing the case [28]. A total of 60 interviews were conducted with the mid-level managers (quality managers, HR managers, managers for strategic development) and top-level management (general directors, financial and sales directors) of selected companies. Semi-structured interviews were conducted based on the methodology and rules presented by [1, 24].

Content analysis was used to process the data. As stated by [16] content analysis is a research technique for making replicable and valid inferences from data to their context. Content analysis can be considered for all kinds of written text no matter the source of the information and which include: observations of scenes, pictures, focus group interview and interview [3].

By integrating the obtained results, a diagram of a comprehensive process of performance measurement and management was designed, in which critical issues within contemporary performance measurement and management process were identified. Because the inability to ensure that performance indicators are well-balanced is the most critical issue for these systems, this research study also covers this area. This part of research study is motivated by Stivers [25] and Chow and Van der Stede [10] who examined the use of financial versus nonfinancial measures and how managers weight corporate performance measures when evaluated performance.

On the basis of literature review studies we created research instrument that is composed of 33 financial and non-financial performance indicators that covered all key areas of business performance. Within each company, we directed this survey to financial managers and quality managers. The survey asked managers to identify performance indicators that are used in their company and to indicate their degree of importance and the extent of their usage in strategic planning, using a seven-point scale.

In this part of study, we ask three research questions:

1. Which specific indicators are used in the company's current performance management systems?
2. Which specific indicators do managers consider to be the most important for managing company performance?
3. Which specific performance indicators are used in the process of strategic planning?

4 Findings and Discussion

4.1 Comprehensive Process of Performance Management and Measurement

On the basis of integrating the results, a diagram has been drawn up for a comprehensive performance measurement and management process (see Fig. 1).

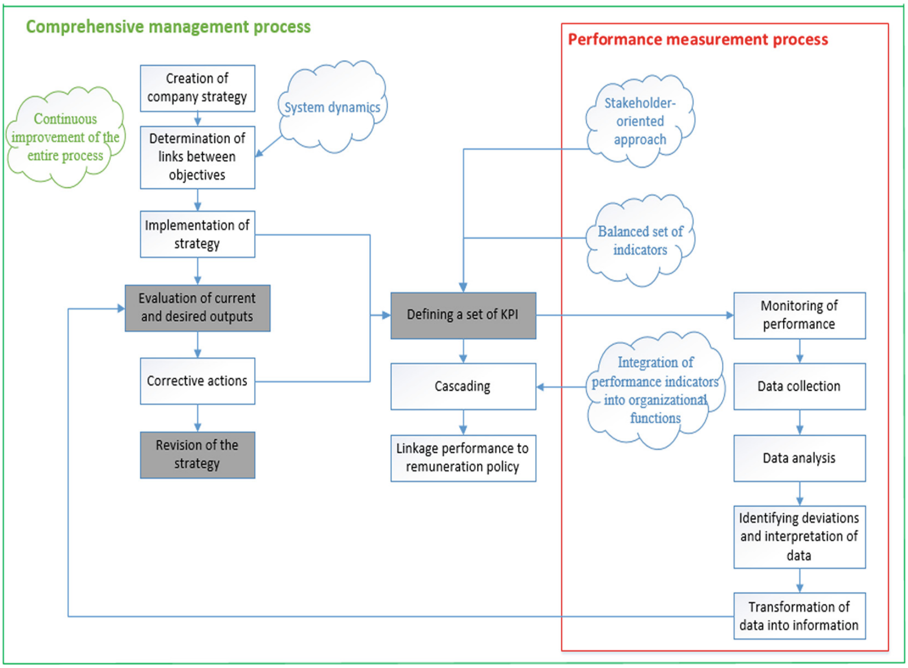

Fig. 1. Comprehensive performance measurement and management process

The first step towards a comprehensive performance measurement and management process is to create a company strategy, which involves establishing a mission, a vision, and strategic objectives. Subsequently, it is necessary to establish relationships between goals using strategic maps, causal mapping, and system dynamics. Using these tools, it is possible to establish a missing objective or objectives (as well as a related performance indicator or indicators). In this way, the system provides a balanced perspective on the company and an understanding of the system's operation as a whole – of all of the system's variables and the relationships between them. Subsequently, it is possible to change these variables, influence their behavior, and manage them. The next successive step is to implement this strategy, i.e., to establish a balanced group of KPIs. The main requirement for attaining balance is to implement an approach focused on stakeholders, i.e., to analyze stakeholder interests and expectations while respecting individual aspects of the business processes. Only in this way is it possible to guarantee balance between the following indicators: financial/non-financial, leading/lagging, internal/external, stakeholder/shareholder-focused, and future/past performance.

Next, the strategic indicators must be described down to their lowest hierarchical level as they relate to the link between employee performance and reward policy, because the most frequent reason for managing performance is to influence employees' behavior, motivation, and rewards. What follow next is the collection, analysis, and interpretation of data, which includes identifying variations in performance. It is necessary to transform the data that was acquired into information, evaluate it in the context of the required outputs, and establish corrective measures. If it is determined that key performance indicators were defined incorrectly, it is necessary to modify and improve them. If the expected results were not achieved, it is necessary to trace the thought processes back to the strategy itself and change our original hypotheses on the strategy results. A culture that is continuously learning and improving performance is created by using a monitoring mechanism that has been set up in this way.

As part of this case study, critical issues were identified for the diagram, which has been set up in this way; these are highlighted. In particular, they concern attaining balance between the individual types of indicators and balanced coverage of all areas of performance. The managers themselves consider this area as the most problematic. The two next most critical issues, concerning evaluating outputs and subsequent strategy revision, closely relate to this.

4.2 The Usage and Importance of Financial Versus Nonfinancial Indicators

Knowledge of the use of new non-financial indicators is still limited in practice. Lingle and Scheemann's survey from 1996 [17] found that financial performance indicators are included in regular management reviews at 98% of the surveyed companies, operating efficiency at 82%, customer satisfaction at 76%, and employee performance at 57%. Chow and Van der Stede [10] stated that, in a study carried out by Wm. Schiemann & Associates, the executives widely acknowledged the limitations of traditional financial measures. Nevertheless, they still favored them over non-financial measures.

Our results demonstrate that the most commonly used indicators in the performance measurement system invariably continue to be profitability, the total cost ratio, cash flow, and sales growth i.e., financial indicators. However, a number of non-financial indicators are seen in the top ten, namely safety, the quality of product/service, and the satisfaction of customers and employees. Of the financial measures, productivity and financial stability ranked in top positions. This indicates that the ratio of financial to non-financial indicators is nearly equal among the top ten most frequently used. This also applies to the perspective of individual areas of performance measurement, because here we can find indicators that fall within all the perspectives used by the BSC method. Three more non-financial indicators follow: employee motivation, training/education, and process quality. More than half of the companies investigated here measure all of these indicators.

As is shown in the graph below (see Fig. 2), non-financial indicators can be seen in lower positions as well – mostly in the area of customers and employees. In customer area indicator of satisfaction is already used routinely, on the contrary customer retention, which for example Nenadal [20] identify as advance degree of excellence of performance measurement in relation to customer, monitor only 40% of companies. Unfortunately the same situation occurs in the area of internal processes where process quality is measured but indicators related to innovation, process time, or production flexibility continues to be underestimated.

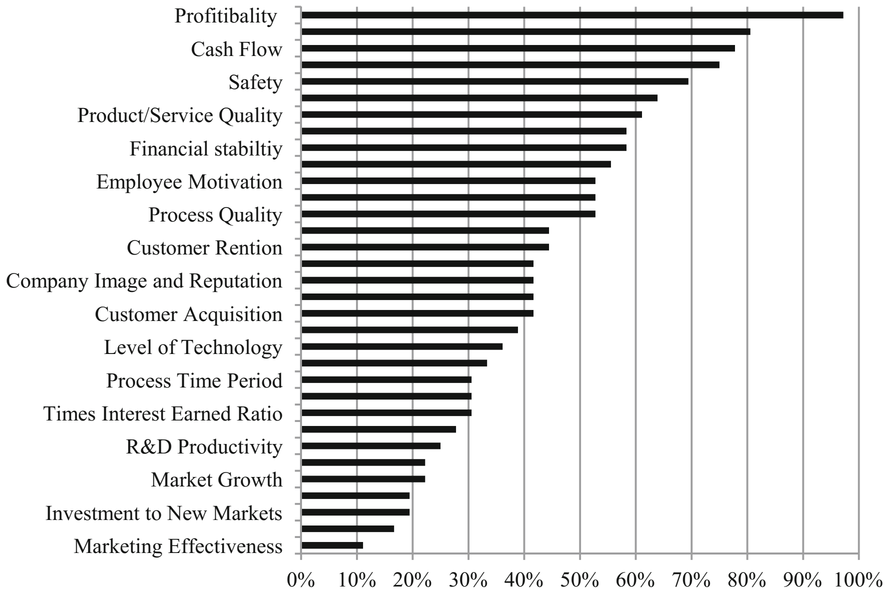

Fig. 2. The relative frequency of the measures used

Despite the fact that typical financial indicators ranked among those most frequently used, it can be stated that they are complemented by so-called intangible measures at more than half of the surveyed companies. An interesting finding is that 40% of the companies also try to monitor indicators that are difficult to measure and concern company culture, image, and reputation.

A little less used are the indicators of core competencies, employee engagement, and marketing effectiveness, i.e., typical indicators focused on improvement. In 1998, research by Stivers et al. [25], which was conducted on American Fortune 500 and Canadian Post 300 companies, revealed that customer service factors are considered the most important measures. On the other hand, factors in the categories of innovation and employee involvement were perceived to be less important in goal setting. Nearly 20 years later, our study has produced similar results, which is very surprising in the current competitive environment – where innovative capabilities and the quality of human resources, research, and technology are unquestionably considered to be the key to success.

Therefore, we also focused on investigating the fact that actual managers consider specific indicators to be the most important for managing a company's performance. From the graph below (see Fig. 3), we can see that nothing has changed significantly in the top rankings. Financial indicators are still considered to be the most important; these are supplemented by the typical indicators of customer satisfaction and product quality.

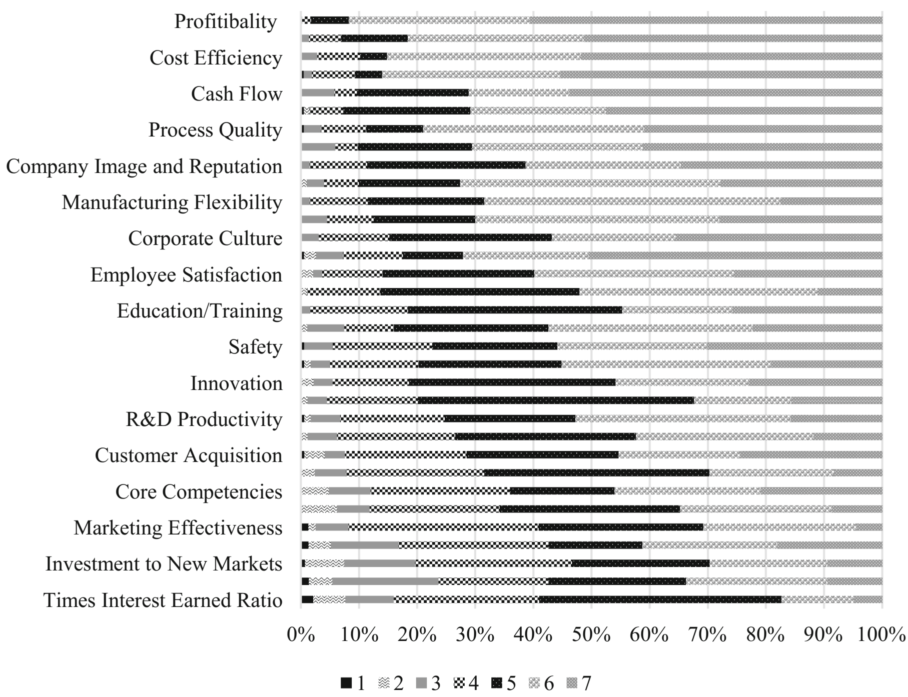

Fig. 3. The importance of specific performance indicators

Only the indicators of process quality, company image and reputation are perceived to be more significant than the degree to which they are used. Thus, it can be seen that managers are now aware of the influence of these leading indicators on increasing company performance. On the other hand, the indicators of sales growth and safety are considered to be less important, despite being frequently used in performance measurement systems. Despite the unprecedented development of managerial techniques focused on continuous improvement, the indicators linked to employee engagement, innovation, core competencies, and process time have, without exception, ranked in the lower half of the graph.

As was stated in the literature review, it often happens in practice that information from performance measurement is not integrated into the process of strategic planning and decision-making even though it is available. This statement was only partially confirmed for the companies we investigated. The reason could be that the companies monitor performance mainly using indicators that can be easily measured. The information acquired using these performance indicators is then used in the process of strategic planning as well. Surprisingly, the only measure that indicated dissent was employee satisfaction. On the other hand, if companies monitor soft issues such as employee motivation and engagement or company culture, image and reputation, they use this information as part of the strategic planning process (see Fig. 4).

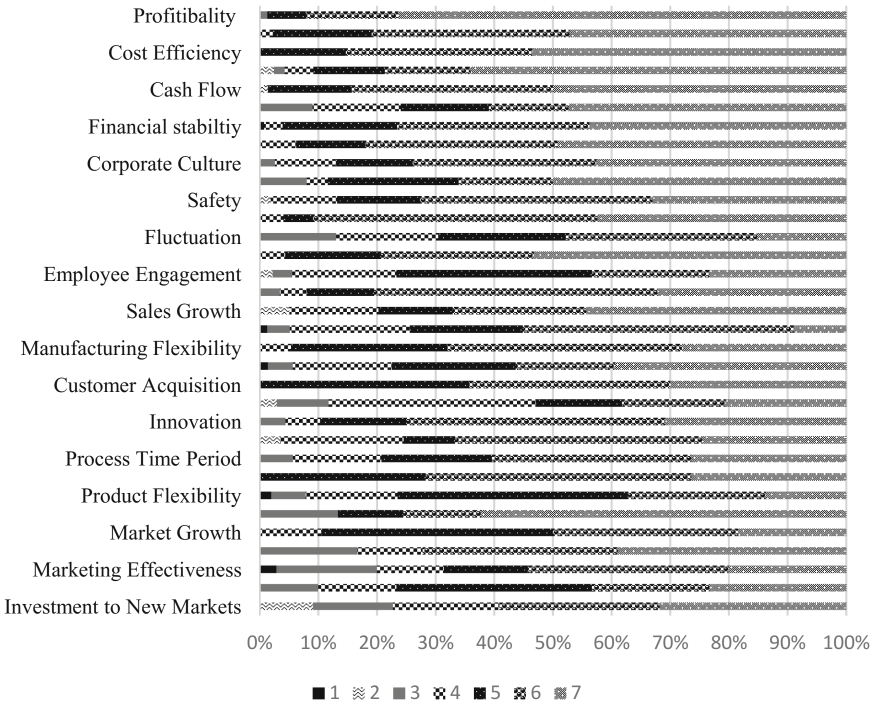

Fig. 4. The degree to which specific performance indicators are used in the strategic planning process

5 Conclusion

A key requirement for success in today's tough competitive struggle is the ability to differentiate oneself from the competition. Constant change in the business and social environments changes the performance measurement system's requirements – in conception and management methods as well as in methods for determining information and managers' professional qualifications. This type of turbulent environment in which companies operate leads to an attempt to understand how to use performance measurement system for continuous improvement and learning.

It is possible to state that the area of company performance measurement theory has been evolving in accordance with the development of global and business trends. The results of this survey demonstrate that, for the time being, the situation in the companies investigated here does not correspond to this development. These companies do not sufficiently react to developmental trends in this area and do not use the full potential of performance measurement system.

The results of the study reveal interesting implications for the mangers developing effective performance measurement and management system. In addition, the proposed comprehensive performance management process can contribute to the development of performance management knowledge. Compared to the previously conducted research studies our surveys revealed continuously increasing trend in the use of set of key performance indicators, which seeks to provide a "balanced" view of a company's performance evaluation. The results indicate that typical financial indicators are complemented by typical nonfinancial indicators from different areas of performance at more than half of the companies. The information from these performance indicators are also used into the process of strategic planning.

However, the approach is still unbalanced in favor of lagging indicators. The competitive-related performance aspects such as innovation, process time period, core competencies, and employee engagement are not sufficiently integrated in performance measurement systems. The disappointing for the authors of the survey is that these indicators are still perceived as less important by the managers. If we accept the widely recognized assumption that innovation and intellectual capital create competitive advantage, then it is essential that indicators related to these areas must be part of the strategic performance management system. In other words, still there a wide gap exists between what is used in practice and what is considered as effective in literature.

In general the companies need to pay more attention to indicators aimed at improving of performance that are currently used rarely. The managers need help to learning how to define these performance indicators and use the information derived from them in the strategic planning process. Only the integration of indicators reflecting important competitive aspects of performance can guarantee the balance between individual types of indicators and thus fulfil an essential prerequisite for effective performance management and measurement process.

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Deep Leadership and Knowledge Management: Conceptual Framework and a Case Study

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Abstract. The aim of this paper is to bring together in to the same organizational framework the concepts of Deep Leadership and Knowledge Management. We propose that when synchronizing the four loops of learning, the organization will achieve a permanent competitive advantage. A case study of knowledge transfer from Finland to China based on private company structures is presented. As a conclusion bigger emphasis should be placed on knowledge transfer and competence development of local personnel both at team and individual levels.

Keywords: Transformational leadership · Knowledge management
Deep leadership · Deep learning · Knowledge transfer · Technology transfer

1 Introduction

The relationship in between leadership and management has been a famous topic of studies and discussions for many decades. Both concepts are needed, but how do they relate to each other? Which is more important? How do we combine these concepts effectively in the praxis of organizations? The change in our operational environment is getting faster. Foreseeing the future challenges is becoming more and more complex. Disruptive technologies and artificial intelligence will soon bring totally new possibilities and threats for the business and also armed forces globally. Deep learning is a concept that can melt the processes of leadership and management for better organizational performance and resilience for the future.

In the Finnish Defense Forces (FDF), a systematic approach to apply transformational leadership for leadership development was introduced already in the late 1990s. Since then, a comprehensive model and program, called Deep Leadership® (DL), has been successfully used in the FDF for twenty years [1]. Evidence-based transformation of the military culture in Finland has been widely noted internally and internationally [2].

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ABB is one of the global leaders in power and automation technologies. ABB has operations in around 100 countries and is dedicated to help its clients to use electrical power efficiently and lower environmental impact. Leadership and knowledge management are key success factors to ABB, in order to drive innovation, to attract and retain talent and to act responsibly [3].

1.1 Transformational Leadership and Deep Learning

All leaders are active or potential wielders of power, but all wielders of power are not truly leaders. The basic function of leadership is to unite the individual objectives of the leader and subordinates in order to achieve the higher objective (vision). This thought therefore includes the possibility that people do not have to agree on everything, but the vision and direction of activity have to unite individuals [4].

There are two main concepts of authority in moral philosophy: command and respect. Command is based on organizational structure and official positions – hierarchical relations are “lines of command”. Respect is based on mutual trust and it is something that can not be ordered. In traditional organizations, both sources of authority are needed. Thus, the most effective leadership is based on respect. In the end, leadership and ethics are inseparable – unethical leadership is an oxymoron [5].

Transactional leadership is the most typical manifestation of leadership. It is based on command and reciprocal activity in which a leader approaches a subordinate in order to exchange something, like a salary for work. In transactional leadership it is essential that the leader attempts to achieve certain goals by influencing his subordinates, irrespective of the objectives of the subordinates. The extraordinary wide possibilities to punish subordinates are reflecting the transactional nature of military cultures all over the world [6].

Transformational leadership is more complex and more effective. Authentic transformational leadership must be grounded in moral foundations. Its primary source of power is respect. Here a leader recognizes and exploits the needs and demands of other people. Furthermore, a transformational leader aims to recognize the motives of her/his subordinate, fulfill their needs at increasingly higher levels and thus make the subordinates commit themselves comprehensively. The result at best is a stimulating and constructive interactive relationship, in which the objectives of the leader and subordinates approach each other and in which leaders can become supporters and coaches of the professional growth of their subordinates. These leaders also set a good example of learning for their subordinates and therefore support all learning activities through their behavior. The leader and the subordinates share the path of human development: personal growth [7].

A transactional leader functions according to an organization’s prevailing culture, but a transformational leader can change and develop organizational culture. Culture is unavoidably an important part of an organization, and leaders have many ways to communicate for example the key values and ethics of the organization. Implicit means lean on the value foundation, traditions and rituals that rise from history [8]. Training programs, among other things, belong to strategic means. The significance of culture is great in military organizations, as well. Inefficient leaders lean on the organization, its routines and their formal positions. Efficient leaders show with their behavior the direction and policy for other people, changing established procedures if need be [9].

Bennis and Nanus, Wofford and Goodwin as well as Jantzi and Leithwood Colvin, Fullan, among others, deal with the deep learning process of development as a leader [10–12]. In the area of behavioral sciences, especially in pedagogy and in the conceptual field of the constructive conception of learning can be found the established term deep learning that is the antonym of surface learning. In the process of deep learning the learner concentrates on the significance and goal of information, attempting to understand its fundamental purpose and its connection to his own experiences and previous knowledge. Weighing the reasons for preconceived ideas is also related to this process. Deep learning therefore has to do with the reformulation of individual perspectives of meaning at least on a mental level. It deals with learning strategies, concluding that deep learning is connected to inner motivation [1].

How does deep learning manifest itself in the knowledge and skills of an individual? Deep learning is taking place when the learner understands the entity related to information, is able to use this information in a new problem situation and is able to make choices and function effectively in new and surprising conditions [13]. Deep learning also includes the development of one's own conceptions, appreciations and activities and their critical assessment. In fact, leadership is based on the same human mechanisms as deep learning in the context of individual development [14].

1.2 The Deep Leadership® Model and Feedback Tool

The Deep Leadership® Model (DLM) is a tool that has been developed for the Finnish cultural environment firstly in the military context in late 1990's. It leans on the basic assumptions of the transformational leadership and the empirical research that has been done to formulate the change leadership paradigm since 1980's. Secondly, DLM is based constructivist approach to deep learning [15]. The research done by the leading schools of these paradigms – transformational leadership and deep learning –formulate the basic scientific pillars of the DLM.

Deep Leadership® coaching process has been designed to enhance the leadership culture in any operational environment. The four cornerstones of deep leadership describe the content of excellent leadership behavior and this information does not change in time. The DLM contains information that should be deepened in coaching and applied to the needs of different professions. The model consists of the constructivist framework of leadership behavior.

The concrete developmental tool based on the model is the Deep Leadership Questionnaire (DLQ) with the help of which 360° profile information is collected for individuals - not only the leaders but for all employees. This viewpoint restricts the structure of the model: the model only includes those dimensions that can be evaluated in a reliable manner with external feedback. The model includes only one dimension from the foundation of behavior, i.e. the potential of the leader, and that is the "professional skills". From all possible outcomes the model includes three dimensions: efficiency, satisfaction and extra effort. The structure of the DLM with three main dimensions and 10 factors is shown in Fig. 1.

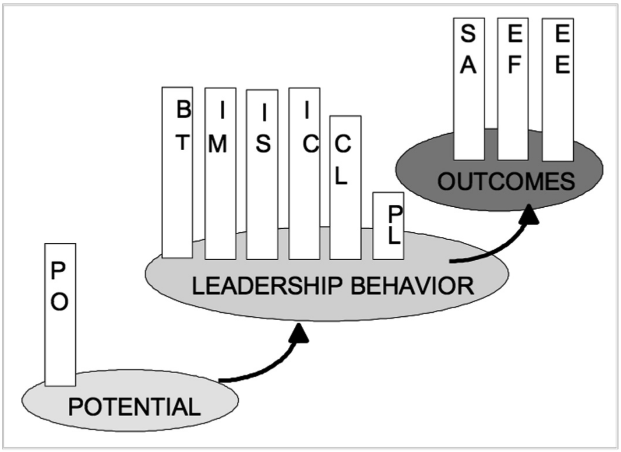

Fig. 1. The Deep Leadership Model (DLM) [1]

Leadership behavior is modelled with three main dimensions, which are deep leadership (DL), controlling/corrective leadership (CL) and passive leadership (PL). The main dimension of deep leadership (DL) behavior is divided into four factors (cornerstones), which are building trust, and confidence (BT), inspirational motivation (IM), intellectual stimulation (IS) and individualized consideration (IC). The model and the related questionnaire are built up from 10 factors, the main contents of which are summarized in the following.

Professional skills (PO) measures the knowledge and practical skills needed by a leader in his current assignment.

Building trust and confidence (BT) is the first of the cornerstones of deep leadership. A leader offers a behavioral model to his subordinates. This kind of leaders are respected and even admired, thus this is not a personal goal for this kind of a leader.

Inspirational motivation (IM) becomes evident when a leader paints an challenging vision and gets other people to find from their work new meaning and new features. The unity of the group increases with shared goals and experiences.

Intellectual stimulation (IS) is manifested when the leader supports the innovativeness and creativity of is subordinates by questioning the basic assumptions, seeking new possible solutions to problems and new approaches to work.

Individualized consideration (IC) is based on a positive conception of people in general and genuine interest in subordinates as human beings.

Controlling and corrective leadership (CL) is the dimension of transactional leadership in the model. Control becomes evident especially in coaching procedures. These kinds of leaders do not have sufficient trust in their subordinates.

Passive leadership (PL) is in practice non-leadership. This type of a leader mainly keeps to him/her. The leader becomes involved only when he has to: a mistake has already been made and the powers of the subordinates are not enough to solve the situation.

Effectiveness (EF) is the efficiency of the entire organization on which the leader has an effect.

Satisfaction (SA) is extensive, related to the efficiency and success of the organization, but also to the leader.

Extra effort (EE) grows under the leader. Subordinates' commitment to the work community, to the leader and to the goals of the activity creates a phenomenon in which people voluntarily increase their work contribution.

The DLM has been built to act as a tool for coaching that gives a direction to personal development aspirations. At organization level the greatest challenges have to do with established structures and routines as well as feedback culture. The development of leadership behavior at individual level requires also the logical development of feedback culture in the entire organization [16]. Finally, it has to be noticed that the most critical outcome of effective leadership coaching is the enhanced learning attitude of the trainees –without willingness to learn the tools of development are useless.

2 Knowledge Management in Complex and Dynamic Environments

The role of knowledge and knowledge workers and efficient as a competitive advantage has received a considerable attention in management theories (e.g. [17, 18]). The common hierarchy of knowledge, as a part of organizational information and knowledge management, can be defined as follows: data, information, knowledge, expertise/intelligence and wisdom which are illustrated in Fig. 2.

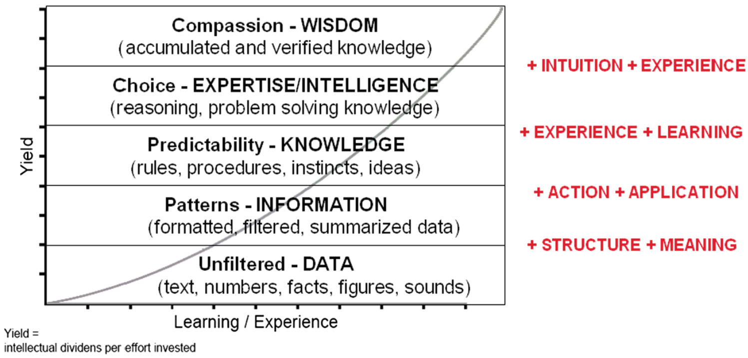

Fig. 2. Common hierarchy of knowledge [19]

The creation and diffusion of knowledge have become increasingly important factors in competitiveness and knowledge is a high valuable commodity that in embedded in products (especially high technology) and knowledge services (knowledge intensive and digital services) [20, 21]. At the same time the competitive advantage and value of knowledge is becoming shorter emphasizing the need for combining knowledge management and transformational leadership to enable the transient competitive advantage.

2.1 Knowledge and Training Activities

The value of a firm's intellect increases when moving up the intellectual scale from cognitive knowledge to creative intellect, as illustrated in Fig. 3. Most organizations however, reverse this priority e.g. in their learning and organizational development activities, virtually focusing their attention on basic skills development and little or none on systems, motivational or creative skills, resulting predictable mediocrity and loss of profit [22].

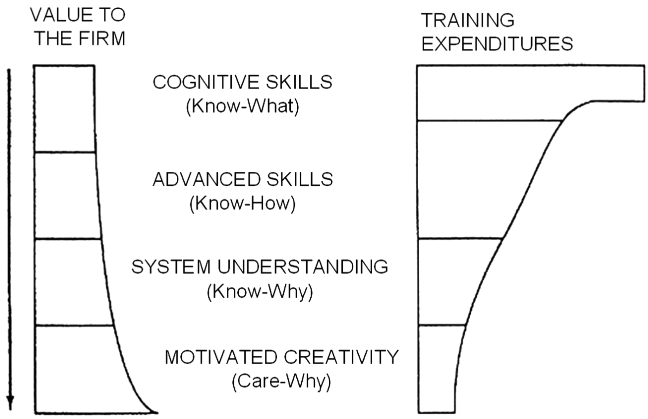

Fig. 3. Skills value vs. development expenditures [22]

2.2 Knowledge Creation

The knowledge creation process in an organization takes place in ontological and epistemological dimensions, as illustrated in Fig. 4 [23, p. 57]. The epistemological knowledge dimension has been classified into tacit knowledge, which is personal, context specific and hard to communicate, and into explicit knowledge, which is transmittable in formal, systematic language and which can also be integrated into ICT systems and tools [23, p. 59]. The ontological dimension includes individual, group/team, organization and inter-organization levels [23]. The same dimensions, extended with inter-organizational have been the organizational dimensions in the integrated concept presented in this paper.

The knowledge creation process in organizations is an iterative, spiral process, in which knowledge is first created at the individual level and then crystallized as a part of the organizational knowledge network, as illustrated in Fig. 4 [23]. Organizational knowledge has also been defined in the strategic management field as knowledge stocks and knowledge flows. The organizational knowledge at a particular point in time can be defined as the "knowledge stock" which also represents intellectual capital in organization and organizational learning [24].

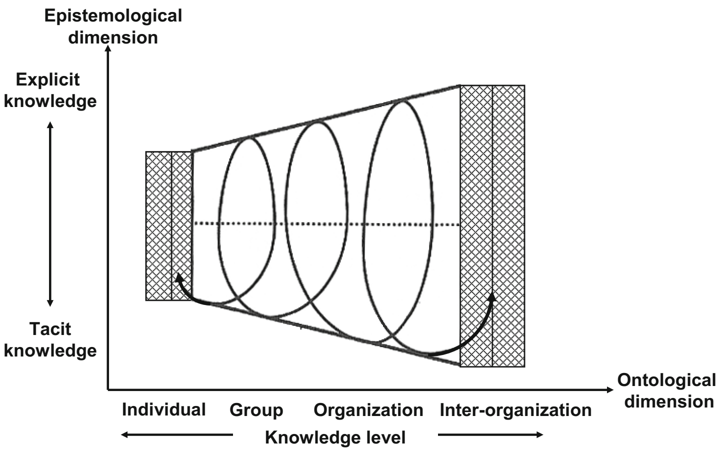

Fig. 4. Two dimensions of the knowledge creation process [23]

The organizational learning and the change in knowledge stocks depend on knowledge flows in the organization. These definitions integrate intellectual capital, organizational learning and knowledge management [24].

The strategy for knowledge transfer can be either knowledge codification or personalization. In codification the primary approach is to codify the organizational knowledge into different processes, systems and repositories. In the knowledge personalization approach, the primary mode for knowledge transfer is direct interaction among people. In most organizations, both approaches are normally needed, depending on the case.

2.3 Knowledge Processes in Organizations

The major knowledge processes can generally be represented as four sub-processes: knowledge scanning/mapping, knowledge generation, knowledge codification and knowledge transfer/realization [18]. The knowledge scanning and mapping process includes e.g. business and technology foresight, where potential new areas are systematically scanned. The knowledge generation process includes the processes of creation, capturing/acquisition and development of knowledge.

The knowledge codification process covers the conversion of knowledge into accessible format and the storing of knowledge. The knowledge transfer process includes the sharing of knowledge from the point of generation or codification to the point of using and applying it in an organization [18].

Nonaka (defined the goal for knowledge transfer in organizations as "tapping of tacit, highly subjective insights or intentions of an individual employee and making these insights available for the whole company".

Dixon defined common knowledge as the knowledge that employees generate in the act of accomplishing an organization's tasks in new and innovative ways [25].

3 Conceptual Framework of KMO and DL

Integrated framework combining knowledge management and deep leadership is presented in the Fig. 5. The ontological dimensions in framework are: individual, team/process, organizational and inter-organizational levels where both knowledge management and deep leadership processes take place normally. Four learning loops are the integrating mechanisms of KMO and DL in these levels. From strategy perspective, the key challenge is to effectively integrated and synchronize all these four learning loops for knowledge transfer, organizational development and change.

At *Individual level* the focus is in knowledge, skills and competencies which can be developed with personal feedback tools, competence profiles/maps, competence assessments and HRD tools (e.g. 70:20:10 model). Deep leadership aims to the full commitment of the cornerstones of DL (seen like shared practical values). The focus in learning is to confirm single loop learning which can be a challenge in complex and dynamic work environments having focus in troubleshooting and firefighting. The presence of the idea and practices of deep learning is vital.

At *team level* the focus is at development of cross-functional team and process capabilities which often are dynamic capabilities [26]. The learning process is based on double loop learning where the best practices of processes are systematically identified and improved. The DL is based on team level learning process. Understanding and using the unique personalities, personal skills and knowledge are the source of creative and motivating team processes.

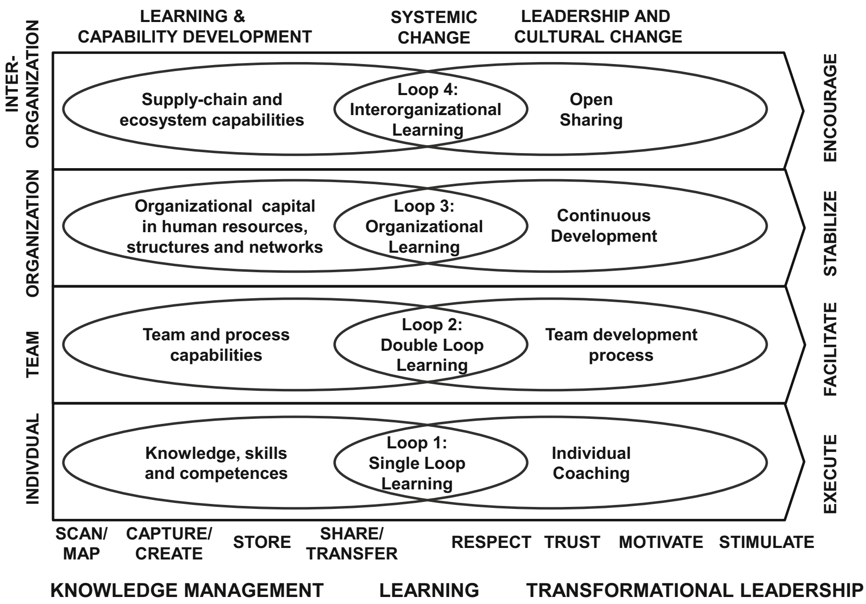

Fig. 5. Conceptual framework for knowledge management and deep leadership in organizations

At *organizational level* the focus of development is in organizational capital including human resources, organizational structures and networks. The learning process is organizational learning where strategic capabilities are identified and developed based on strategic targets. Deep leadership is focusing to continuous improvement of the leadership system and development of the culture.

At *inter-organizational level* the development of capabilities are focusing to business ecosystems or supplier network capabilities which often are complementing capabilities. The learning process is inter-organizational combining benchmarking and learning from the best partners. Deep leadership is focusing to create open interaction and accelerating open or semi-open innovation in supplier network type of organizational structures.

In the systematic organizational development and change these levels are the key areas when analyzing, planning and execution transformation programs. A typical challenge is that the focus in the programs covers mainly individual competences and team, organizational and inter-organizational aspects are neglected. Beyond this, the synchronization of these levels and the respective learning loops is mostly forgotten.

4 A Case Study: Product and Technology Transfer Projects

A case study focusing to transfer of complex technology knowledge from Finland to China is presented. This case explains and verifies the application of the framework in real life case projects. It also explains the relationship of deep learning, transformational leadership, and knowledge management.

Ramp-up of a new production unit in emerging market (e.g. in China) is both a *strategic and operational challenge* for technology companies [19]. Effective introduction of new products and technologies is a critical success enabler for business growth and the challenge is how to minimize the time needed to competence, production capability and time-to-profit development in ramp-ups.

The solution was to develop a systematic concept and toolbox for product and technology transfer projects with the following targets: (1) To develop competencies and capabilities to execute knowledge transfer projects, (2) To harmonize way of working in project management, (3) To transfer global know-how and best practices between geographical units in a systematic way and (4) To create a foundation for project, program, portfolio and risk management. The concept was used in product and technology transfer with the emphasis in systematic knowledge, competence and capability transfer from sending unit (a global unit already having the competence and know-how) to receiving unit (a new production unit e.g. in China or Poland where competencies and capabilities need to be developed). The major focus the concept was in the knowledge and competence transfer so all tools of deep leadership were not fully utilized. The focus in the leadership was in leading cross-border and cross-functional project teams both in sending and receiving units (Fig. 6).

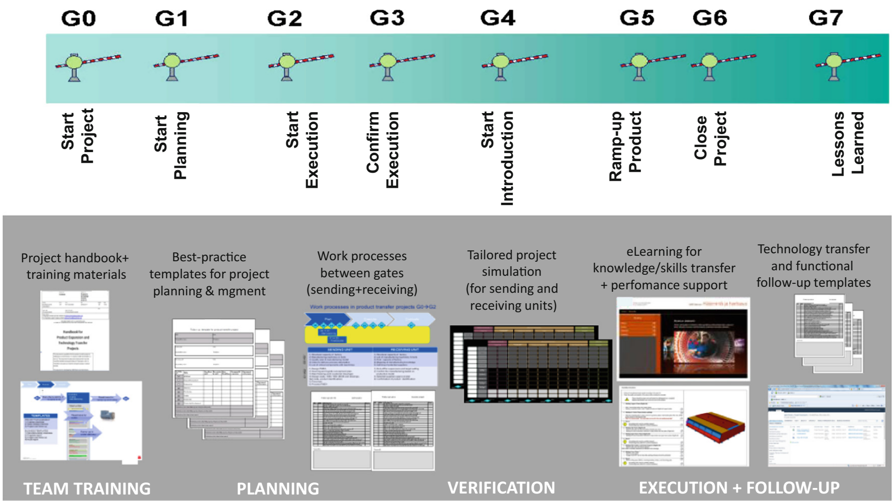

Fig. 6. Operational concept and a toolbox for knowledge transfer was based on stage-gate project model, knowledge and competence transfer tools (e.g. best practice eTools, simulations). The toolbox was used for knowledge transfer between sending and receiving units [27].

Typical Leadership challenges identified in product transfer projects are:

(1) Lots of different working cultures, local practices, roles and tools in different locations, (2) project teams have never used gate-model nor product transfer, (3) project teams and members are overloaded with other functional tasks and (4) there is a lot of undocumented tacit knowledge related to products and operations (Fig. 7).

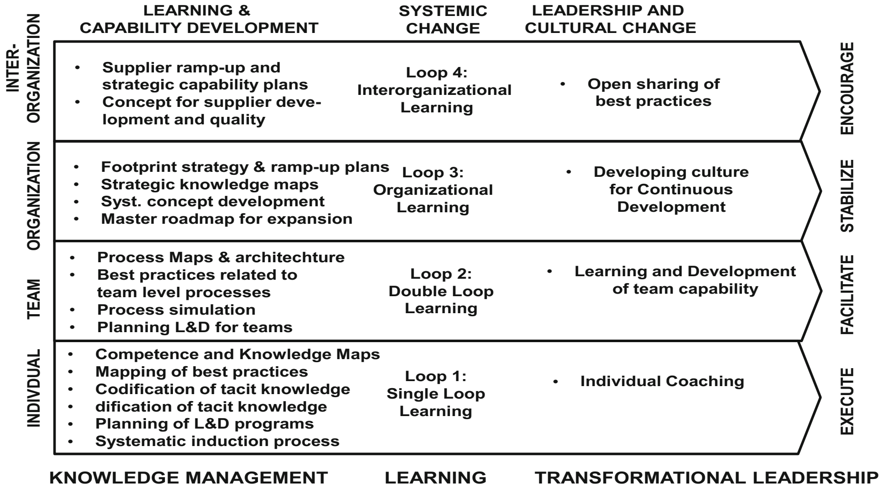

Fig. 7. Application of conceptual framework in product and technology transfer projects

In the case study the following business benefits were identified [27]:

(1) Individual level: faster time to competence and transfer of learning
(2) Team level: improved cross-functional collaboration and co-operation
(3) Organizational level: Critical risks could be identified and mitigated
(4) Organizational level: double number of projects could be implemented
(5) Inter-organizational level: improved ramp-up of local suppliers.

5 Conclusions and Future Recommendations

Concept created a common culture, understanding and way of working for the key project teams and people providing a platform for sharing lessons learned, best practices and know-how in cross-border teams [27]. In the long term a common model was developed for global production footprint expansions. As a future recommendation for technology transfer projects, bigger emphasis should be placed on knowledge transfer and competence development of local personnel both team and individuals but also the project leaders.

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Agile Coaching: The Knowledge Management Perspective

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Abstract. Currently, almost half of IT projects are managed in a traditional, sequential, plan-based manner. The leading development methods, successful for decades, are based on the so-called waterfall model. However, rapidly changing business environments push software development companies to adapt newer, leaner and more agile development methods. They promise development teams to welcome changing requirements, deliver software quickly and respond to new customer requests instantly. This is why transition to agile, mostly scrum-based development methods have been common lately. In order to avoid learning from their mistakes, companies usually seek help while adopting agile practices, related knowledge and experiences. Professionals, Agile Coaches, offer it.

This paper summarizes the rationale for adopting agile methods, the role of an Agile Coach in this area, and the knowledge needed and offered by Agile Coaches. The correct selection of knowledge management facilities is critical in this process; this is why we also present them. We present our own experiences as an example of a successfully executed coaching project. The outcome is rather interesting: A novel agile development method implies lowering the degree of ICT support in an application's development lifecycle. On the other hand, we managed to level up the communication between employees. As a result, general project-related knowledge increased.

Keywords: Agile software development · Agile Coaching · Agile adoption ICT support · KM support

1 Introduction

The agile manifesto [1] has almost reached full two decades since its introduction. In 2001, the manifesto was the result of years of efforts to introduce new approaches to the software engineering area as a response to faster changing requirements and growing demand for efficient software development. Several development methods appeared to implement manifesto ideas. They include XP (eXtreme Programming), Crystal, DSDM (Dynamic Systems Development Method), FDD (Feature-Driven Development), Scrum and others. Today, more than 70% of all agile methods are derivates of Scrum [7, 8].

At first glance, agile approaches seem to be a strong deviation from several decades of established process models based on strictly defined long-term plans, a clear

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sequence of activities, well-defined processes and roles of participants, etc. However, agility in practice also means a strongly regulated set of rules and methods that, by using engineering approaches, leads to fully functional, well-documented information solutions and services. Agile approaches are also not a magic wand that is capable of addressing a number of challenges within the development cycle, but merely an important tool for minimizing the risks associated with the size, cost, and quality of the final IT solutions and services.

For several years now, we know that, for successful agile methods introduction in companies, among other things, the key is in leadership support along with changing the mindset of involved employees. Today, many company leaders understand the many advantages of leaner developmental methods. Business agility has even become an indicator of company maturity.

Taking all this into account, it is not surprising that advocating agile methods and introducing them to daily routine at many companies is not considered as additional, unnecessary work. It is a full-time employment, namely Agile Coaching. It is insignificant if a company employs their own Agile Coaches in order to achieve agile transformation or simply hire external coworkers. In both cases, an Agile Coach is confronted with a need to analyze the current state of processes, current level of employees' knowledge on processes, current satisfaction and obstacles, as well as the advantages offered by current development practices. To sum up, agile coach have to extract implicit and explicit knowledge in order to propose and introduce a novel (or appropriately adapted) leaner and agile development method. During adoption of a new method, there are also many knowledge management-related issues. They are linked with educating employees, measuring their confidence in new methods and based on this to fit new methods to the target company. In this paper, we would like to give an overview of the Knowledge Management (KM) approaches that we used during our last Agile Coaching project. We also present some interesting observations on perceived knowledge level of involved individuals and how it corresponds with the level of using ICT.

The structure of his paper is as follows. In the next section, we give a brief overview on current state-of-the-art in Agile Coaching. We focus on KM-related issues, which every Agile Coach has to overcome. During the coaching process overview (Sect. 3) we firstly summarize the goals of Agile Coach. Before conclusion (Sect. 4) we present important points in our experience on the latest coaching project (Subsect. 3.2). The focus is on knowledge transfer, related to ICT support.

2 Agile Methods and Agile Coaching – Literature Review

Since two decades of agile methods consolidation [1] they have become mainstream. Companies employing agile practices are no longer considered to be "outliers", but rather companies of the norm. Newly emerging development teams primarily chose agile development methods for their practice [8]. On the other hand, more and more established companies try to incorporate new, leaner approaches completely od partially. A relatively new role of agile coaches emerged with their high demand for professionally executed transformation.

The coaching profession is relatively well-known and consolidated now. There are also specialized consulting companies and bodies of knowledge, specialized in Agile Coaching, e.g. the Agile Caching Institute [6]. In addition to offering their services, they also publish valuable information on both opportunities and threats while adopting agile methods. An example is also cited in this paper [2]: “Developing an Internal Agile Coaching Capability: A Cornerstone for Sustainable Organizational Agility”.

Authors, such as Sidky et al., promote their own approaches to adopting agile methods properly [3]: “A disciplined approach to adopting agile practices: The agile adoption framework”. They do not necessarily expect transition to be executed by Coaches. Another example is Gandomani and Nafchi in “An empirically-developed frame-work for Agile transition and adoption: A Grounded Theory approach” [5]. They provide a novel empirically developed transition framework to facilitate transformation. They also report empirical evaluation of the findings, and the theoretical and practical implications of them. The framework can also incorporate Agile Coaches, but they are not strictly required.

The area of coaching has also been exposed to research. O’Connor and Duchonova in “Assessing the Value of an Agile Coach in Agile Method Adoption” [4] explores the value of Agile Coaching for companies adopting agile methods. They base their research on Return On Investment (ROI) and conclude that there is direct financial value in using an Agile Coach for agile adoption.

3 The Coaching Process

3.1 The Goals of the Agile Coach

In order to implement agile transition successfully, companies usually hire Agile Coaches. They offer much more than just standing up and training some teams. Even with training, self-organized teams don’t just magically appear and hit their full stride. Just as important, organizations need solid Agile Coaches to help establish the deep, institutional capability required to become a truly agile organization. With a strong Agile Coaching capability, it would become possible to [2]:

- Enhance product delivery flow throughout an organization,
- Scale safely by ensuring that Agile Coach skills and gravitas are a match for a given team/program/organization,
- Ensure team performance,
- Create a sustainable agile capability that lasts long after key players move on,
- Reduce or eliminate reliance on external Agile Coach Consultants.

Agile Coaches are also a guarantee to avoid a situation where organizations or development teams pick only popular agile approaches to their daily routine, which can become a long-term obstacle. In addition, to avoid this ‘a la carte’ agile adoption and to do it properly, the coaching supported agile adoption process contains the following steps [3]:

- Set business goals (e.g. reduce time to market, reduce errors in production etc.),
- Choose (a) pilot project(s),
- Analyze the company's and project's characteristics (size, criticality, etc.) and
- current practices,
- Choose the method(s) to adopt,
- Choose the practices to adopt and their interrelation,
- Train the development team and the management,
- Start applying the chosen practices.

3.2 The Case - Practical Experience

Lately, we conducted an agile transition project in a medium-sized international development company. In addition to numerous offices around the world, they have several development divisions in four countries, including Hardware, System and Consumer Software divisions.

The three decades old heavyweight sequential development method showed many advantages to date and it enabled the company to prosper. However, since competition in every domain is growing, excellence, high adoptability and fast delivery times are becoming inevitably needed. This is why their management, with a strong bottom-up demand, decided to address issues which originate from rather outdated development processes. They performed it via renewing their existing processes on the one hand and in parallel, started to introduce an appropriate, tailor-made agile method to selected projects on the other hand.

Our role in this transition was twofold. Firstly, they asked us to design and introduce a tailor-made agile method with all their specifics taken into account. Secondly, we were in charge for coaching three selected projects in agile adoption and preparing teams to proceed on their own to spread the method all over the company – if the method would prove itself. We were involved in the transition for roughly one year.

We are presenting activities, transferred knowledge, supporting management facilities and lessons learned in the following subsections with focus on knowledge transfer and its methods and facilities.

Part 1: Developing an Agile Method. After initial meetings with development leads, intended to identify preliminary drawbacks in existing development processes and potentials for going agile, the activities began for selecting and potentially adopting an appropriate agile method. Before achieving general agreement on which agile method to choose as the basis and how it needs to be adopted, we organized two presentation and brainstorming workshops for key employees to clarify the ideas. The activities that followed were directed towards creating the best possible development method with common agreement. They are summarized in Table 1, which also shows involved deliverables and their types, and the knowledge that was transferred. For every activity we performed, we also show related deliverables to the customer and the knowledge associated with it.

Table 1. Activities, deliverables and knowledge transfer during agile method development.

Activity	Deliverable	KM facility involved	Knowledge prerequisite in the company	Knowledge transferred to/from the company
Review of methods state-of-the art & workshop #1	– Printed presentation – Digital presentation – Report on current methods usage	Internal documentation repository	Current development methods Current activities that address existing method issues	The range of methods Positives and negatives according to the company's domain
Systematic review of best practices in the industry	– Report on best practices – Presentation material (printed and digital) – Checklists on selecting practices	Internal documentation repository	/	Current best industry practices Practices that could work in the company
Designing and documenting the adopted agile method	– Initial version of the adopted agile method (report) – Presentation (printed and digital)	Internal documentation repository		Main ideas on the adopted agile method
Designing transition process	Transition presentation (printed and digital)	Internal documentation repository		Main ideas on how to start using the method
Workshop #2			Critical overview on practices	Current view in new method Critical responses Possible modifications
Designing and documenting camera-ready version of novel agile method	New agile development method (report)	Internal documentation repository		New development method: roles, meetings, handouts etc.

As shown in the Table above, we can see that creating a novel development method was primarily an incremental process. We started with a general method, combined with best-of-the-best approaches. After a few report and idea exchanges on Workshops we created, we agreed on the final agile method.

This paper is not about the method itself, but rather about introducing the method to the company and KM related issues. However, the content of the method also dictates which KM facility developers use, when, why and how. This is why we would like to summarize just a few KM-related aspects of the new method:

- Customer requirements are collected in the same repository as in the old method. However, we do not imply an advanced usage of the existing requirements repository – we simply consider it to be a digital representation of requirements.
- Managers do not monitor project progress via existing systems for managing tasks, but via personal involvement and communication on a daily and weekly basis with development leads and developers.
- Developers primarily use agreed over written information in order to complete their tasks.
- Development teams have the freedom to choose the method of managing their tasks that they agree on before the iteration.
- The team coordinate themselves weekly with a short meeting. They do it informally. Managers use simple spreadsheet documents to monitor shared functionalities.

With aspects that we mentioned, we would like to stress a very important shift in processes. We put IT-based KM facilities to the minimum. Even when we require it, involved people are (in the beginning) free to choose what and in which way they use it. On the other hand, we have introduced frequent, short and focused meetings where those involved exchange their ideas in person. Developers do it daily, development leads and management on a weekly basis. One could say we exchanged high usage of KM facilities with more focused communication in order to increase knowledge flow during development.

Part 2: Agile Coaching. In addition to designing and documenting a novel agile development method, they also invited us to help with its introduction. This is to perform Agile Coaching to the point, where company employees could spread the word on their own. This is why we were with developers in person for several months – in the beginning several times during the week in every development team, later just occasionally.

Before coaching three typical projects (involving several in-house, abroad and outsourced development teams – from both System and Management Software and Hardware Development divisions), we performed several short focused hands-on Workshop sessions in order to introduce novel approaches. Involved employees welcome some approaches (e.g. more focused work on new functionalities, less bureaucracy), but some approaches raised a lot of distrust (e.g. using a pair of scissors, pen and paper for planning a week to come). We overcame most of the dilemmas by working together. On a weekly basis, we measured satisfaction and perception of changes. Based on this, we also altered the method to reflect gained experience. Table 2 summarizes activities that we performed for several months during the coaching period.

Table 2. Activities, deliverables and tools, used during the coaching.

Activity	Deliverables/tools involved	KM facility involved
Presenting different aspects (developers, QA, managers) on the method – several workshops	Presentation (printed and digital)	Internal documentation repository
Facilitating project planning meetings	Printed meeting roadmap	/
Facilitating team planning meetings	Printed meeting roadmap	/
Facilitating team coordination meetings	Printed meeting roadmap	/
Facilitating demonstrations	Printed meeting roadmap	/
Measuring developers and managers' satisfaction with process changes	Online questionnaire	Questionnaire repository (Google forms in our case)
Reporting the progress	Report on activities, method perception and proposed improvements	/
Adopting the method as needed	Development method with approved improvements	Internal documentation repository

We also show in Table 2, that we minimized our distant, virtual cooperation while coaching. We rather involved ourselves in personal contact with people, practicing the novel method. However, it is clear that we were not present at all teams in coordination sessions, which usually took place as an online conference calls.

In Table 3, we would like to stress which KM facilities (namely Application Lifecycle Management, Requirement Management etc.) were used heavily by employees, regarding the new method.

Table 3. Activities, deliverables and tools, used by development teams.

Activity	Deliverables/tools involved
Gathering requirements	Existing system for managing requirements –content-related functionalities (estimates, progress etc. are left blank)
Planning project – current iteration	Spreadsheet for monitoring progress of selected high priority functionalities
Planning iteration	Selected method for managing tasks – we encouraged teams to use physical kanban table
Daily development	/
Coordinating teams	Spreadsheet for monitoring progress
Demonstrations	Existing system for managing requirements, Spreadsheet for monitoring progress

In Tables 2 and 3 we demonstrated how little knowledge management solutions are used in the new method. However, it supports sufficient knowledge transfer from content workers to developers while it also enables a strong digital trace on what was going on during the development.

During the coaching process, we transferred knowledge and practices to employees that uses them on daily basis successfully. In order to be sure that we are on the right track, periodically we measured employees' perception, satisfaction and subjective productivity via questionnaires. We would like to give an insight on changes during the coaching by exposing some data from the last questionnaire. Some questions were general, some questions compared the old development method with the new one, and the last questions were on subjective thoughts, if and what would be good to change. We will make a rationale on results in the Conclusion Section. Figure 1 shows the developers' perception on how they understand requirements, compared to the old development method. An important shared of involved employees shared their perception that it had improved. Figure 2 demonstrated several communication-related improvements (with Quality-Assurance, with other teams and overall). Figure 3 shows that the majority of employees can now focus their work more towards developing new features. Figure 4 is rather surprising, which says that developers like physical boards

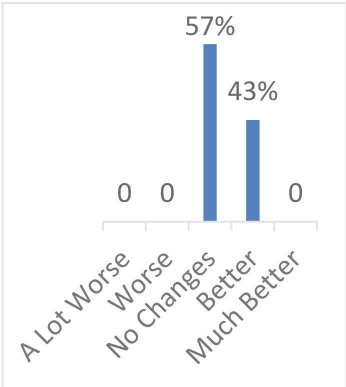

Fig. 1. How did the understanding of the requirements change?

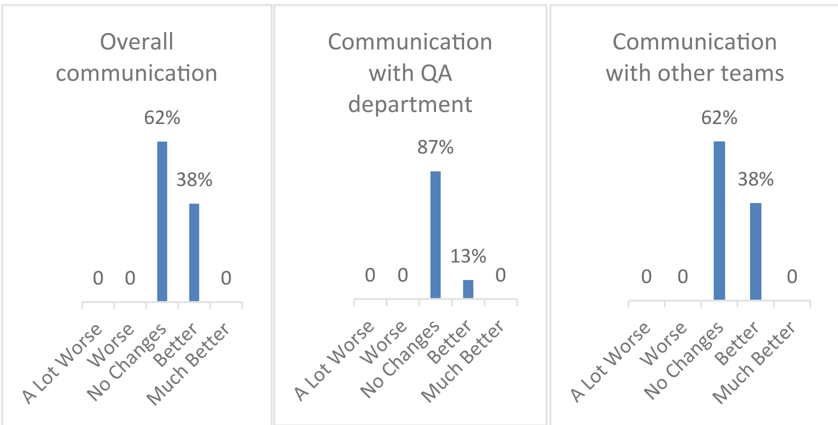

Fig. 2. How did the communication change?

more than digital versions in Jura, YouTrack etc. At the beginning, there was a huge resistance to “childish” tools like the physical kanban board.

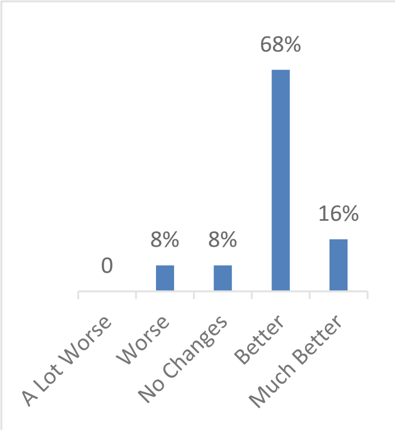

Fig. 3. How did the focus on work change?

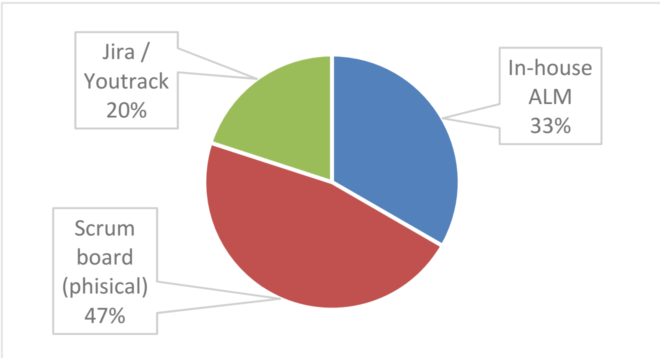

Fig. 4. What facilities do you like to manage project-related daily tasks?

Part 3: Fine Tuning After Coaching. Based on the proposed, introduced and during coaching, adopted agile development method, we prepare some final resources in order to accelerate company-wide method introduction. They include several documents:

- Simple-to-follow roadmap on project meetings,
- Checklists for every meeting,
- TODO lists for every project role,
- Frequently Asked Questions (FAQ) and lessons learned from three pilot projects,
- A set of possible KPI (Key Performance Indicators) metrices for reporting project health and progress to management.

During the coaching activities, employees also upgraded their internal application lifecycle management software to meet all new method requirements. They include a simplified requirement to solution tracking, online kanban boards and support for task estimates. Developers really started to like the physical Kanban board, but in order to meet management requests to report project KPIs easily, they decided to introduce a digital version of the boards with features like automatic measuring progress. Those are also used now by the Quality Assurance team to adjust their testing activities with development ones. Documenting teams also use the same tools in order to integrate their work with development. This is why we can state that the novel development method captures the process from requirement analysis until production-ready solution.

4 Conclusions

In this paper, we summarized the rationale for adopting agile methods, the role of an Agile Coach in this area and knowledge needed and offered by Agile Coaches. If we sum up our own experiences, we can do it by observing the results of questionnaires (some of the most representative are shown in Figs. 1, 2, 3 and 4).

What was proved in practice is the following: The new method really sidelines numerous KM facilities in the company. However, it brings development teams and permanent focused communication to the center. As a result, despite lowering traditional KM activities, we can see a major shift towards increased knowledge flow in the project, and increased project-related knowledge in every single individual. One could argue at this point, that people generally dislike (too many) ICT support in the project, as long as understanding the goals is not a problem. Obviously having proper communication, where possible, can be an even better option than ICT-supported KM facilities. However, we always need a lot of small, but yet important amount of digital support. They include easy-to-follow roadmaps, checklists, live FAQ and lessons learned documents and others. We would also like to stress, that it is not our intention to state that KM facilities, a lot of documentation, and a large digital footprint of development activities are necessarily a bad thing. It depends on the nature of the project and, importantly, the people involved. In some cases, our approach might not work – for those cases the company also preserved the traditional method, proved over decades. It will be used in projects where the novel agile method would not, judged by people involved, give appropriate results. This also aligns with the trend in so-called bimodal development companies, which combine traditional development approaches in one set of projects, but like to employ agile, leaner methods where applicable.

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Knowledge Communication Model: Malaysian Public Service Phenomena

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Abstract. Malaysian Public Service (MSP) is moving towards efficient citizen-centric and focus on enhancing productivity through a whole-of-government approach supported by a lean and agile organization, competent talent, effective delivery of projects, and efficient services of the local authority. In addition to that, to determine the right direction especially for Information and Communication Technology (ICT) thrust strategy is also one of main concern. Thus, common perceptive between Information Technology (IT) experts and decision makers are essential to ensure for high-quality decision making and coordinated organization achievement. The knowledge integration between IT experts and decision makers is crucial, must well-communicate and comprehensible by both parties. Through the initial study, the phenomena and challenges on knowledge communication process in MSP can be clearly understood.

Keywords: IT experts · Decision makers · Knowledge communication Malaysian public service (MSP) · ICT projects

1 Introduction

Knowledge is certainly important in the era of globalization and Knowledge Management (KM) has extensively covered the significance of knowledge in the organization. Knowledge also plays a huge role as one of the elements in decision making process to all organizations [1]. An organization is a body that consist of various individuals whose responsibility and different functions to reach common objectives. According to Davenport et al. [2] knowledge is defined as high-value resources where it is a combination of information which consist of experience, analysis, opinion and surroundings that would be prepared to apply for decisions and further activities. With suitable support system, KM also plays a critical role in development of sustaining organizations competitive advantages [3]. As stated by Clark [4], KM is based on the idea by Nonaka [5] of 'spiral process' theory movement between explicit and tacit knowledge. However, since the increasing interest of Project Management (PM) occurring simultaneously with KM as a rising field, therefore a suitable understanding in Knowledge Management Body of Knowledge (KMBOK) would facilitate in managing

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knowledge as the most useful resources in the organizations. Donovan [6] stated that KMBOK consists of four elements which are Knowledge System Knowledge (KSK), Project Management Body of Knowledge (PMBOK), Leadership and Managerial Knowledge (LMK) and Organizational System, Structure and Process Knowledge (OSSPK). These elements are referred as it complements KMBOK in terms of organizational social, cultural, skills, tools and knowledge of managers to achieve organizations' mission and vision.

However, KMBOK and PMBOK are two divisions of management that are interconnected in both practical and theoretical ways [7] but harmonize with each other. The PM requires managing knowledge and KM is an essential for PM to process including human resources, technical and socio-cultural while PMBOK consists of integration management, scope management, time management, cost management, quality management, human resource management, communication management, risk management and procurement management are all sensible components of KMBOK [6, 8]. This coincides with studies by Yaacob et al. [9] that achievement of organization target depends on two main elements which are humanity and non-humanity. Leadership, expertise and commitment to work are a few examples of humanity elements while processes, policies, technologies and equipments are non-humanity elements. Hence for any organization to maintain establish and competitiveness, both elements (humanity and non-humanity) must collaborate and complete with each other and finally work as an excellent team. Ever since knowledge plays crucial part in an organization, dealing with the knowledge requires creation, communication and sharing within and between different areas. Thus, for an ICT project management goes efficiently, a suitable decision making during project initiation is highly crucial. According to Eppler [10] *the success and outcomes of an organization is closely related to strategic capabilities in knowledge communication whilst accomplishing decision making process*. Observations and opinions from experts are commonly required in almost all fields, in general to develop the understanding of any situation [11].

As in the context of Malaysian Public Service (MSP), the expanding of public expectations towards service deliverables is in the respond to energetic population and technology trending. Consequently, the ability and strategic thinking are required to generate high-performance results other than capability to produce suitable planning in order to construct establish direction of the organization. As it is notice, process of communicating the expert knowledge is the most effective and efficient transfer of experiences, opinions, views and skills among experts and decision makers. Knowledge communication is further than just communicating information or emotions such as facts, figure, hopes, commitment and others because it requires expressing perspective, basic hypothesis, personal opinions, experiences and background of situation. According to Eppler [10] *knowledge communication can be viewed as the (purposeful) activity of interactively conveying and constructing insights, assessments, experiences or skills through verbal and non-verbal means*. In term of Information and Communication Technology (ICT), since many applications or projects will be developed soon in Malaysia and one main standard shall be produced in order to ensure that it is world's class quality, an exploration on how the development of MSP ICT projects is one of interesting area to look into [12]. Therefore a suitable knowledge communication model is compulsory for organizations to produce the best product in their field. This is because according to [13] the IT experts and decision makers are members of a group responsible for making decisions and planning future direction of the organization, hence the failure of ICT projects must not only be imposed and settled on ICT and technical side but on the other hand decision makers should be proactive in identifying issues ranging from the decision making level for the planning, implementation to monitoring of ICT projects. Knowledge communication as a whole requires not only the information but personal experience and opinion too. It is usually more than communicating the information (e.g.: graphs, charts, figures etc.) or emotions (e.g.: annoyance, amazed, sleepy etc.) because it requires conveying text, background and basic assumptions [10, 14]. Although the trend of knowledge communication has been going on for quite some time in many organization but it is still new in the world of academic research learning. Thus, the aim of this paper is to discover knowledge communication process in Malaysian Public Service (MSP).

In order to do that, an initial study was conducted for clarification in understanding knowledge communication process. The initial study was performed by interviewing with three participants that have experience with ICT project in MSP. Subsequently, literature analysis was conducted to identify factors and challenges in knowledge communication. The following sections are organized as follow; Sect. 2 discusses on methodology applied. Section 3 then describe on analysis of the findings and discussion of the study. Finally, Sect. 4 concludes and provides recommended scope for future research.

2 Methodology Applied

A qualitative method was adopted, which consisted of three phases as follows.

2.1 Literature Review

Initially, literatures were identified by using the search keyword of knowledge communication using the search keywords from four electronic libraries (ACM Digital Library, Springer Link and SCOPUS). The topics covers from different fields such as Computer Science, Social Science, Medicine, Engineering, Business, Management and Accounting, Nursing, Arts, Mathematics, Decision Science, Education and Psychology. From there, any duplication on the title of articles and DOI will be removed for further review. After that, the filtering process on title and abstract. However, the searching was expanding through a manual search from Google Scholar database and "snowball" concept by Handcock and Gile [15] was applied as this is to ensure that all the literatures that are not indexing in any digital libraries will be handled as well.

2.2 Initial Study

The next phase was a series of semi-structured interviews conducted with three participants involve in ICT project in Malaysian public service. The participants were selected according to purposive sampling strategy by Patton [16]. According to Patton

[16], the information-rich qualitative data, analysis and interpretation would enable to study the case in depth and capability to learn about issues to the purpose of inquiry. The evaluation intends to observe the decision making process in a natural way. Details of the selected experts are listed in Table 1.

Table 1. Characteristics of the participants

Criteria	Participant	Designation	Years of experience in ICT projects	Length of interview session
• Professional/ Managers/ Executives • >5 years working experience • Involve in ICT project	P1	Deputy Secretary General	10 years	45 min
	P2	Senior IT officer	12 years	1 h
	P3	Principal Assistant Secretary	5 years	50 min

The processes involved in this phase were preparing the interview sessions that included the interview schedule and interview guide. The topics outlined in the interview guide were: (1) the scenario in knowledge communication between IT experts and decision makers in Malaysian public service, and (2) the issues and challenges in knowledge communication. The respondents were interviewed face-to-face and follow-ups were conducted via email and other communication tools. Each session was manually recorded and taped.

2.3 Analysis and Conclusion

Results from the literature review and initial study discussed. Thematic Analysis (TA) by Braun and Clarke [17] is applied for identifying and analyzing patterns on data collected.

3 Findings and Discussion

The result from the document analysis and initial study interview session are concluded in Table 2 whilst the situation of knowledge communication process in MSP is presented in rich picture concept as in Fig. 1.

Further explanation on the issues and challenges are as follows:

3.1 Cognitive Biases

A cognitive bias is a type of error in thinking that occurs when people are processing and interpreting information in the world around. In this collaborative situation, the four types of cognitive biases (self-serving biased, cognitive fluency, sunk cost fallacy and confirmation biased) will become more dense and cloud the judgment since each of

Table 2. Knowledge communication challenges

Knowledge communication challenges	Authors	Initial study in MSP		
		P1	P2	P3
Cognitive biases	[10, 14, 18–20]	X	√	√
Communication biases	[10, 14, 21, 22]	X	√	√
Argumentation fallacies	[10, 14, 23]	√	√	√
Set-up to fail syndrome	[10, 24]	√	√	X
Common knowledge effect	[18, 23, 24]	√	√	√
Lack of common ground	[24–26]	√	√	√

the users has their own cognitive bias [20]. According to Eppler and Mengis [14, 24] cognitive biases may cause knowledge incorrectly interpreted due to one side only. This will lead to the conflict when each of the users relies on their mental model and bases on their own cognitive biased [19]. P2 mentioned that:

> "*It is hard to convince the top management as they would only listen to those whom they always communicate compare to us the technical team*".

Therefore, it is essential to address the need to communicate the knowledge integration that handle the variety of people's function, roles, knowledge and social backgrounds.

3.2 Communication Biases

Communication biases occurred when the knowledge is influence during communication through audience tuning, misattribution bias, saying-is-believing effect and shared reality. Higgins et al. [27] mentioned that a good communication is when the communicator takes the audience into account whilst constructing the message. According to Echterhoff et al. [22] and Eppler [10, 14] audience tuning is a process of tuning the message according to the audience's characteristics. Therefore the transmitted messages are affected together with the judgement and knowledge. While on the other hand, misattribution bias refers to the message rather than the audience's characteristics. P3 point out about this:

> *"The IT expert tends to describe technical item without knowing how other members in the meeting being clueless about it and often the boredom environment fills in the meeting room".*

Shared reality acts as establishing the reliability of an experience and collective identity between communicator and audience [21]. It allows people to elaborate on the description and highlight selective information, forming a corroborative structure and effectively increase the scope of discussion involved. Another communication bias occurred when saying-is-believing effect on auto-persuasion has stronger side. For an example P2 mentioned that the IT experts should have an appealing character in order to facilitate all matters when obtaining the ICT project approval.

3.3 Argumentation Fallacies

During explaining or demonstrate the new ideas, people tend to disagree rather than knowledge claim such as over-generalizing the topic, engaging to false majorities or false expertise, interpreting and assessing too much or reacting with direct attacks at a person rather than at a knowledge claim. A study conducted by Cetintas and Ozupek [23] revealed to overcome the uncertainty, any statement difficulties that caused misunderstanding and incoherence should be discarded. The difficulty to get an overall picture which complexity of any issue is suppose to be simple and accurate enough to be significant; and lack of skills to deal with conflicts constructively between IT experts and decision makers. On the other hand, P1 stated:

> *"Decision makers should be proactive in identifying issues ranging from whether the decision making level for the planning, implementation and monitoring of ICT projects".*

3.4 Set-Up to Fail Syndrome

A study by Mengis and Eppler [24] stated issues on self-fulfilling prediction and de-motivating opinion to the expert when decision makers are projecting their initial expectation of an expert's performance such as misses dateline that may lead to lower performance. However, the compatibility between decision makers and experts based on resemblance of attitudes, social characteristics and education backgrounds can have significant impact on decision makers' impressions. As result of this when the experts suggest new proposal to the decision makers, regularly it will get discarded due to this syndrome.

3.5 Common Knowledge Effect

As mentioned earlier, common knowledge effect happened when the group only to agree on commonly shared pieces of information rather than unique or new knowledge. To several other groups, there is a person who do not accept outdated and do not want to update the knowledge themselves. These people have agreed on existing knowledge and reluctant to acquire new knowledge [23]. Therefore it is difficult for the experts to propose the new technology in ICT projects as there is common knowledge effect is valid in the meeting.

3.6 Lack of Common Ground

Common ground refers to the decision makers and experts make assumptions according to their background principle. According to studies by Carlile [25] if those assumptions are wrong or inconsistent, possibility of difficult communication will happen. As mentioned by P2 and P3, with people's different background, scope and diversity of the various specialties of ideas it is difficult to understand as a whole when the integration is carried out between various domains of knowledge. Since P2 mentioned:

"When IT experts and decision makers discuss on particular issue without proper guidelines they will construct an overall picture of the issues based on their own understanding".

Whilst P3 also stated:

"The uncertainty and confusion between IT experts and decision makers in the establishment of a comprehensive project overview will lead to actions that deviated in the phase of analysis and subsequent synthesis".

Recent study by McKinley et al. [26] revealed the processes of forming common ground help to assist the present communication but it also promotes a stable record of that event besides facilitating conversation into the future.

Based on an initial study shows that there are knowledge communication difficulty occurred between IT experts and decision makers. The IT experts and decision makers as mentioned by P1 and P2 are members of a group who responsible for making decisions and planning future direction of the organization and in this context is Malaysian public service. Hence the failure of ICT projects must not only be imposed and settled on ICT and technical side. According to all participants (P1, P2 and P3), as the Malaysian government has released most of the allocations for ICT projects it is expected that output/outcome must be equal to money invested. As indicated by P1 and P2, in Malaysian Public Service effective IT steering committee contributes in developing and maintaining organizations' ICT projects management and infrastructure facility. In Malaysian public service, the ICT projects were decided during a steering committee meeting. In order to visualize the situation of knowledge communication process, rich picture concept is applied (please refer to Fig. 1).

Rich picture is a tool for reasoning about work content and originated in the Soft System Methodology (SSM) in 1972 [28]. SSM is to understand human activity in a way that is meaningful to the actors in that system. Rich pictures are generally constructed by interviewing people [29]. The rich picture provides classify and reasons about all the information given by users. It will point to places where to find out more or noticeable challenges in the process. The rich picture consists of structure, interrelationships and the concerns. The structure element refers to aspects of the work contexts that slow to change such as organizational hierarchy of a firm, geographic localities and physical equipment. It includes all the people who could be affected by the introduction of the new system. The interrelationship refers to the transformations happen while doing the process. The transformations might consist of supplies, documents and data/information while concerns or issues [28] is referring to ideas of an individual's motivation. The advantage of using rich picture is the ability to review back with people who have given the information.

Figure 1 shows the knowledge communication process happens in almost all situations and as per validated by all participants (P1, P2 and P3) the communication difficulty between IT experts and decision makers occurred along the process. This initiation glitch may interrupt the flow of ICT project and contribute to the increase of project cost.

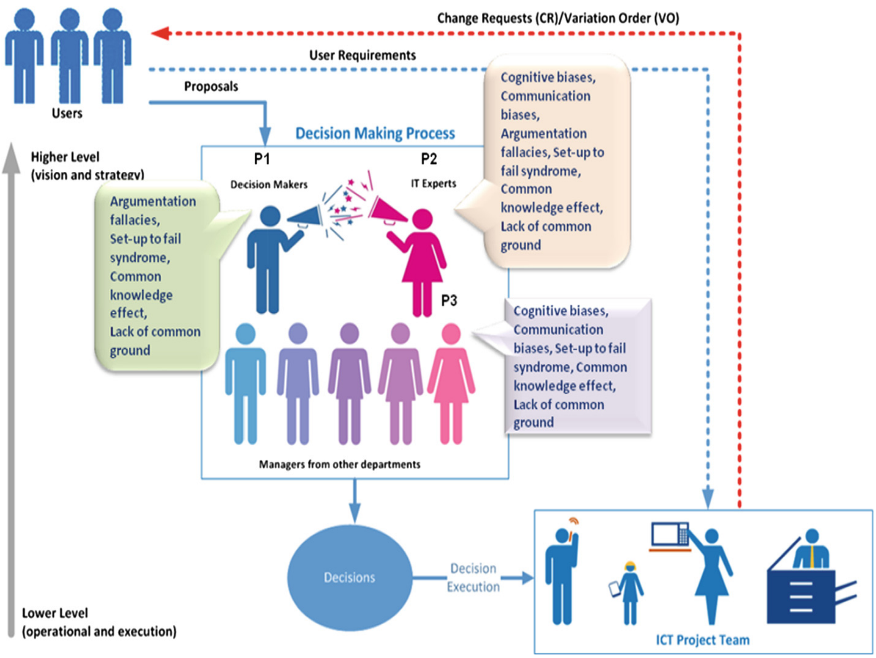

Fig. 1. Scenario of knowledge communication process between IT experts and decision makers

4 Conclusion and Future Works

This paper presents the findings on knowledge communication process within the ICT project in Malaysian public service. The research identified that by having granularity points from literature review as to develop a strong basis and at the same time develop a deeper understanding about why and how the problem became more detailed in the knowledge communication particulars. Then, by semi structured interview, each of the challenges has been verified and furthermore, we enriched each of the points by gaining deeper understanding about how it gave impact and consequences in the real tasks settings. Eventhough, the knowledge communication challenges that have been described by real organizations demonstrated similarity to the set of challenges from the document analysis. Hence, the challenges have been described in more details and a deeper perspective especially on the impact and the consequences of the challenges towards the value and quality of the knowledge communication outcomes. Based on result, IT experts are having problems with explanation of their findings to the decision makers.

With different individual backgrounds, extensive scopes, and diverse ideas, it is difficult to grasp the big picture, especially when the integration is carried out between various domains of knowledge. Therefore further study on factors and challenges should be carried out as case study in Malaysian public service. A conceptual model development is also highly recommended for respective authorities to take effective measures to improve knowledge communication situation in their organization.

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Knowledge Sharing

A Meta-analysis of Knowledge Sharing in Virtual Communities: The Moderating Effect of Membership Types

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Abstract. The willingness of individuals to share their knowledge in a virtual community has become an important issue for community success. However, when exploring the question "Why are people willing to share their knowledge with others in virtual communities," it appears that there are many inconsistent results, which include positive, negative, or no effects at all. Thus, it is necessary to conduct a meta-analysis to summarize the varied outcomes of relevant research. This study analyzed a total of 63 papers (including 52 journal papers and 11 conference papers) reporting empirical studies selected from several well-known databases, including ABI/INFORM, Business Source Premier, Elsevier ScienceDirect, Emerald, JSTOR, and Wiley InterScience, published between 2002 and 2016. These papers extensively discussed critical factors affecting knowledge sharing by members of virtual communities. Intrinsic and extrinsic motivations (such as reputation, reciprocity, altruism, and knowledge self-efficacy), social-capital factors (such as social interaction, interpersonal trust, identification, and shared languages) and knowledge-sharing outcomes (such as intention, behavior, quantity, and quality) were considered. Membership types (all members versus contributors) were used as a moderating variable. The relevant analysis was conducted using Comprehensive Meta-analysis Software. Results show that membership types play an important role as they moderate or restrain relationships based on certain knowledge-sharing variables. Our findings provide a knowledge map for conducting relevant academic research, and we provide more specific suggestions to virtual community moderators and administrators.

Keywords: Meta-analysis · Virtual communities · Knowledge sharing
Knowledge contribution

1 Introduction

In a Web 2.0 environment, there are various ways to bring people together through networks, allowing individuals to share their knowledge and personal experiences, and to acquire knowledge from others. Typical applications include blogs, social networks, communities, forums, and content aggregators. A virtual community is a collection of society that emanates from virtual space with sufficient people, sufficient interpersonal

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emotions, and sufficient interpersonal relationships, and which develops on the internet over time [1]. A virtual community provides a convenient platform for users to search for, or contribute, their knowledge. The online environment also allows users to turn to different virtual communities with a simple click. There has been an accumulation of studies on issues of knowledge sharing in virtual communities. However, many studies have contributed inconsistent results of "why are people willing to share knowledge to virtual communities."

For example, some studies found that economic reward has a positive effect on knowledge-sharing behavior [2], but other studies found no effect at all [3]. Inconsistent results have also been reported on the trait of reputation. For example, some studies found that reputation has a positive impact on the quantity of knowledge sharing [4, 5], but other studies found that it has no influence at all [4, 6]. Several studies have shown inconsistent results regarding reciprocity. Some studies found that reciprocity has a positive impact on the quantity of knowledge sharing [4, 5], other studies reported a negative impact on the quantity of knowledge sharing [7], and still other studies found that reciprocity has no influence at all [3, 8]. These research studies explored different knowledge-sharing outcomes (i.e., knowledge-sharing intention, knowledge-sharing behavior, knowledge-sharing quantity, and knowledge-sharing quality).

A meta-analysis, a research method for combining the primary results from similar research topics, estimates effect size. The effect size represents the degree of strength between variables, and we used effect size to find the strongest relationships between our variables. The scope of this study includes candidate papers relating to knowledge sharing in virtual communities from 2002 to 2016. Intrinsic and extrinsic motivations (i.e., reputation, reciprocity, altruism, and knowledge self-efficacy), social-capital factors (i.e., social interaction, interpersonal trust, identification, and shared languages), knowledge-sharing outcomes (i.e., intentions, behaviors, quantity, and quality), and membership types (i.e., all members and contributors) were considered as study variables. This study searched through several major academic databases, including ABI/INFORM, Business Source Premier, Elsevier ScienceDirect, Emerald, JSTOR, and Wiley InterScience. We used certain keywords to search candidate papers, including "knowledge sharing," "knowledge contribution," "information sharing," and "information contribution." Candidate papers were only included in our meta-analysis if (1) they were empirical studies with correlation coefficients, (2) their research topics were related to knowledge sharing or knowledge-sharing contributions in virtual communities, and the research variables were consistent with our study variables, and (3) the sample size had been reported.

2 Literature Review

2.1 Intrinsic and Extrinsic Motivators

Deci [9] points out that individual motivations can be classified into two characteristics, i.e. intrinsic motivation and extrinsic motivation. Intrinsic and extrinsic motivations are critical factors affecting human behavior [10]. An individual is intrinsically motivated when he or she performs a specific action or activity without external reward, but performs it for obtaining pleasure, satisfaction, or happiness. Pleasure and satisfaction can also come from intrinsic motivations [11] such as enjoyment in helping others (altruism), or self-challenge. In contrast, individuals are extrinsically motivated when they are performing specific behaviors to achieve a goal [11]. Extrinsic motivations are activated by extrinsic factors, such as reward, punishment, threat, promise, social status, or reputation. An individual who is intrinsically motivated may change their actions or create different results compared to when they are extrinsically motivated [12].

2.2 Social-Capital Factors

Social capital emphasizes the resources that arise from relationships between individuals and organizations and includes factors such as group identification, behavioral norms, and interpersonal networks. Social capital influences both the individual and the group. Therefore, social capital is composed of several characteristics, including network relationships, interpersonal trust, and social norms, and these characteristics can make participants cooperate with others more effectively in the pursuit of common goals.

Nahapiet and Ghoshal [13] defined social capital as consisting of three dimensions: (1) A structural dimension focuses on the appropriate embedded relationships and relationship networks, and these kinds of relationships exist either between individuals or between groups. Furthermore, the linkage styles that exist within the structural dimension can be divided into three aspects: network ties, network configuration, and appropriable organizations - that is the networks created for one purpose that may be used for another [14]. (2) A relational dimension refers to the interpersonal relationships that people develop over time. It is the core dimension of social capital in that special relationships, such as friendship, respect, and trust, are built through interactions, which then further reinforce people’s behaviors and the accumulation of social capital. Relational dimensions include aspects such as trust, norms, obligations and expectations, as well as identification. These four factors are especially important as they boost relationships between individuals. (3) A cognitive dimension refers to the development of a shared language, a shared code of conduct, and shared narratives between the members of the social network. It helps all members gain a better understanding of one another, and facilitates the discussion of important issues, communication, assistance, and knowledge sharing.

2.3 Types of Virtual Community Memberships

In terms of classification of virtual community memberships, Ridings [15] define “contributors” as the major producers of community contents as they often post knowledge to the communities [6]. Taylor [16] defines “contributors” as the people who post an above-average number of articles and who visit communities regularly. Preece et al. [17] define “lurkers” as the people who regularly participate in the activities of the community but seldom post articles. Kollock and Smith [18] describe "lurkers" as free riders, referring to those who ask a few questions but never provide direct answers to relevant questions, collect information from the community but never transfer information to other members, or those who read ongoing discussions of topics but do not contribute to any issues. In summary, member types can be categorized as contributors, lurkers, and community members. Contributors refers to those who have experience of knowledge sharing already. Lurkers are the ones without any knowledge-sharing experience, or the ones who share knowledge below the average level. Community members refer to all the members of a community within the sample studies, regardless of their knowledge-sharing experiences, and hence, includes both contributors and lurkers. In our study, we distinguished between contributors (those with knowledge-sharing experience) and all community members (all members, with or without knowledge-sharing experience). We could not include lurkers since such sample studies are rare.

3 Research Methodology

3.1 Research Model

Figure 1 and Table 1 show the research model and the definitions of the research variables.

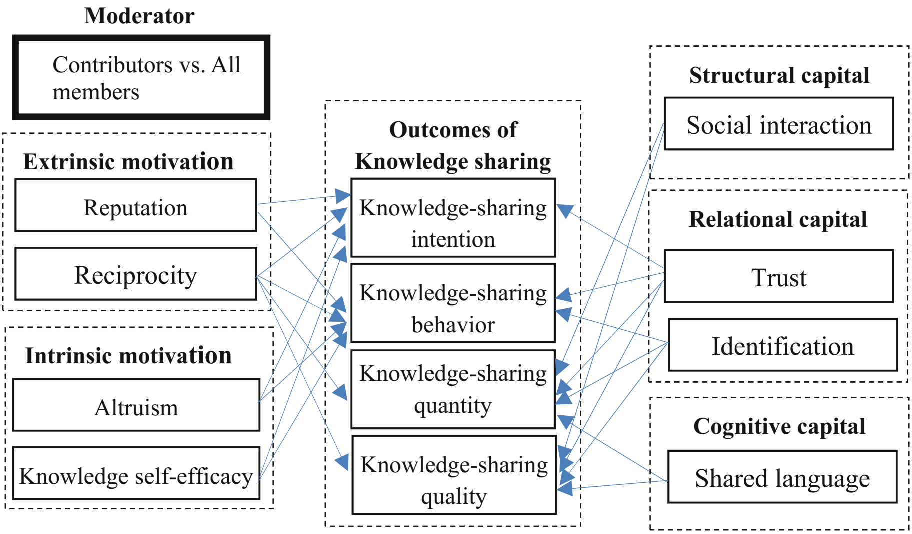

Fig. 1. Research model

Table 1. Variable definitions and references

Variables	Definition
Reputation	The perception that contributing knowledge will enhance one's reputation and status in the profession [7]
Reciprocity	The perception that current knowledge-contribution behavior leads to future requests for knowledge being met [19]
Knowledge self-efficacy	The degree of confidence in one's ability to provide knowledge that is valuable to others [2]
Altruism	The perception of pleasure obtained from helping others through knowledge contribution [20]
Social interaction ties	The strength of the relationships, the amount of time spent, and the communication frequency among members of virtual communities [5]
Interpersonal trust	The degree of belief in good intent, competence, and reliability of members with respect to knowledge sharing and reusing in virtual communities [21]
Identification	The perception of similarity of values, as well as membership in, and loyalty to, the virtual communities [22]
Shared language	Participants understand each other and build common vocabulary in their domains, enhancing the efficiency of communication between people with similar backgrounds or practical experiences [5]
Knowledge-sharing intention	The degree to which one believes that one will engage in a knowledge-sharing act [23]
Knowledge-sharing behavior	The voluntary act of community members to make information available to others [19]
Knowledge-sharing quantity	The frequency with which virtual communities share knowledge [5, 7]
Knowledge sharing quality	The extent to which the knowledge shared within virtual communities is helpful and useful [5, 7]

3.2 Steps for Conducting the Meta-analysis

The most important aspect of a meta-analysis that we wished to explore is that of effect size. There are a number of practical and widely-used methods to study effect size [24–26], and we conducted the following four steps in our meta-analysis:

Research Design. First, we defined the research questions that needed to be understood by considering the antecedent variables that affect knowledge sharing. We limited the scope of this study to those variables related to the theory of intrinsic and extrinsic motivation, the theory of social capital, and our understanding of the moderating role of membership types. We identified independent and dependent variables while designing our research framework. Independent variables included extrinsic motivations (reputation and reciprocity), intrinsic motivations (altruism, and knowledge self-efficacy) structural capital (social interaction), relationship capital (interpersonal trust and identification) and cognitive capital (shared language). Dependent variables included knowledge-sharing intentions, knowledge-sharing behaviors, and knowledge-sharing quality and quality.

Literature Search. We conducted a literature search to find relevant sample studies. A total of 63 papers (including 52 journal papers and 11 conference papers) reporting empirical studies were used for conducting the meta-analysis.

Data Coding Design and Extraction. After completion of the literature collection, we designed and created the coding tables, and then extracted data samples from the literature based on the contents of each study, their relevance to our research questions, and the integrity of the information provided. The data included the author, date, research variables, number of samples, statistics, sharing systems, and membership type. Membership types were coded as “contributors” or “members” according to the source of the research participants.

We set three requirements during this stage: we wanted to avoid comparing incompatible variables; we wanted to avoid our own subjectivity during the coding process; and we wanted to avoid duplicating data from the same studies (for example, if one paper had been published at a seminar and in a journal, then the journal paper was given priority). To achieve these requirements, two authors worked together to jointly establish the coding tables. Then each author reviewed and judged the data extraction from the literature independently according to the coding principles. If we encountered a problem of classification, the two authors had to discuss and make a combined decision. If the two authors were unable to reach a consensus, a third author was asked to make a final decision.

Data Analysis. The data was analyzed after completion of the data coding procedure. At present, there are four common methods of meta-analysis provided by Glass [27], Hedges and Olkin [28], Hunter and Schmidt [24], and Rosenthal [25], and each method has its own advantages and disadvantages. After considering our data characteristics and effectiveness, we decided to adopt Rosenthal’s [25] technical method to conduct our meta-analysis, and used the average product-moment correlation coefficient r as the effect size estimate. If the original literature study did not provide the correlation coefficient or the number of samples, we used the p value, t value, F value, or Z value to calculate an r value. The meta-analysis was conducted using Comprehensive Meta-analysis V2.0 software. When logging into the system, the direction of each study, whether positive, negative or not significant, was logged for analysis. Rosenthal [25] first converts the various statistics to r values and then to Z_i values. Equation (1) transforms Fisher’s to a Z value, Eq. (2) calculates the weighted mean effect size, and Eq. (3) calculates fail-safe N:

$$Z_i = \frac{1}{2}\ln\left(\frac{1+r_i}{1-r_i}\right) \tag{1}$$

$$\overline{ES} = \frac{\sum (N_i - 3)Z_i}{\sum (N_i - 3)} \tag{2}$$

$$N_{fs_{0.05}} = \left(\frac{\sum ES}{1.645}\right)^2 - K \tag{3}$$

Where K = number of studies

A *Z*-test was then conducted to compare two membership-type groups. First, we calculated the difference in effect size between the two groups in Eq. (4); then we used Eq. (5) to calculate the standard error of that difference; and Eq. (6) to calculate the *Z* value:

$$Diff = M_b - M_a \tag{4}$$

$$SE_{Diff} = \sqrt{V_{M_a} + V_{M_b}} \tag{5}$$

$$Z_{Diff} = \frac{Diff}{SE_{Diff}} \tag{6}$$

4 Results

4.1 Qualitative Classifications

Table 2 shows the 63 studies in the meta-analysis. The final sample included 52 journal articles and 11 conference papers. We conduct the meta-analysis to examine the significant relationships and relationship strength. Pearson's correlation coefficient (r) was used as the effect size. The magnitude of the effect size was applied according to Hemphill's [29] guidelines: $r < 0.20$ was considered a low effect size magnitude; $r = 0.20$ to 0.30 were considered medium effect size magnitudes; and $r > 0.30$ was considered a high effect size magnitude. The measure of heterogeneity between studies was conducted using Q-statistic, where heterogeneity exists when $p < 0.05$. The *Z*-test was used to compare two membership-type groups, where significant difference exists when $p < 0.05$. The results are shown in Table 2.

Table 2. Meta-analysis results: comparing "contributors" and "members" research

Relationships	Type	*K*	*r*	LL	UL	*Z* Value	*p(Z)*	*Q*	*p(Q)*	*Failsafe N*	Comparing A versus P			
											Diff	SE	*Z* value	*p(Z)*
Reputation	A	4	0.370	0.134	0.250	3.078	0.002	7.407	0.060	284				
→ Knowledge-sharing	P	6	0.371	0.178	0.565	3.763	0.000	2.757	0.737	404	-0.001	0.156	-0.007	0.994
intention	C	10	0.371	0.221	0.521	4.861	0.000	10.164	0.337	1375				
Reputation	A	2	0.421	0.087	0.756	2.467	0.014	1.459	0.227	-				
→ Knowledge-sharing	P	2	-0.098	-0.427	0.232	-0.581	0.561	0.718	0.397	-	0.519	0.240	2.166	0.030
behavior	C	4	0.158	-0.077	0.393	1.316	0.188	6.867	0.076	24				
Reciprocity	A	2	0.700	0.431	0.970	5.094	0.000	0.554	0.457	-				
→ Knowledge-sharing	P	8	0.524	0.389	0.658	7.622	0.000	9.696	0.206	1040	0.176	0.154	1.148	0.251
intention	C	10	0.559	0.439	0.680	9.095	0.000	11.569	0.239	1840				
Reciprocity	A	4	0.189	-0.035	0.413	1.655	0.098	2.502	0.475	61				
→ Knowledge-sharing	P	4	0.110	-0.113	0.332	0.963	0.335	4.213	0.239	11	0.079	0.161	0.494	0.621
behavior	C	8	0.149	-0.009	0.307	1.851	0.060	6.959	0.433	131				
Reciprocity	A	1	0.485	0.155	0.815	2.883	0.004	0.000	-	-				
→ Knowledge-sharing	P	2	0.005	-0.231	0.242	0.045	0.964	1.000	0.317	-	0.480	0.207	2.315	0.021
quantity	C	3	0.169	-0.024	0.361	1.719	0.086	6.360	0.042	17				
Reciprocity	A	1	0.576	-0.164	1.316	1.525	0.127	0.000	-	-				
→ Knowledge-sharing	P	2	0.310	-0.215	0.836	1.158	0.247	1.000	0.317	-	0.266	0.463	0.573	0.566
quality	C	3	0.399	-0.029	0.828	1.827	0.068	1.329	0.515	104				
Altruism → Knowledge-	A	4	0.602	0.408	0.797	6.062	0.000	3.180	0.365	649				
sharing intention	P	9	0.548	0.401	0.695	7.301	0.000	7.196	0.516	1484	0.054	0.124	0.440	0.660
	C	13	0.567	0.450	0.685	9.480	0.000	10.569	0.566	4106				
Altruism → Knowledge-	A	5	0.586	0.281	0.891	3.767	0.000	2.919	0.571	656				
sharing behavior	P	2	-0.019	-0.499	0.461	-0.077	0.939	0.082	0.775	-	0.605	0.290	2.085	0.037
	C	7	0.412	0.155	0.670	3.139	0.002	7.407	0.285	664				
Knowledge self-	A	6	0.534	0.340	0.727	5.406	0.000	2.707	0.745	930				
efficacy → Knowledge-	P	8	0.448	0.280	0.616	5.216	0.000	13.181	0.068	816	0.086	0.131	0.655	0.512
sharing intention	C	14	0.485	0.358	0.612	7.483	0.000	16.317	0.232	3501				
Knowledge self-	A	9	0.354	0.221	0.487	5.216	0.000	11.587	0.171	1070				
efficacy → Knowledge-	P	3	0.550	0.320	0.779	4.699	0.000	0.034	0.983	210	-0.196	0.135	-1.449	0.147
sharing behavior	C	12	0.403	0.288	0.518	6.869	0.000	13.721	0.249	2238				
Trust → Knowledge-	A	5	0.523	0.400	0.647	8.307	0.000	4.475	0.346	708				
sharing intention	P	4	0.428	0.284	0.572	5.826	0.000	1.360	0.715	157	0.095	0.097	0.981	0.327
	C	9	0.483	0.389	0.577	10.099	0.000	6.796	0.559	1540				
Social interaction	A	1	0.131	-0.949	1.211	0.238	0.812	0.000	-	-				
→ Knowledge-sharing	P	2	0.351	0.216	0.486	5.105	0.000	1.000	0.317	-	-0.22	0.555	-0.396	0.692
quantity	C	3	0.347	0.214	0.481	5.095	0.000	1.157	0.561	43				
Social interaction	A	1	0.332	0.077	0.587	2.549	0.011	0.000	-	-				
→ Knowledge-sharing	P	2	0.265	0.082	0.448	2.838	0.005	1.000	0.317	-	0.067	0.16	0.418	0.676
quality	C	3	0.288	0.139	0.437	3.792	0.000	1.175	0.556	49				
Trust → Knowledge-	A	9	0.522	0.395	0.649	8.036	0.000	9.789	0.280	1498				
sharing behavior	P	6	0.436	0.283	0.588	5.599	0.000	7.235	0.204	600	0.086	0.101	0.850	0.395
	C	15	0.487	0.389	0.584	9.757	0.000	17.746	0.219	4006				
Trust → Knowledge-	A	1	0.192	-0.67	1.054	0.436	0.663	0.000	-	-				
sharing quantity	P	2	0.200	-0.41	0.811	0.643	0.521	1.000	0.317	-	-0.008	0.539	-0.015	0.988
	C	3	0.197	-0.301	0.696	0.777	0.437	1.000	0.607	17				
Trust → Knowledge-	A	1	0.709	0.159	1.259	2.528	0.015	0.000	-	-				
sharing quality	P	2	0.496	0.106	0.886	2.493	0.017	1.000	0.317	-	0.213	0.344	0.619	0.536
	C	3	0.567	0.249	0.885	3.496	0.000	1.383	0.501	204				
Identification	A	8	0.557	0.319	0.794	4.597	0.000	6.165	0.521	1338				
→ Knowledge-sharing	P	3	0.535	0.149	0.92	2.717	0.007	1.950	0.377	268	0.022	0.231	0.095	0.924
behavior	C	11	0.551	0.348	0.753	5.339	0.000	8.125	0.617	2811				
Identification	A	1	0.354	-0.481	1.189	0.831	0.406	0.000	-	-				
→ Knowledge-sharing	P	2	0.141	-0.069	0.352	1.317	0.188	1.000	0.317	-	0.213	0.439	0.484	0.628
quantity	C	3	0.154	-0.05	0.358	1.480	0.139	1.234	0.540	27				
Identification	A	1	0.618	0.207	1.029	2.95	0.003	0.000	-	-				
→ Knowledge-sharing	P	2	0.514	0.274	0.754	4.197	0.000	1.000	0.317	-	0.104	0.243	0.429	0.668
quality	C	3	0.540	0.333	0.748	5.112	0.000	1.184	0.553	186				
Shared language	A	1	0.549	-0.219	1.317	1.401	0.161	0.000	-	-				
→ Knowledge-sharing	P	2	0.029	-0.21	0.268	0.234	0.815	1.000	0.317	-	0.52	0.41	1.268	0.205
quantity	C	3	0.075	-0.154	0.303	0.640	0.522	2.069	0.355	22				
Shared language	A	1	0.563	0.119	1.007	2.485	0.013	0.000	-	-				
→Knowledge-sharing	P	2	0.239	-0.683	1.162	0.509	0.611	1.000	0.317	-	0.324	0.522	0.62	0.535
quality	C	3	0.502	0.102	0.902	2.46	0.014	1.384	0.501	87				

Notes: -: Not enough data to run the analysis; Shaded cells indicate significant results. A: All members; P: Contributors; C: Combined "all members" and "contributors"; *K*: Total number of studies; *r*: Mean effect size; LL, Lower limit; UL, Upper limit; Q: *Q* statistic for heterogeneity; Diff: difference of effect size; SE: standard error

4.2 Discussion

In this study, we explored the effect of intrinsic and extrinsic motivations (reputation, reciprocity, altruism, and knowledge self-efficacy) and social-capital factors (social interaction, interpersonal trust, identification, and shared language) on knowledge-sharing outcomes (intentions, behavior, quantity and quality). We used membership types as a moderator variable. This study analyzed a total of 63 papers (including 52 journal papers and 11 conference papers). The results, which are summarized in Table 3, indicate that there are three significant relationships for different membership types (all members or contributors). These three relationships include the effect of reputation on knowledge-sharing behavior, the effect of reciprocity on knowledge-sharing quantity, and the effect of altruism on knowledge-sharing behavior.

Table 3. The comparison between different membership type (all members and contributors)

Results	Supported relationships
These relationships may exist in both the group of all members and the group of contributors. There is no significant difference between the two groups	• Reputation → knowledge-sharing intention • Reciprocity → knowledge-sharing intention • Altruism → knowledge-sharing intention • Knowledge self-efficacy → knowledge-sharing intention • Knowledge self-efficacy → knowledge-sharing behavior • Social interaction → knowledge-sharing quality • Trust → knowledge-sharing intention • Trust → knowledge-sharing behavior • Trust → knowledge-sharing quality • Identification → knowledge-sharing behavior • Identification → knowledge-sharing quality
These relationships may exist in the group of all members but not in the group of contributors. There is a significant difference between the two groups	• Reputation → knowledge-sharing behavior • Reciprocity → knowledge-sharing quantity • Altruism → knowledge-sharing behavior
These relationships may exist in either the group of all members or the group of contributors. There is no significant difference between the two groups	• Social interaction → knowledge-sharing quantity • Shared language → knowledge-sharing quality
These relationships do not exist in either the group of all members or the group of contributors. There is no significant difference between the two groups	• Reciprocity → knowledge-sharing behavior • Reciprocity → knowledge-sharing quality • Trust → knowledge-sharing quantity • Identification → knowledge-sharing quantity • Shared language → knowledge-sharing quantity

5 Conclusion

This study advances our understanding of knowledge sharing in virtual communities in two ways. First, although a considerable number of empirical studies on factors affecting knowledge sharing have been completed, these studies have also highlighted conflicts and contradictions in the conclusions that have been reached. Our study collected and reviewed numerous relevant papers, classified them by membership types (contributors or all members), and conducted a meta-analysis to eliminate sources of errors. This process has allowed us to understand the importance of the relationships between intrinsic and extrinsic motivation and social capital on knowledge-sharing outcomes. Second, the findings of this study not only provide a research map for exploring knowledge-sharing behaviors in virtual communities, but also helps academic researchers better understand the current state of knowledge-sharing research. We believe that further research can now more easily explore specific factors with lower-level influences.

Additionally, our results have practical implications. Virtual community administrators and moderators now have a better understanding of the correlation strength between antecedent variables and knowledge-sharing outcomes. They will be able to use our results to strategize and plan community activities. Furthermore, virtual community administrators will be better able to incentivize different members (contributors or members) based on their understanding of the effects between individual motivation, social capital, and knowledge sharing.

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The Impact of Knowledge Sharing on Information Systems: A Review

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Abstract. Recently, knowledge sharing (KS) has become an essential research field in the context of knowledge management (KM). Information systems (ISs) are playing a key role in facilitating the process of KS. According to the literature, research neglects to review studies regarding the impact of KS on ISs. Therefore, the main objective of this study is to review studies regarding the impact of KS on ISs with an advanced focus on M-learning, social media, ERP systems, and weblogs. Furthermore, the synthesis of the research problems, research methods, and findings of the surveyed studies will assist the scholars in pursuing their future studies. Further discussions and implications are also presented in the study.

Keywords: Knowledge sharing · Information systems · M-learning
Social media · Weblogs · ERP systems

1 Introduction

Knowledge sharing (KS) is an essential process in building up the overall knowledge management (KM) procedures [1, 2]. KS acts as a magic bullet to be incorporated into the individual and organizational minds by enhancing their power to learn through the usage of information technologies [3]. Institutions are always trying to establish an environment that supports knowledge sharing process among the staff members [4]. Staff members that always come up with innovative ideas to achieve a particular task are persuaded to share knowledge if they possess a constructive outlook about that knowledge. A study by [5] defines KS as the explicit or tacit knowledge management by virtue of which knowledge can be transferred, generated, and used. Nowadays, social media has become a part of our daily lives [6]. Online social media has turned into a significant hub for knowledge sharing, updating people about every current incident within seconds [7, 8]. In simple words, online social media acts as a facilitator for knowledge management especially when it comes to knowledge being created,

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shared, and renovated. Social media offers interactive features (e.g., personal profiles, group discussions, and freedom to express personal opinions), which in turn facilitates KS [9]. In that, social media makes the knowledge sharing process more convenient. Thus, the significance of social media in conveying knowledge about every occurrence is evident [10].

Recently, organizations are facing a challenging issue in gathering and analyzing statistics that were based on homogenized data [11]. Accordingly, this creates the need for the Enterprise Resource Planning (ERP) systems, the quick information provider for divergent users at the same time. Executive processes and single-entry information recording and trails are assembled together under these ERP systems. ERP systems function as a business application that serves as a platform and intertwines all the data extracted as a result of organization business developments and related purposeful sectors [12]. Various organizations are adopting ERP systems which benefit them in their daily routine tasks. Taking into consideration the importance of knowledge economics in the current era, several industries are utilizing knowledge in the form of effective tool which consequently enhances their ability to perform effectively and efficiently. Knowledge sharing among the various processes that knowledge management offers, is a crucial component of ERP systems. The reason for its importance lies in the primary objective that KM provides to reprocess and share of knowledge resources while taking the significance of organization to better levels [13].

Mobile learning (M-learning) is a new trend in the era of technology and education that enables the learners to acquire their learning through the use of small portable computing devices [14–18]. The next stage in the enhancement of distance learning is M-learning. M-learning is a significant tool for lifetime learning since it enables the learners to access their mobile devices and provides them the chance to learn with irrespective of time and place [19]. In addition, mobile phones offer various features including, phone calls, text messages, internet surfing, access to social networks, capture photographs, and audio/video recording among other features [20]. Knowledge sharing as one of KM processes is another useful feature that M-learning offers deliberately for the student's welfare. Studies conducted by [1, 2] pointed out that M-learning enables the students to share the learning materials among each other; thus, facilitating the process of knowledge sharing. Another study conducted by [21] indicated that students feel convenient to share their knowledge with each other through the use of M-learning and social networks. A weblog is another source of disseminating knowledge among individuals. Individuals are encouraged to post topics on weblogs which in turn facilitate the process of knowledge sharing by the author and the process of knowledge acquisition of the reader. Research sheds light on the importance of understanding the influence of knowledge sharing on such type of information systems (i.e. weblogs) [22].

Overall, knowledge sharing is an essential process in facilitating and promoting information systems. It has been noticed that research didn't extensively tackle and review the influence of knowledge sharing on information systems. Accordingly, the aim of this study is to review studies related to the impact of knowledge sharing on information systems with more focus on social media, ERP systems, M-learning, and Weblogs. Thus, this study attempts to answer the following research question:

- What is the impact of knowledge sharing on social media, ERP systems, M-learning, and weblogs?

2 Knowledge Sharing and M-Learning

Organizations are extensively utilizing mobile technology devices in order to run their businesses efficiently since mobile technology enables strong communication and mobility [23]. It became essential to make use of the useful features of these devices within the process of learning [24]. Human interaction and the ease of access to knowledge resources at any time and in any place can be possible through mobile devices [25]. According to Table 1, various studies were carried out to link knowledge sharing with M-learning. A study of [26] examined the features of students' knowledge sharing of health technology using M-learning in professional and technological institutes. A scale was certified to measure the existing scenario regarding students' knowledge sharing of health technology through the development of a model. 3102 students from 16 professional and technological colleges in Taiwan were involved in a questionnaire survey. Findings indicated that sharing attitude, behavior norm, sharing behavior, sharing an intention, and sharing control with respect to the theory of planning behavior (TPB) were evident in the students' knowledge sharing of health technology. Students' knowledge sharing of health technology model was verified with good fit using structural equation modeling (SEM). Results pointed out that knowledge sharing behavior of students had positive effects on health technology.

A study of [27] studied the integration of social network design and M-Learning through knowledge sharing. The M-learning system was developed from IPTV (Suan Dusit Internet Broadcasting: SDIB) to mobile IPTV and then further expanded to M-learning system. It was indicated through the results that learners were able to share knowledge and increase social interaction through the M-Learning system. Authors of the study [1] applied different KM processes on an academic institution in Oman using E-podium technology and M-learning. In that, M-learning was employed to share the lecture materials and assignments between the lecturers and students. Through M-learning, students are able to acquire knowledge and work together using the facilities of internet and technology. But, the implementation of M-learning systems depends on M-learning acceptance by educators and learners. A significant factor which assists in understanding if educators and learners are willing to use M-learning is the attitudes they have towards M-learning technology [28]. A study of [25] studied several positive factors with regard to knowledge management attempting to examine the acceptance of M-learning systems. 152 participants were involved in the study. Findings indicated that there is a considerable positive influence on improving the satisfaction of learners, empowering system functions, encouraging autonomy of learners, and increasing interaction and communication activities towards the acceptance of M-learning systems.

Table 1. A summary of knowledge sharing and M-learning studies

Study	Research purpose	Method	Findings
[26]	Investigating the students' knowledge sharing of health technology using M-learning in professional and technological institutes	Survey and interview	Knowledge sharing behavior of students had positive effects on health technology using M-learning
[27]	Examining the integration of social network design and M-learning through knowledge sharing	Experiment	Results indicated that learners were able to share knowledge and increase their social interaction through the M-learning system
[25]	Examining the factors that affect the acceptance of M-learning systems	Survey	There is a considerable positive influence on improving the satisfaction of learners, empowering system functions, encouraging autonomy of learners, and increasing interaction and communication activities on the acceptance of M-learning systems
[1]	Examining the effect of KM processes on E-podium technology and M-learning	Experiment	It is indicated that KM processes in general and KS in specific play a key role in affecting the students' performance using E-podium and M-learning

3 Knowledge Sharing and Social Media

The act of sharing is pretty simple for every human being but knowledge sharing inside a company is not as easy and simple [29]. The procedure in which knowledge is transferred to others in an informative way that can be easily used is called knowledge sharing [30]. According to [31], knowledge sharing is an act of sharing information such that it may help others in solving their issues and creating new perspectives. It is also not possible in today's world to ignore the social media and social media websites like Facebook, Twitter, YouTube, and LinkedIn that may have a drastic effect on the entire population. The social media even affects the personal relationships of people and has created many challenges even more difficult but has also created many new possibilities to work in an interactive environment. There is a dire need in companies to mainstream the new items and services and keep updated about knowledge sharing to survive their businesses. Social media usage has a substantial effect on businesses growth [32]. Table 2 illustrates briefly the knowledge sharing and social media studies.

Although social media use has become widespread, knowledge workers and managers want to feel more connected to this new world of technology, but they do not have enough motivation, or they are not aware of its significant advantages [33]. The organizations, however, do not want their employees to be highly involved in social media as they may misuse it. A survey was carried out about the internal and external social media technologies that were used to share knowledge for their working purposes [34]. The survey was held and completed in Hungary with the aid of its profitable and non-profitable organizations through the use of qualitative methods. It was in the form of an online survey including 299 individuals. Results showed that external social media was not preferred by the people of Hungary. However, supported organizations were managed to get the best use out of social media benefits.

Many studies were attempted to motivate people to use social media aiming to help their organizations and help each other by sharing knowledge. A study carried out by [35] studied the trends of Nielsen (a global information and measurement company of social media) in order to create a culture in which social media make it easy and possible to share knowledge. The research was in the form of semi-structured questionnaires for a sample of workers in Nielsen's Television Audience Measurement Department. The authors also held many interviews with some employees in order to examine the employees' behavior and thinking about the use of social media tools for creating a knowledge sharing culture. The results indicated that the employees have a positive attitude for using social media to share knowledge. A study of [10] have studied the effects of social media in terms of its effectiveness in sharing information regarding disasters. The disasters caused by the flood are somewhat alarming and social media proved to be very useful in such incidents by means of knowledge sharing. The research used real examples of Australia and Malaysia on how they have used social media in the time of natural disasters.

A study of [36] studied the motivation factor in workers in Danish companies and the factors that influence the knowledge sharing through social media in an organization environment. Results showed that the social media has a distinct influence on improving internal communication, knowledge sharing, and partnership in organizations. In addition, results revealed a positive attitude of the workers for sharing knowledge as it is more important than keeping the information for one person only. Another study conducted by [37] studied the effects of social media in terms of organizational knowledge sharing. Social media has been researched with respect to Web 2.0 technologies in which organizations are giving the proper communication tools for their employees. The study illustrated the theory behind using social media as a technology that can help in collecting knowledge and to donate knowledge. The research has also focused on the factors that affect the workers when using social media in their office atmosphere. All the various aspects of knowledge sharing have been discussed. A total of 343 online questionnaires were distributed. Results indicated that the use of social media was affected by personal, organizational, and technological factors.

Authors of [38] conducted a research study that focused on the factors that influence the individuals' use of social media and why they may not be interested in the enterprise social media. The proposed model was derived through the integration of demographic, individual, organizational, and technological factors which might affect

Table 2. A summary of knowledge sharing and social media studies

Study	Research purpose	Method	Findings
[38]	Examining the factors that influence the use of individuals' use of social media and why they may not be interested in the enterprise social media	Qualitative methods	The noteworthy drivers are: enjoy helping others, monetary rewards, management support, change of knowledge sharing behavior and recognition. The noteworthy identified hurdles to knowledge sharing are: change of behavior, lack of trust, and lack of time
[10]	Studying the use of online media for the act of knowledge sharing during the flood period	Research articles' results and observations	One of the most critical aspects of social media effectiveness is how it can be used to collect people for an event or maybe in times of disasters
[34]	There is a dire need in companies to mainstream the new items and services and keep updated about knowledge sharing as it very important for their business	Survey	The results showed that external social media was not preferred by the people of Hungary in the organizations but in organizations in which they are supported, people know how to get the best use out of them
[36]	Studied the motivation factor in workers in Danish companies and the factors that influence the knowledge sharing through social media in an organization environment	Online survey	Results showed that social media has a distinct influence on improving internal communication, knowledge sharing, and partnership in organizations and showed a positive attitude by the workers through sharing of knowledge
[35]	Studied the trends in Nielsen to create a culture in which social media make it easy and possible to share knowledge	Survey and interview	Results indicated that the employees have a positive attitude for using social media to share knowledge
[37]	Studied the effects of social media in terms of organizational knowledge sharing	Online survey	The use of social media was affected by personal, organizational, and technological factors

the employees to share knowledge. The model was then tested through qualitative methods on a sample of 114 respondents in Denmark. A qualitative study was used to explain the quantitative results' findings which direct it towards the hurdles and drivers to share knowledge in an organization. The noteworthy drivers are: enjoy helping others, monetary rewards, management support, change of knowledge sharing behavior, and recognition. The noteworthy identified hurdles to knowledge sharing are: change of behavior, lack of trust, and lack of time.

4 Knowledge Sharing and Weblogs

Weblogs is simply known as blogs that have undergone exceptional growth on the internet. Blogs were initially known as online writing tools that allow their users to maintain records of their personal online writing [39]. However, the blog soon became a significant part of the online culture [40]. Blogs allow their users to choose any topic they like, and to publish a particular material regarding that topic on a website [41]. When a blog is written on a well-known issue, it may draw a lot of attention and create a lot of impact on the society [22]. Blogs serve as a novel medium for social communication. Weblogs were becoming widely known and their impact on community is apparent. However, it is not evident what inspires a person to take part in blogging. One of the key processes of knowledge management is knowledge sharing. Several professionals are participating in web blogging, where they put forward their ideas and thoughts. Different techniques need to be examined to encourage people to share their personal knowledge and to help other community members in sharing their experience [42]. The way a person's aim is affected by social, individual, and motivational factors has been examined by [43]. A survey was carried out amongst 283 subjects to evaluate the model put forward. According to the findings, personal innovativeness, perceived enjoyment, and perceived usefulness directly influenced an individual's intention to use blogs. In contrast, the individual's motivational factors were affected by subjective norms and blog self-efficacy, which then affected a person's behavioral intent with respect to the use of blogs. Table 3 demonstrates briefly the knowledge sharing and weblogs studies.

A study of [44] discussed the knowledge reservoir sharing through blogs to determine those classes of knowledge blogs which could be viewed several times by the users each day. An algorithm has been designed for this purpose, known as Knowledge Request-Response Algorithm, which is able to determine the extent of correlation between the requested and responded knowledge that exists between knowledge sender and knowledge receiver. Another study conducted by [42] has studied the factors that affect the voluntary knowledge sharing in a virtual community. There is a special emphasis on three groups related to the sharing culture (i.e. fairness, openness, and identification). These groups are taken to be a linear combination. The theoretical model is examined by surveying 442 members of three online communities. Apart from the positive effects of equity and sincerity on community sharing culture, it is also observed that enjoying helping, sharing culture, and usefulness/relevance have a strong association with knowledge sharing behavior.

Table 3. A summary of knowledge sharing and weblogs studies

Study	Research purpose	Method	Findings
[44]	Determine the classes of knowledge blogs which could be viewed several times by the users each day	Quantitative studies and theories	There is a positive link between the perceived interest in blogging and the individual's attitude to sharing the knowledge

(*continued*)

Table 3. (*continued*)

Study	Research purpose	Method	Findings
[42]	Examining the factors that influence the voluntary knowledge sharing in a virtual community	Survey	Results showed that there is a positive effect of equity and sincerity on community sharing culture
[43]	To study the social, individual, and motivational factors that affects the usage of blogs	Survey	Personal innovativeness, perceived enjoyment, and perceived usefulness have a positive impact on the individual's intention to use blogs
[22]	Studying the reason about why people taking part in blog activities is yet unknown	Survey	The blog users' behavior towards participation was based on social factors (community identification) and attitude towards blogging. The results also showed that the participation was greatly influenced by user-friendly blogs and knowledge sharing (altruism and reputation) which estimated up to 78% of the variance

5 Knowledge Sharing and ERP Systems

Enterprise Resource Planning (ERP) systems have been developed by various organizations in the past few years to include information and information-based processes in and over functional divisions. Since the ERP systems are not utilized to a large extent, the majority of organizations are not able to attain the expected business objectives [45]. The way that ERP systems help organizations to perform their functions, need to be examined [46]. A study of [47] sought to comprehend the way in which knowledge sharing affected ERP system use and the factors that influenced knowledge sharing abilities of employees following the preliminary adoption of an ERP system. The conceptual model was developed using a few social oriented theories. A total of 804 ERP users belonging to 53 Taiwan companies were included in the survey. The results showed that the research model was correct to a certain extent. Additionally, results indicated that social capital, self-efficacy, and intrinsic motivation affect knowledge sharing to a large extent. Nonetheless, it was also found that there was a weak impact of extrinsic motivation on knowledge sharing. Table 4 describes briefly the knowledge sharing and ERP systems studies.

Several organizations who have adopted ERP are not able to comprehend the significance of tacit knowledge sharing while implementing ERP. Tacit knowledge sharing is an essential issue in the execution of any ERP system since it is involved in complex organization procedures, in externally based procedures, and in legacy mechanisms. The outcomes pertaining to the facilitators of tacit knowledge sharing while implementing ERP were put forward by [48]. This study adds on to the present

Table 4. A summary of knowledge sharing and ERP systems studies

Study	Research purpose	Method	Findings
[49]	Analyzing the role of knowledge transfer process in achieving a successful execution of ERP	Survey	A significant role is performed by consulting companies and management backing in bringing about knowledge transfer within ERP systems
[48]	Discussed the tacit knowledge sharing within the implementation of ERP systems	Systematic literature review	Recognizing the appropriate tacit knowledge sharing factors allows managers to be able to arrange implementation activities and resources such that they are successful in ERP mechanisms
[47]	Sought to comprehend the way in which knowledge sharing affect ERP system use and the factors that influence knowledge sharing abilities of employees following the preliminary adoption of an ERP system	Survey	Results indicated that social capital, self-efficacy, and intrinsic motivation affect knowledge sharing to a large extent. Nonetheless, it was also found that there was a weak impact of extrinsic motivation on knowledge sharing

knowledge on tacit knowledge sharing in ERP implementation by recognizing and classifying those variables that help in tacit knowledge sharing while ERP systems are being adopted. Understanding the appropriate tacit knowledge sharing factors allows managers to be able to arrange implementation activities and resources such that they are successful in ERP workings. A research model was developed by [49] to analyze the role of knowledge transfer process in achieving a successful execution of ERP systems. The initial models were altered to incorporate ideas and routes that were considered to be relevant for the study. Data was collected through a questionnaire survey. Besides, qualitative case studies were carried out to examine the perspectives of users and their experience with respect to knowledge transfer in the execution of ERP at two Indonesian organizations. It was determined in the study that effective knowledge transfer forecasts the results of ERP system implementation in Indonesian SMEs. According to these findings, a significant role is performed by consulting companies and management backing in bringing about knowledge transfer within ERP systems.

6 Discussion

A study of [50] stated that it is still important to perform a thorough study on each dimension of M-learning as M-learning in Saudi Arabia is still in its early phases. The findings from this initial study could be used to support further research and to develop some advanced M-learning systems for students in the future. A study of [48] has discussed the inclusion of tacit knowledge management into ERP project management and how such integration is critical, strategic, and related to the success of the ERP system implementation on the whole. Various directives are offered for practitioners who can be used for their ERP implementations. Lastly, the study provides guidelines for areas of subsequent research and presents research questions that emerge from these outcomes. Hence, the dynamic of tacit knowledge while performing ERP implementation is a potential area for future research. Another study carried out by [36] claimed that there are various limitations in their study. There are just 114 respondents belonging to 13 companies in Denmark from which the empirical data is obtained. A more prominent sample could be collected from various organizations, different segments, and other different countries. There is a need for further research to focus on cultural factors that may have an impact on employees' knowledge sharing using social media in other countries and perform a comparison of the results. Besides, it is noted that the technological factors that were studied did not perform a significant role as a motivator of social media and knowledge sharing. Hence, further studies may understand the effect of other additional factors like: interface design, quality of knowledge, security, and sensitivity of knowledge.

It was claimed by [34] that there would be an increase in the usage of internal as well as the external use of the social media tools. This gives a new point of view on social media. A vast amount of information and knowledge can be shared through the help of social media tools along with the external environment in which various social factors perform a critical role. In this new world of rapid evolution, various technologies have been created to facilitate social capital relationships. A study of [51] concentrated on universities in Ho Chi Minh City (Vietnam). Therefore, there is a restriction in generalizing the findings. Further research should take this point into account and attempt to conduct studies that could be generalized.

7 Conclusion and Future Work

In this paper, we have deliberated the impact of knowledge sharing on information systems. It is evident that the importance of knowledge in the ongoing century cannot be neglected. The concept of knowledge sharing that has laid down a theoretical foundation for various organizations can be utilized by the enterprise to reinforce this concept. Knowledge sharing benefits two major portions of the society; i.e. educational class related to academic institutions and the professionals who are currently working in the field. In this research paper, we have discussed the existing literature and provided a brief insight into the concept of knowledge sharing. This study provides an insight into the effect of knowledge sharing on information systems with more focus on M-learning, social media, Weblogs, and ERP systems. As a future work, we are currently working on studying the impact of knowledge sharing on E-learning system acceptance as this issue still needs further examination.

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Promoting Knowledge Sharing and Value Co-creation Between University and Learners: A Learning Model Based on Communities of Practice and Service-Dominant Logic

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Abstract. Learning is a continuing social action that takes place through interactions between the lecturers and the community of students and knowledge sharing is an integral part of the learning process for a class in the university to engage in co-creating of learning values. Research and industry experience on knowledge sharing confirm the benefits of knowledge sharing for generating new ideas, team building & silo breaking, creating sense of purpose, and avoiding making the same mistakes several times, to name a few. Although it seems trivial that there are many benefits of knowledge sharing, in practice it is not easy to encourage students to do so because of the organizational, technical and cultural barriers. The literature shows tertiary students are not naturally willing to share knowledge voluntarily. Numerous studies have been carried to identify barriers to knowledge sharing, but there is a scarcity of research conducted to help students, working in a classroom setting, to overcome those barriers that are important for the co-creation of learning value. Forming communities of practice (CoPs) among students can contribute significantly to both knowledge sharing and learning. When students are able and willing to share knowledge, then an innovative learning environment can be created to encourage students to engage in value co-creation. This paper takes a closer look at service-dominant (S-D) logic frameworks and their application to students in the university, in order to facilitate co-creation of learning value. Drawing on the conceptual basis of CoPs and S-D logic, this paper proposes a learning model that may offer the opportunity for promoting knowledge sharing and co-creating of learning value between university and students working in a classroom setting.

Keywords: Community of practice · Knowledge sharing
Service-dominant logic · Value co-creation

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1 Introduction

Learning is much more than a function of individual efforts to acquire and absorb knowledge externally. In fact, learning is a social process along within the context of our daily life experiences while knowledge sharing is an integral part of that process and a fundamental element in making it effective [1, 2].

In the classes, tertiary students are encouraged to conduct group works to order to interact with otherclass participants via all sorts of learning activities. Tertiary programs can be seen as the training venues that help students to be "reflective practitioners" and equipped with the skills to solve complex problems [3, 4]. Learning through interaction with peers has thus been an important component in the class.

Co-creation of value is an important facet of service-dominant (S-D) logic. S-D logic, as being introduced by Vargo and Lusch [5], believes that a customer works together with the organizations to covert the value proposition into the final co-created value. The customer is thus considered to be "a co-creator of value" [6]. Although the S-D logic is originally developed in the marketing area, it is possible to be applied to other areas beyond the delivery of products and services, as being suggested by Chalcraft and Lynch [7].

Education has been considered as being a service by the North American Industry Classification System [2]. Subsequently, there is literature investigates related issues from the service aspect in order to ensure the academic quality [8] and student satisfaction [9, 10].

Despite of the high relevance, as S-D logic is an important aspect of service science, there is a scarcity of literature viewing education from such an aspect. Thus, it could potentially bring valuable contributions to apply the service concept of S-D logic to study education and its providers [12].

In the tertiary environment, there are various value propositions provided by the institutions to the students such as the class venues, teaching materials, lectures, acvities and learning assessments, thus, offering value propositions to the students. The students, being the customer, can engage in co-creation of value through effort and work on their part, for example, when they graduate, or by giving feedbacks to their university. The process is similar to the key concept in the S-D logic, where vendors provides products or services to the customers who also can have involvement and feedbacks in the use of the products and services [11].

The value to a student would be more than just the learning processes. The value actually is perceived in a number of aspects such as the skill developing stages, job preparation, knowledge creation and possibly enjoyment as well by different students determining what the value is [12]. This situation would particularly applicable at the tertiary education level as the students are normally mature and self-motivated – tentatively have higher expectation in the learning processes and intention to participate in the value co-creation processes to gain benefits. It would draw our attention on investigating what would facilitate such processes in the classes and how the tertiary institutions could prepare them to improve the delivery of value which is defined by the various students (co-creators).

This paper, therefore aims to find out how the S-D Logic can be applied in a tertiary educational environmentt – in our case, at a university, and specifically where the students are working in a classroom setting.

Within the context of this study, the environment where the students work in a classroom setting is considered as a “learning community”.

The literature suggests that a way of bringing students for learning interactions with peers is to form the Communities of practice (CoPs), gathering a group of people with similar interests to address common concerns, problems, or performance with regular interaction [13]. CoPs indicate that tertiary students’ social engagements and lives form the essential process by which they learn in the professional programs [3]. The learning value of these CoPs derives from the ability to develop a collective intention to advance in learning, what the students are trying to achieve, and what value has been co-created [14].

This paper approaches education as a service through the lens of CoPs and S-D logic. Using CoPs and S-D logic as a conceptual framework, a “learning model” is proposed for that purpose to help students to overcome knowledge sharing barrier and engage in co-creating value for themselves as well as other stakeholders in the context, such as the other students, universities, not-for-profit-oganizations, enterprises in the commercial sectors, and government institutions.

Using Seinäjoki University of Applied Science[1] course as a case, a study [15] examines various dimensions of knowledge sharing behavior among students and determines if CoPs developed at the beginning of the course continues to function throughout the duration of the knowledge management course. Moreover, it investigates the functions of COPs as a supporting structure that enables students to overcome the cultural barrier to knowledge sharing among them and co-create educational value.

The rest of the paper is organized into five sections. In the next section, we review briefly the importance of knowledge sharing as a prerequisite for value co-creation and the barriers to knowledge sharing. We continue with what has been done in the literature and provide value co-creation examples in the higher education sector. Then the research gap is discussed with proposing the use of CoPs to create a conceptual model that helps tertiary students to overcome knowledge sharing barrier and engage in value co-creation. The paper finishes the suggestion of ongoing works and the direction of future studies.

2 Knowledge Sharing and Barrier

Research and industrial experience could confirm the benefits of knowledge sharing such as generating new ideas (innovation), team building & silo breaking, sense of purpose, and avoiding making the same mistakes several times [16]. However, there are a number of barriers to knowledge sharing identified in the literature making it difficult to ensure a worthy return on investment by knowledge management.

[1] Seinäjoki University of Applied Sciences (Seinäjoki UAS) is a multidisciplinary tertiary institution, research, development and innovation in West Finland.

We believe, in the context of tertiary education, the barrier to knowledge sharing will not encourage students, working in a classroom setting, to engage in co-creation of educational value. Numerous studies have been carried to identify barriers to knowledge sharing [17–19], but there is a short of research conducted to help students, working in a classroom setting, to overcome those barriers which are important for the co-creation of educational value.

For example, Riege [19] has identified more than 30 barriers to knowledge sharing that managers must consider. The few examplesare trust issues to the accuracy and credibility of the knowledge source and content, the hierarchical organization structure and culture slowing down the sharing practice, and the integration problems of IT systems and processes which hinder the sharing processes. Likewise, Sun and Scott [20] note that there could be at least fourteen sources leading to the barrier of knowledge sharing.

Similar results are actually reported on the knowledge sharing processes in the university classrooms. Based on a survey, there are only 44% of students in the three Singaporean universities willing to share learning knowledge voluntarily and in another report, it indicates as many as 84% students of a Saudi Abradia University would not share knowledge voluntarily [21, 22].

The literature therefore further confirms the needs to overcome such barriers as aforementioned, the value of learning would require a co-creation process at the tertiary environment.

3 Service-Dominant (S-D) Logic and Co-creation of Value in the Education Sector

Service-Dominant (S-D) logic [6] provides a broader framework for evaluating of how value is created and co-created among multiple participants. S-D logic comes out from the area of service marketing that has rooted strongly in academic research since the early 1980s [23]. The fact that services are fundamentally different from the physical goods is highlighted by the literature. Along the track, Vargo and Lusch [6] indicate that there is now a new dominant logic for marketing research, namely the "service-dominant (S-D) logic" [23, pp. 46–47]. In this view, physical goods are not produced for their own sake along, rather, the goods are delivered associated with services together to fufill the expectation and the customers can realize the value wanted [24].

Comparing to the physical goods delivery, in the S-D Logic, it is more than the value exchange but the value created in use by the beneficiary [6, 23]. More than the products and services, there could be significant influences on the value co-creation processes incurred by the interaction between the vendors and the customers. This notion actually that suggests the use of a network or community approach to see the value providers (vendor) and co-creators (customers) with the S-D logic [12].

Today, many enterprises are building new learning and innovation capabilities to co-create adaptive and personalized value with their customers. A study by Xie et al. [25] describes a commercially successful story on value co-creation between firms and customers, using big data-based cooperative assets with four cases of the Chinese companies in clothing and furniture businesses. Other examples include, but not limited to companies such as Adidas, Dell PC's and BMW; they successfully apply mass customization concept to engage in value co-creation with the customers [26].

As mentioned above, S-D logic is not only for the marketing industries [27] and can be considered of "a generalizable mindset" [7] in many sectors inclusive of the educational context.

We concur with Beckman et al. that the S-D logic framework "seems to be applicable" [12, p. 24] in de Educational context. Drawing on the conceptual basis of CoPs and S-D logic as a framework for our learning model, and confirmed by initial the pilot case study at a University in Finland [15] we could conclude that the five axioms of S-D logic can be applied and integrated in the Educational context, specifically in the contxct of this paper: promoting knowledge sharing and co-creating of learning value between university and students working in a classroom setting. The 5 axioms of S-D logic [23, pp. 46–47] are listed below and an example of the applicability and integration of the 5 axioms in an educational context is described based on the result of the pilot case study at a university in Finland [15]:

1. Service is the fundamental basis of exchange.
2. Value is co-created by multiple actors, always including the beneficiary.
3. All actors are resource integrators.
4. Value is always uniquely and phenomenologically determined by the beneficiary.
5. Value co-creation is coordinated.

The case study was carried out in March–April 2014 using a knowledge management course at a university in Finland. The course was attended by 32 students from 15 different countries, forming 5 learning communities (of practice), working in a classroom setting. Throughout the duration of the course the lecturer and students were all members of a community (of practice) with the lecturer acting as a facilitator and knowledge broker. The Researcher was acting as a participating observer. At the end of the course each of the 5 learning communities presented the results of their project. All students were asked to provide feedbacks using feedback forms and 7 students participated in a face-to-face, open interview conducted by the Researcher.

Throughout the duration of the course, sharing of knowledge and new knowledge creation took place, showing that exchange of service and value was co-created by multiple actors and resource integrators, with the lecturer being "service providers" and students as "customers", this is in accordance with suggestions by a number of researchers [9, 28, 29]. Chalcraft et al. [30] refers students as customers, collaborator or co-creator. Students and the lecturers were both resources and beneficiaries and both parties (multiple actors) were involved in co-creation of value. Berthon and John [32] suggest students living together in a campus environment enjoy sharing social experience having people with similar interests share activities. This can be a motivator for students to engage in co-creation. The value for the students was fulfilling part of the requirements for graduating and for the lecturer (as a resource of the university) valuable feedback for improvements of the next semester. While all students benefited from the same value of getting new knowledge from the course and passing the exams, each students may have acquired personal, specific and unique value, as determined by him or herself. To conclude with the 5th axiom, the whole process of knowledge sharing and co-creation of value took place during the course was carried out in a coordinated manner in accordance with the rules defined by the university.

The literature [33] shows that a growing number of universities implement value co-creation and collaboration processes in their curriculums; some examples are as below:

- Elon University, North Carolina, USA, in education, introduced student-staff design teams for selecting text books
- University College Dublin, Ireland, in geography, used students work in curriculum
- University of Reading, UK, in classics, invite students to define and write their own essay.

4 Community of Practice

As aforementioned, a potential application of S-D logic is to link to education by investigating the type of students in a form of community. It could bring implications to understand the students' profiles in designing the programs and preparing the class settings. In specific, it is to have an emphasis on the students' roles and their characteristics in order to help the delivering of education. The potential is actually related to an established learning concept, namely the Communities of Practice (COPs).

The concept of CoPs refers to a group of stakeholders who posit a common interest, a goal to achieve with passsions, or a set of problems to overcome, and who continue to gain the knowledge and expertise together in the related area [35, 36]. In this concept, CoPs are not the official organizational units such as departments or project teams.

This idea was initially generated in a project in which Wenger and Leave [36] studied knowledge sharing via apprenticeship. Through observing a group of Xerox's technicians, it is found that they learn together by share their experiences and stories of copy machine repairing.

Their study finds that learning can be a done more than a student to guru condition and are often the interleaved relationships among a community of people. This phenomenon brough about the opportunities for people who have the same interests and earger to learn skills in the same areas, particularly when in the context when the knowledge can be generated via the actual experiences. This is why nowadays many workshops provide more than just instructions but sometimes the gathering of similar professionals to share with their practical experiences and very often online communities are formed as the interest groups. The observation is further supported by the literature [e.g., 18]. This concept is further is advocated by the practice of industries including some famous organizations (e.g., the training programs in the World Bank to their staff and stakeholders).

From the SD-logic aspect, developing and building aa learning community for students needs to be designed in a way to allow and to facilitate the co-creation activities. There should be a level of flexibility that students could gain access to learning resources and to interact with other participants both in the class as well as the none-instruction time.

Review of literature confirms students with higher educations are not willing to share knowledge voluntarily due to the barriers. This phenomenon tends to vary from one region to another region worldwide [21, 22]. We believe CoPs can be used to create a conceptual model that will overcome the knowledge sharing barriers and create a learning environment that motivates students to engage fully in co-creation activities.

Research by Keyes [18] confirms that CoPs lead to a positive influences by fostering a culture of sharing. However, there are not many reports in the literature investigating the detail and usefulness of CoPs for the knowledge sharing processes, particularly among students in the teriary education, working in a classroom setting.

We argue, CoPs as described by Wenger et al. [34] in " Cultivating Communities of Practice" may be used as a framework for promoting knowledge sharing and value, but it lacks focus on promoting classroom education as a "service" that will enable co-creation of value as described in the concept of service-dominant logic. On the other hand, we believe that only when students are able and willing to share knowledge, then an innovative learning environment will be created to encourage students to engage in value co-creation. Therefore, we believe that by integrating CoPs and S-D logic as a conceptual framework we can develop a "learning model" that utilize the strength of both concepts.

5 The Proposed Learning Model

By incorporating the concepts of S-D logic and CoP, a learning model is suggested as a conceptual framework. It should be rigorous enough to support the work of researchers in providing scientific validity and reliability. At the same time the design of the framework should provide flexibility for accommodating different requirements of stakeholders in tertiary education; this may be influenced by geographical location, cultural differences, government regulation and recourses. An example as to how the proposed model may be implemented is given below. Figure 1 gives an example of a diagram of the learning model. Figure 2 provides a conceptual view of how CoPs can be formed among students working in a classroom setting [15].

Phase 1: Develop a university course using the framework based on the axioms of S-D logic [23, pp. 46–47] and the five- stage process of co-creation developed by Etgar [11, p. 99], as described in the previous section.

Phase 2: Introduce CoPs in the mentioned course using Wenger [34, 35] framework: Cultivating Communities of Practice, and adapt it to a classroom setting. Form communities of practice (CoPs) among students attending the course to create an environment that promotes knowledge sharing among the students and enable co-creation of value through collaboration with their fellow students and the lecturer.

Phase 3: After completion of the course, collect data from the observation during the classroom sessions and semi-structured interviews with the students to assess the usefulness of the "learning model", i.e. whether knowledge sharing has taken place among the students and co-created value that has taken place between the students, lecturers, universities and other stakeholders.

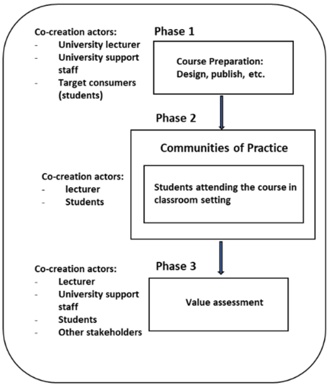

Fig. 1. The learning model.

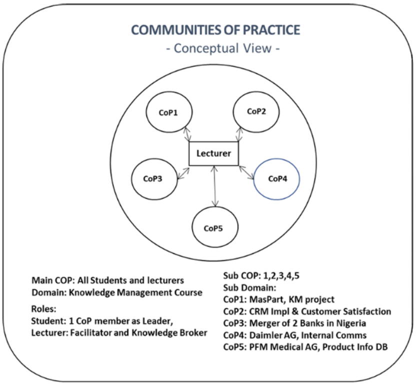

Fig. 2. Conceptual view phase 2. An example from a case study on CoPs and knowledge sharing at a University in West Finland [15].

6 Conclusion Remark and the Future Work

This research-in-progress paper has taken the first step towards promoting knowledge sharing by forming a conceptual framework incorporating a community of practice for students in a university, working in a classroom setting. We argue this is a prerequisite in order to create an environment where students will be able and willing to engage in co-creation of learning value with their peers, lecturer(s) and other stakeholders. Furthermore, we review the literature to explore if the service-definition logic (S-D) logic concept can be applied for promoting value co-creation in a university. It is hopped by further framing these concepts, the tertiary insitutions and educators could make the classes more interactive and interesting, and establish the learning situation to let the lecturers and students realizing the education value.

As the next phase of the study, works are necessary to further develop and apply the "learning model" in a business course. After completion, data can be collected from the observation during the classroom sessions and semi-open interviews with the students to assess whether knowledge sharing and co-creation of value have taken place between the students, lecturers, universities and other stakeholders.

It is believed that for the later, a study can use, among other methods, the concept of "cycle and measurement of value creation" [14]. Moreover, future research can conduct a comparison of multinational empirical data that will help to highlight the differences influenced by the demographical factors such as cultural, policies, and resources.

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Knowledge Sharing in a Virtual Community: Business Case in China

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Abstract. A virtual community is defined as a group of people with similar interests and ideas who are connected over the Internet. In Virtual Communities of Practice (VCoP) it is expected that individuals can exchange their ideas and knowledge in areas of a particular expertise that users have. This paper focuses on the motivations for individuals' willingness to share their knowledge in professional VCoPs and facilitates the innovation process. The purpose of this paper is to construct a conceptual model that explains factors affecting users' participation in VCoPs. First, there is a brief review of previous studies on the success factors that enable individual's knowledge sharing and community loyalty. The paper then presents a business case study in China where a professional virtual community was created so as to deliver business values to its host company and its members.

Keywords: Knowledge sharing · Virtual Communities of Practice (VCoPs) Business case

1 Introduction

A virtual community is a kind of social network where individuals with similar interests and backgrounds are connected via the Internet platforms (e.g. discussion forum, social network sites (SNSs), online chatrooms, weblogs, etc.). It is commonly believed that an individual's knowledge sharing is the important element for the concept of a virtual community [8, 21, 23, 24]. Therefore, companies can now leverage the collaboration among members in virtual communities through some facilitations. Through the ease of the virtual community's knowledge sharing and interconnectivity of people, companies can enable the innovation process and develop their employees' creativity [19]. Perceived participation in the virtual community can result in an innovation experience.

Voluntary participation is the key to a virtual community. It was found that social contracts and trust are important for the success of virtual communities as they motivate individuals to participate in them [20]. Yoon and Wang also found that social interaction ties and identification with social capital have significant effects on the individual's knowledge sharing intentions and knowledge quality in virtual communities [22].

Willingness of participation and incentive mechanisms in virtual communities are important topics as they facilitate knowledge sharing [3]. Liao et al. constructed structural equation models to test the motivations of individual users' attitudes toward knowledge sharing in the virtual community [11]. With a sample of 473 Taiwanese

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participants in the study, they found that utilitarian motivation (reciprocity, reputation), hedonic motivation (enjoying helping), control belief (self-efficacy) and contextual force (sharing culture) affects users' intention to share their knowledge in the virtual communities. Lin and Huang tried to test user knowledge sharing behaviour in Google Answers [10]. They also found that non-monetary rewards, such as advanced ranks in the communities and the need for self-fulfilment, are important motivators for users' knowledge sharing in virtual communities.

Apart from those virtual communities formed voluntarily without predefined objectives, virtual communities of practice (VCoPs) are established in the workplace for specified tasks, where all registered members benefit from participation and the sharing of expertise. Individuals' willingness to share the knowledge they own in a VCoP is an important research area. Table 1 summarizes the previous knowledge sharing studies on the use of VCoPs in particular disciplines. Obviously, the motivators (i.e. trust and incentive) of people participating in a VCoP and technological factors have been popular research areas over recent years. The level of user participation in VCoPs has been the common dependent factor in previous studies. Of particular concern are the barriers affecting a user's participation in VCoP.

2 The Case Study in China

LKKER China (http://www.lkker.com/) is an open online platform that was launched in 2016 for product innovation and design (Fig. 1). Its business model creates value by facilitating information sharing and exchanges among its registered users (i.e. designers, corporate buyers, end-users and investors). It aims at speeding up the product design process and easing communication between designers and clients. 'Everyone can be a designer' is its core concept. Freelance product designers around the world can enjoy the online marketplace provided by LKKER. To the corporate buyers, it enables access to the virtual design team of 30,347 registered designers (i.e. the figure in November 2017). From the crowdsourcing process, the registered designers can get paid for their designs. They can even compete with some well-established design agencies.

Table 1. Previous knowledge sharing studies on the use of virtual communities of practice (VCoPs)

Year of publication	Authors	Discipline	Major findings
2005	Dubé, Bourhis, Jacob	Several organizations from public and private sector, para-governmental	Organizational structure of an organization and the success or failure of a VCoP at the launching stage
2006	Ardichvili, Maurer, Li, Wentling and Stuedemann	Engineering	The cultural factors on knowledge seeking and sharing patterns in a VCoP
2009	Cook-Craig, Sabah	Social work	The effect of VCoP usage, the impact that organizational endorsement of organizational learning has on worker involvement in the community

(*continued*)

Table 1. (*continued*)

Year of publication	Authors	Discipline	Major findings
2009	Curran, Murphy, Abidi, Sinclair, McGrath	Health	Knowledge seeking and sharing behaviour in a virtual community of emergency practice
2010	Sabah, Cook-Craig	Social work	Test a model of organizational learning designed to teach social workers how to use learning to change practice
2011	Majewski, Usoro & Khan	R&D	Developed and tested a model for knowledge sharing (norms of reciprocity, trust in the perception of community and knowledge provision and reception) in VCoPs
2012	Eggs	Research institution	Develops a model of trust with human capital, structural capital and relationship capital in a VCoP
2014	Nistor, Baltes, Dascălu, Mihăilă, Smeaton & Trăuşan-Matu	Education	Verified the technology acceptance model in the participation of a VCoP
2015	Jiménez-Zarco, González-González, Saigí-Rubió, & Torrent-Sellens	Health	The perception of efficiency and effectiveness in collaboration with the members of the VCoP as positively influencing the perceived satisfaction
2015	Nistor, Trăuşan-Matu, Dascălu, Duttweiler, Chiru, Baltes, & Smeaton	Education	Based on the polyphonic social knowledge building model, appreciates an automated dialogue assessment in the Internet-based argumentative open-ended learning environments
2016	Adedoyin	Social work	Review on the use of VCoPs as a type of digital tool in enhancing the social work profession.
2017	Mutamba	Education	Develop an inter-relationship between organizational learning, learning organizations, virtual technology, and VCoPs
2017	Ponsford, Ford, Korjonen, Hughes, Keswani, Pliakas & Egan	Health	Identify the main barriers using VCoPs as a proliferation of information sources

Traditionally, when a company is looking for a product design or new marketing concepts, the company buyer will approach an individual designer or agency for the outsource project. With the open platform powered by LKKER, corporate buyers can set their own budget and get access an unlimited number of designs worldwide to

Fig. 1. The landing page of LKKER, in Chinese (http://www.lkker.com/)

consider per project. The number of design ideas that clients can receive depends on the scope of their project and the information they provide on the platform. They can receive the completed design services based on their specified needs and preferences (see Fig. 2). The freelance registered designers can refine their work in response to the feedback and ideas from the platform. Therefore, both sides need to be able to freely exchange information on the platform. The corporate buyers will have the final say over which design will receive the business deal (Fig. 3). It is mutually beneficial for both business buyers and designers.

The core management team of LKKER includes several famous industrial designers in China and they are responsible for leading the way in the innovation process. Table 2 lists the key development stage of the platform.

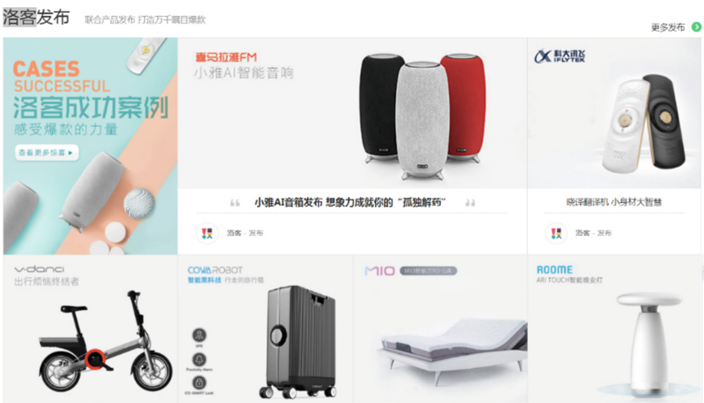

Fig. 2. The success design project from LKKER platform, in Chinese

Table 2. Key development stage of the LKKER open design platform

Period	Key development stage
16 August 2016	LKKER official platform launched
26 July 2016	Second offline promotion event
17 July 2016	Promotion in APEC SMETC
30 June 2016	First live broadcast with 300,000 views
16 June 2016	LKKER platform beta version tested
26 May 2016	Crowdfunding for RMB10,000,000 design project
6 May 2016	First offline promotion event with 100+ famous designers in China
11 March 2016	First crowdsourcing project launched
2 February 2016	Concept of LKKER open platform founded with 5 founders

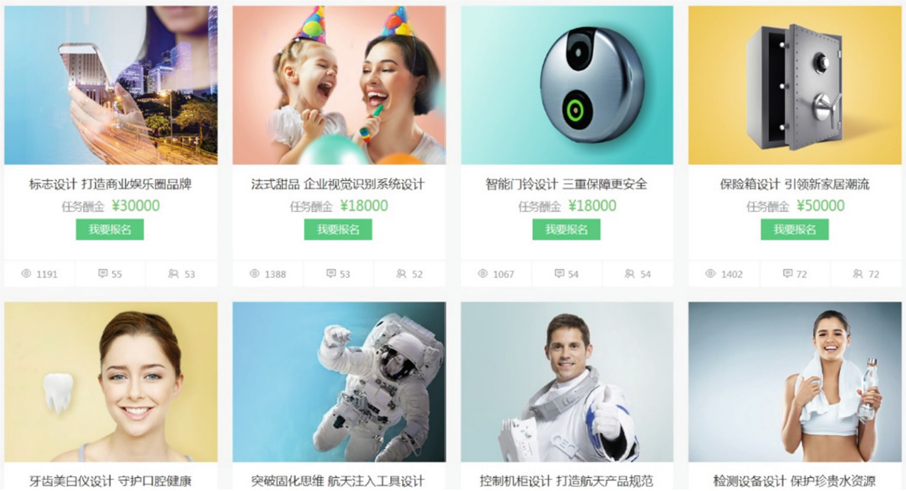

Fig. 3. Current project from LKKER platform, in Chinese (http://www.lkker.com/taskList)

To access the platform for the first time, both designer and corporate user need to register, as shown in Fig. 4. A unique user ID and passwords can be assigned by the user. The user ID will be validated via the mobile phone with validation passwords. For the corporate user, more details will be asked about their business nature so as to categorize their design projects (Fig. 5).

After logging into the platform, users can browse available design projects by different category. They can select a particular project and detailed information will be provided (Fig. 6). Designers in a collaborative setting provided can benefit from the open discussion among other designers (Fig. 7). It can be assumed that throughout the discussion process on the platform, people will read those comments and participate in the discussion. According to this framework, designers build on their knowledge through their active participation in discussing and sharing ideas with other registered users (Fig. 8) on the platform. They actively engage in the process when showing their interests in a particular design project by mutually explaining the project contents, giving feedback and asking relevant questions.

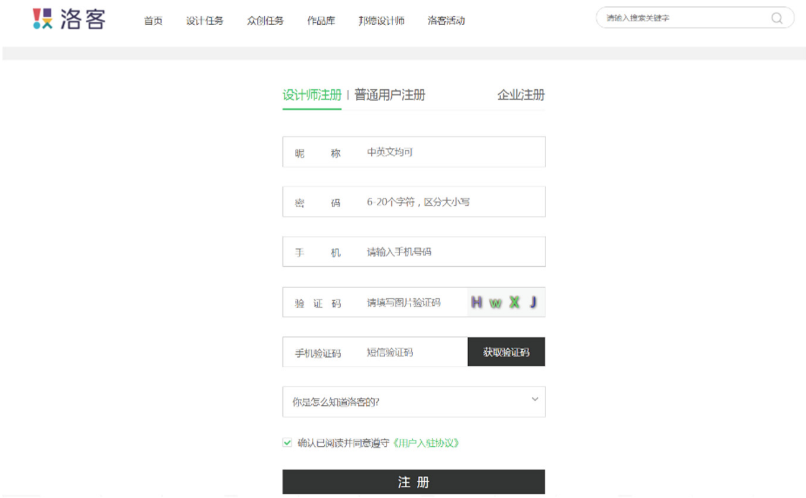

Fig. 4. User registration page (individual designer), in Chinese (http://www.lkker.com/goRegister)

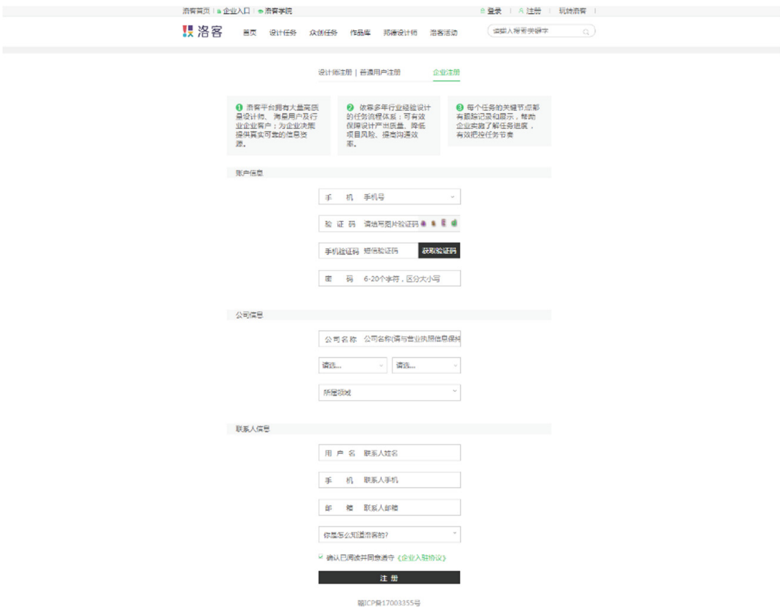

Fig. 5. User registration page (corporate user), in Chinese (http://www.lkker.com/goRegister)

Fig. 6. Project sourcing information for designers, in Chinese (http://www.lkker.com/t/twk43ba22w33o)

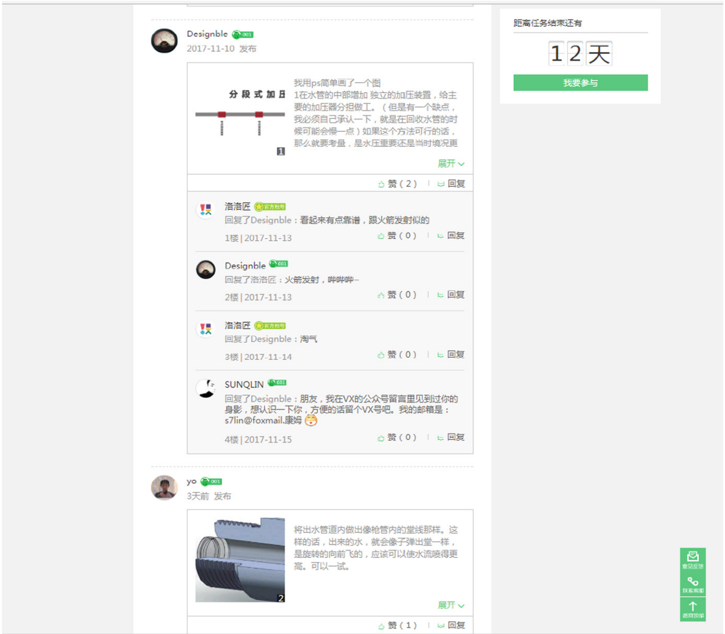

Fig. 7. Information sharing on the platform, in Chinese (http://www.lkker.com/c_i/pqnlr7mnd7vk3)

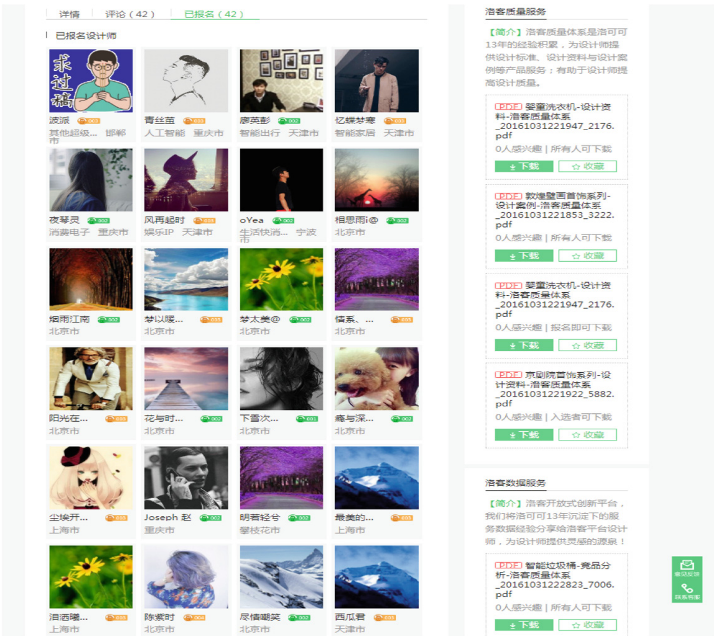

Fig. 8. User profile in particular project discussion, in Chinese (http://www.lkker.com/t_e/twk43ba22w33o#main-ct-box)

3 Conceptual Framework and Research Questions

Building on prior research, the conceptual framework presented here posits the individual as an active agent within the institutional and social environment operate in the selected business case. Four key constructs and the demographic parameters of this model are shown in Fig. 9 below. Four research questions were developed from the previous empirical studies discussed in Table 1 on the basis of the causal linkages in this model.

Research Question 1: Is there any positive relationship between the project financial reward and the participation on the platform?

Research Question 2: Is there any positive relationship between the number of users and their participation on the platform?

Research Question 3: Is there any particular topic that users prefer to discuss on the platform?

Research Question 4: Are there any gender and experience effects' on the participation on the platform?

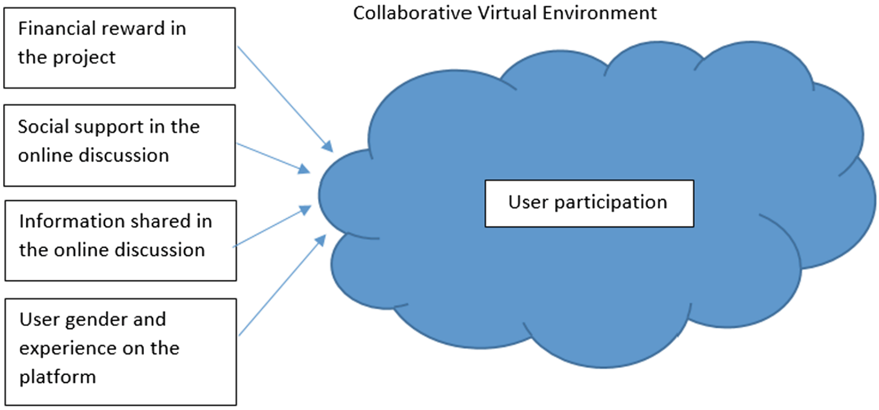

Fig. 9. Conceptual framework

4 Proposed Research Design

A qualitative study was proposed to investigate the research questions through direct observations and content analysis on the comments collected on the platform. Researchers will consistently take notes while observing and reflecting upon the online discussions on the platform over a specified time period. Those data will then be translated, grouped and coded. Two researchers independently backward translate the data and validate them. Patterns from the data will then be extracted and sorted into categories and sub-categories, according to their common themes and meanings. Finally, using the research questions as a guide, and will be discussed accordingly.

5 Concluding Remarks

It is generally accepted in the innovation process that the generation of individuals' ideas are facilitated by interactive communication with other people. The online interaction provided by the VCoP appears to have compensated for a lack of personal social interaction. In addition, technology enables anyone to be reached from anywhere in the globe. It would seem that the level of interaction in a virtual community is at least as good as in a traditional physical workplace. Indeed, this interaction and collaboration is, in many ways, more flexible and extensive than in the physical environment. The case study in China suggest that an open VCoP can be a vehicle for innovation and creativity. The study also identifies some motivators in developing an effective VCoP for business functions.

Nevertheless, VCoP still faces numerous challenges – most of which are associated with the technology. These include the following:

- Participants need to have fast and stable Internet access to communicate with other business partners in the innovation process;
- Participants need to be active in their own knowledge sharing process – that is, they need to make use of the information technology to extract knowledge for their own distinctive purposes.

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Collaboration and Knowledge Sharing as a Key to Success of Entrepreneurial Ecosystem

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Abstract. Collaboration and active interaction among people with different backgrounds is crucial in order to be able to solve complex and multidisciplinary problems experienced by start-up entrepreneurs. Their success is depending on social relations pattern over a set of persons, positions, groups, and organizations. The need for the collaboration has increased over the years as start-up entrepreneurs are competing with global players with advanced personal, financial, technological and other resources. Therefore, this paper describes and analyzes a complex collaborative environment to support knowledge sharing and coordination of actions to increase success rate of new entrepreneurs in the Zilina region. During the past seven years a collaborative environment around which motivated individuals organize themselves to attain a common objective has been developed.

Keywords: Collaboration · Start-Up · Ecosystem · Entrepreneurship Stakeholders · Knowledge sharing · Social network

1 Introduction

In our previous papers [15, 16] we focused on the development of an entrepreneurship ecosystem in the Zilina region. After many years of trials and errors we have created ecosystem in which people, organizations, programs, etc. are well managed in order to achieve effective coordination of their actions. This positively impacted the establishment of new companies that were able to sustain on the market for a longer period than before. Most of the new startup entrepreneurs that were "nurtured" in the Zilina ecosystem successfully survived the first period of their entrepreneurial journey called "Death Valley". Some of them are even serial entrepreneurs nowadays.

We observed that coordination of actions and just-in-time knowledge sharing was the crucial change that contributed to success. In the Zilina region there are several actors that have substantially helped to the development of the ecosystem. These were active individuals from various organizations that were passionate about supporting the entrepreneurship in the region and created not only a university course but several events to support the emergence of new companies. In the last three years new projects

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have been implemented that has helped start-up entrepreneurs such as University Science Park, Research Centre, National Business Center, etc. Those projects have had a major impact on the ecosystem as we had not experienced such huge and impactful projects in the past.

During the past seven years we have been focusing on the activities and constantly rebuilding the content of the university courses or events to be up-to-date and reflect new trends and theories. We found out that content of the course or events did not cause the problems that new start-ups were experiencing. The only problem was consistency and the lack of coordination of actions. The major problem has still stayed undiscovered, until now.

Due to the lack of motivated people who have been collaborating and helping each other the new start-up companies experienced problems that led to their bankruptcy. By studying dozens of local companies and their problems we found out that insufficient expertise and resilience to collaborate was their biggest problem. Despite the fact that most of the programs and events have provided significant knowledge to the founders their lack of expertise in various areas such as sales or finances contributed to ongoing problems. Due to the lack of knowledge in various business areas they were not able to substantially develop their business plans which resulted in refusal of investors to invest in their businesses. On the other had it led to the bankruptcy of these start-up companies as they were no longer able to finance the development of their start-ups.

In our paper we analyze entrepreneurial ecosystem in Zilina region and provide recommendations for further development of collaboration activities among main actors in order to increase the success rate of emerging start-ups. Related theoretical background is investigated as well as the research methodology is described. Benefits and on contrary drawbacks of collaboration were described in order to analyze ecosystem and draw conclusions.

2 Literature Review

Inter-firm collaboration has become an ever-present phenomenon in corporate practice. Since the 1980s, the frequency and diversity of corporate alliances have increased continuously [8].

In the case of entrepreneurship ecosystem development inter-firm collaboration is inadequate. Cross-sector collaboration is more appropriate. This type of collaboration is the interaction of two or more organizational sectors: the public sector (governmental units at all levels - local, state, and national), the private or for-profit sector, and the nonprofit or not-for-profit sector [9].

Cross-Sector collaboration is the voluntary linking of organizations in two or more sectors in a common effort that involves a sharing of information, resources, activities, capabilities, risks and decision-making aimed to achieve an agreed to public outcome that would have been difficult or impossible to achieve by one organization acting alone [5].

2.1 Successful Collaboration and Its Main Factors

Whereas social networks view collaboration from societal relationship standpoint, public administration and public management focus on inter-organizational collaboration or multi-organizational arrangements; it applies similar elements to actual public entities and managers [3, 6, 12].

Agranoff cites the bringing together of many parties, knowledge expansion, and possibility of new solutions as additional benefits of successful collaboration [3, 6]. Emerson, Nabatchi, and Balogh (2012) discuss "uncertainty" as a main driver for collaboration, and the potential to reduce, diffuse, and share risk throughout the process. Finally, several case studies showed how working together over a sustained period of time allowed "collective process skills" to accrue [3, 6, 7].

Lovecek et al. talks about bringing together different skilled people to collaboratively solve complex problem. Tools can help to effectively solve these problems [11].

Several sources identify the need for the "right people" to be incorporated in the collaborative process [1, 2, 6, 7, 13]. In addition to this inclusivity element, successful collaboration requires an acknowledgement of the interdependence among actors as well as a need for joint commitment [4, 6, 7, 10, 12, 14].

As conflict or dealing with differences is likely with such a large, diverse stakeholder group, successful collaboration will identify processes for effectively dealing with these situations [3, 6, 10]. These may require acknowledging an inherent power imbalance within the network; "different actors can occupy different role positions and carry different weights" [3]. Empirical researches generally highlight the influence power and resource imbalance can have within a collaborative system. Several sources cite the utilization of purposeful interaction to build trust and combat these possible issues [4, 6, 12]. Emerson, Nabatchi, and Balogh (2012) refer to this as "principled engagement" and highlight the advantage of face-to-face dialogue at the onset [6, 7].

Based on the literature review and analysis of good practices there were listed the significant benefits, success factors and also barriers of successful collaboration process in the Table 1. It is general knowledge that the collaboration barriers can lie in people, money, technology, etc. But it is difficult to understand and be able to describe what is really hidden behind those words.

Based on our previous studies [15, 16] we found out that the failure of collaboration activities towards developing the Zilina ecosystem was caused by lack of coordination of actions as well as imbalance between effort and benefit of their activities. The leaders felt for a long time that there is huge asymmetry in effort (time and money put into activities) and benefits (measured as number of founders successfully developing their start-ups, number of intrapreneurs, etc.).

We believe that the main motivational factor for collaboration can be balance between effort and benefit. It is difficult to be motivated and contribute to the society by developing solid base for entrepreneurship when people see just a lot of hard work ahead and the vision of the return of the endeavored effort seems miles away.

Table 1. Benefits, success factors and barriers of collaboration [6]

Benefits		Success factors	Barriers
Solutions that allow for mutual benefit among participants	Expanded resource base (information, problem-solving options, knowledge, etc.)	Identification of shared vision/interest	Vulnerability to external changes
Improved decision-making	Broader information/perspective on system issues	Perceived interdependence	Opportunistic behavior
Improved problem-solving	Increased opportunities for efficiency	Avoiding power imbalance	Complexity of exchanges/high transaction costs
Increased ability to resolve/prevent conflicts among participants	Decreased individual risk	Willingness to share information and resources	Differences in risk, risk perception, and risk aversion
Increased desire to collaborate among participants	Increased risk sharing among participants	Clear and documented expectations, commitments, and roles	Asymmetry in costs and benefits
Increased interaction among participants	Increased ability to handle uncertainty	Evaluation and feedback mechanism	Cultural/organizational threat to control
Increased "social capital" (improved reputation, improved relationships, improved collaboration skills)	Increased ability to adapt to changing environment	Effective conflict resolution	Inconsistent membership/high turnover within system
Increased interdependence among participants		Open, repeated communication	
Increased reliance among participants		Mutual respect, understanding, and trust	

3 Research Methodology

Qualitative research was used as core method for data collection. We used the following methods: a **case study describing Zilina entrepreneurial ecosystem** (analysing, summarizing and evaluating the current state of the ecosystem in Zilina city, including relevant stakeholders and relation among them), **content analysis** of the secondary data from websites related to entrepreneurship, collaboration and scientific literature focused on main principles of collaboration and its importance for creating collaborative entrepreneurial ecosystem.

We evaluated the information sources along these factors: what is the current state of start-up ecosystem in Zilina, who are the main actors, what type of collaboration is between those actors and how these actors affected the ecosystem. Data was collected from September 2017 to December 2017. Through the process of triangulation, we used various types of evidence to examine the phenomenon of building start-up ecosystem for new entrepreneurs.

The main question of our research was: *What is the key element contributing to success of start-up entrepreneurs within the Zilina ecosystem?*

4 Analyses of the Start-up Ecosystem in Zilina Region

Gradual improvement of ecosystem is needed in order to improve conditions for the development of new start-up companies with innovative products. Events like *Startup weekend or Hackathons* are helpful in initial validation and further development of entrepreneurial ideas. Organizations are supporting young entrepreneurs with mentoring and financial support at the beginning of their career as entrepreneurs. National and EU projects are helpful in supporting incubator and accelerator activities for start-ups as well as providing free consultancy and events to develop their business skills. However, none of these activities would be sufficient without human interaction and management.

There are several crucial actors in Zilina start-up ecosystem that has provided unique base for emergence of new start-ups. Collaboration of those actors was inadequate due to the fact that the region is so small they felt the need to compete not collaborate. The linkages between actors in the ecosystem are shown in the Fig. 1.

Over the years we have realized that ecosystem is not about the organizations, initiatives, projects, investors, events, companies, etc. (actors), however, it is about the people involved in developing and sustaining the start-up spirit in the region.

Their continuous engagement in entrepreneurial activities has been maintaining and improving the ecosystem. Their spirit is motivating others to start a business as well as keep motivation to run business even during the difficult times. Their networking skills are crucial when connecting young entrepreneurs with investors, media, mentors, etc. Their experience in various fields of business and involvement in many projects has been crucial to succeed in knowledge sharing among the new entrepreneurs.

Each ecosystem has own leaders and so does the Zilina region ecosystem. These leaders organize regular meetings (quarterly, annual) to evaluate the state of the Zilina region ecosystem. Based on their evaluations, leaders together with other experts from companies, government agencies and university search for new ways how to succeed and maximize the outcome of their efforts. These meetings are contributing to innovativeness of the approaches in the ecosystem development.

The aim of this analysis is an identification of main actors of start-up ecosystem in Zilina region, analysis of their impact on the ecosystem and their collaboration activities in order to achieve continuous improvement of the ecosystem.

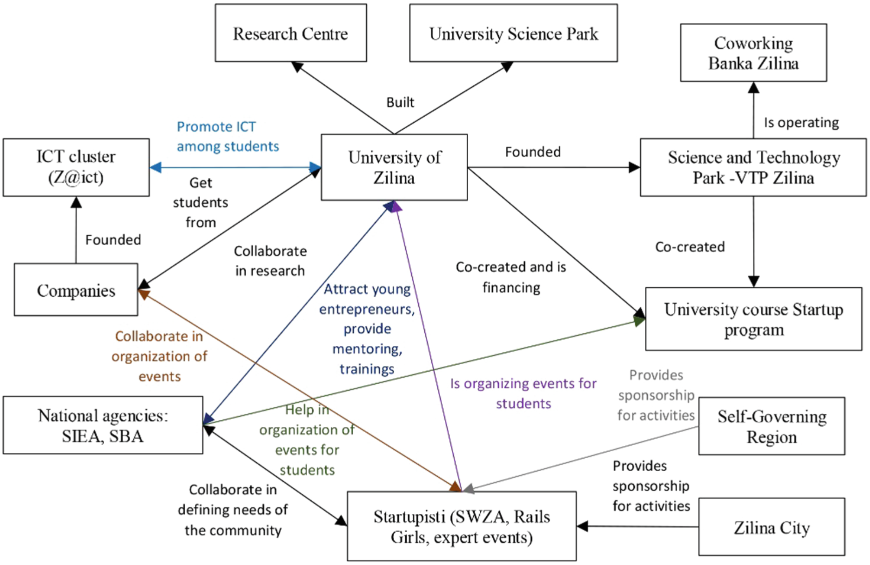

Fig. 1. The linkages between stakeholder players in the ecosystem

4.1 Research Centre and University Science Park

Research Centre and University Science Park are organizational units of the University of Zilina and moreover EU funded national projects. Thanks to these projects many unique technologies were bought as well as a lot of researchers get a chance to work at the Science Park or Research Centre in order to conduct an advanced research and contribute to improvement of applied research and its commercialization. Within these projects incubation and acceleration activities were planned. Those activities were aimed mostly for researchers in order to help them with commercial application of their research results and creation of spin-off companies. These projects ended but the activities within them are still ongoing. These projects had major impact on the research community as well as the whole entrepreneurial ecosystem mainly because of the advanced technologies and skilled people working for them. Without these project commercialization of the research results will be done traditionally and more intuitively which would not lead to better results.

4.2 University of Zilina

University of Zilina (UNIZA) is providing students with the possibility to attend the whole-university subject called Startup program. This program is two-semester and students are getting grades as well as credits for taking the classes and fulfilling the program requirements. Program consists of events such as lectures and workshops where students go through several business topics and are challenged to validate and develop their business ideas into working prototypes. Those are tested with customers. Program ends when students validate their minimum viable products. Marketing and selling tactics are being taught, however not trained in real-life situations as they are required to market and sell their products after the completion of the program. We challenge them to continue in that and provide them with the opportunity to participate in other events or match them with mentors based on their needs.

Several consultants became a part of this program during their PhD studies in 2011. Three of them stayed program leaders. Their background and experiences are very important for the program operation and development. Their skills and importance is described in the following section.

Without the university course students will not be able to learn advanced entrepreneurial skills and so they would not be encouraged to become entrepreneurs or they will give up when first problem arises. As we teach them to be fearless, establish start-up and develop their start-up based on the lean methodology they were able to become real entrepreneurs. Some of them are "magazine stars" and appeared in e.g. Forbes 30 under 30.

4.3 People

There are only few active members of the community that have been constantly working on supporting the entrepreneurship in the Zilina region. Most of them met during their PhD studies at UNIZA and since that they have been active leaders of the community. All of them studied abroad, have long-term entrepreneurial experiences, were part of accelerator programs, worked for investors and startups. They have been involved into many national and EU projects focused on innovation and entrepreneurship. They are regularly invited to participate in various discussion forums and events as experts for entrepreneurship and startup problematic as well as to lead various workshops for development of start-up ideas in different cities in Slovakia.

These start-up community leaders developed an initiative called **Startupisti** which consist of the Facebook group where all young entrepreneurs help each other in the development of new ideas, Facebook page where they share events for young entrepreneurs as well as webpage where they can find other start-up related information. They also help start-ups with matchmaking with investors, mentors, or co-founders. They are in touch with media such as Forbes where the community leaders are asked to advice about the ecosystem and recommend new start-ups to publish their stories.

The Facebook group has reached more than 4000 members which makes it the biggest start-up medium for like-minded people who want to pose start-up related questions and receive well-founded answers.

Organizing events was possible thanks to the founders of startupisti.sk portal who were able to attract funds from various foundations. Those events were unique and we were able to receive positive feedback from the community. More than 500 people attended these events.

People as well as social media have significantly contributed to the success of the ecosystem. Thanks to the community leaders we were able to establish solid base for new star-ups. Leaders are interconnecting all the ecosystem elements together and so the synergistic effect can be achieved. Only by coordinating the otherwise fragmented actions we were able to successfully achieve well-functioning ecosystem. Linkages between leaders, local companies, universities, governmental agencies and national projects are crucial in order to fully exploit the potential of the ecosystem. These linkages were able to be established only thanks to the leaders.

4.4 Coworking Space Banka Zilina

Banka Zilina is the only coworking space in Zilina. It is operated by an organization VTP Zilina which was established in 2001 with the aim to support new entrepreneurs. Since 2003 it has been an operating as business incubator at the campus of the University of Zilina. There were around 25 start-up companies in September 2015. Since 2015 VTP has started to run the coworking space called Banka Zilina. VTP Zilina was an Association of legal entities. It included partners such as Zilina city, University of Zilina, IT cluster, etc. VTP as the Association of legal entities was dissolved at the beginning of the 2018.

In this coworking space there are organized a lot of various events such as lectures, workshops, discussions, competitions, team meetings, conferences, etc. VTP Zilina came up with the original idea of the development of the Startup program subject at the UNIZA. Many events connected with the Startup program are held in Banka. Banka Zilina is substantially contributing to the ecosystem in Zilina region by providing office space to new entrepreneurs, connecting them to events, local companies, people, etc.

4.5 Companies

Collaboration with the companies has a huge impact on the ecosystem and has a great added value because the main idea of all start-up activities is to bring practice into theory. Community leaders collaborate with many companies at different levels. This network is great and it has been built for several years. Many experts from local companies participate in the start-up activities regularly. They are helping as lecturers, motivational speakers, consultants, etc. In most cases even CEOs and senior managers participate. It depends on the nature of the activity. All activities towards start-ups has been regularly financially supported by local companies as the important projects has not been implemented yet. Young people may attend the internship programs in companies or they can collaborate with the company on their start-up projects. A lot of start-uppers get a job in some company after they fail in their start-up. These people are very valuable for companies as they are self-motivated, active and willing to learn.

4.6 Slovak Business Agency

Slovak Business Agency (till 28/2/2014 the National Agency for Development of SMEs) is crucial, and is the oldest specialized non-profit organization for the support of small and medium-sized enterprises (SMEs). Slovak Business Agency was founded in 1993 by a common initiative of the EU and the Government of the Slovak Republic. It is the unique platform of public and private sectors. The founding members include: Ministry of Economy of the Slovak Republic, Entrepreneurs Association of Slovakia, and Slovak Association of Crafts.

Slovak Business Agency is implementing national project in Zilina region called The National business center in regions (hereinafter “NBC”). NBC offers comprehensive support to small and medium-sized enterprises (SMEs) and those interested in starting their business.

The main mission of the NBC is to implement the concept of a one-stop-shop offering a wide portfolio of information and supplementary services to all starting and established businesses in different stages of their life cycles and aspiring entrepreneurs as well as to creative and innovative people who are considering commercializing their idea or product.

This project has substantial impact on the system in Zilina region as the investments to support start-ups by providing them opportunities to attend international conferences, internships abroad or have a consultant for start-up pro bono are unique in Slovakia and especially on a regional level. Project includes also organizing events for start-ups which will financially relieve local companies.

4.7 SIEA

Slovak Innovation and Energy Agency (SIEA) carries the information service for the Ministry of Economy of the Slovak Republic, with special focus on innovations and energy sector. It gathers processes and disseminates information related to the increase of energy efficiency, using of renewable energy sources, combined heat and power and the development of innovation activities.

They launched the project Inovujme.sk. Project aims to raise awareness of the importance of innovation among Slovak micro, small and medium-sized entrepreneurs, as well as among secondary and high school students in all regions. Its main task is to increase Slovakia’s innovation potential. Expert information about innovations spreads through the tools targeted at individual target groups: Regional consulting centers, various activities for students, all-day conference, seminars and workshops, analyzes and forecasts.

A communication with the representatives from SIEA started in the event Innovative Development of the Regions in 2017. The representatives have presented project goals to community leaders and they mutually agreed to collaborate. Our collaboration is focused on the developing of the Startup program at UNIZA by organization of events for start-ups and bringing successful entrepreneurs and lecturers for this course.

5 Discussion

We made a lot of analysis in our previous papers and have adopted various conclusions focused on our Startup program or events we organize for the community. We compared different programs which are successful in the world and also studied a lot of literature to design specific and unique program. But we realized that the way to succeed is more complicated and problems reside in different areas not only design of the activities.

Last year we started to focus on searching for a true cause of the start-up companies' problems. We decided to examine and confirm the assumption that the problem may be in the people, their knowledge sharing and collaboration. This was the breakpoint of our analysis. We used more behavioral theories and started to think more psychologically and sociologically according to investigated literature. We changed our communication with many community actors and were more interested in the people around us.

Participants have been showing more interest into the activities we do. Therefore, we started to think about responsible, self-motivated and knowledgeable people around us who could become new community leaders. We will continue in our effort to make changes in the system of education and develop more successful collaboration with other stakeholders.

Based on the analysis part, recognizing the principles of the collaboration and our experience we realized the need for better collaboration and knowledge sharing between the start-up communities.

Many years we have been looking for motivated people who could become our followers and to start to manage the ecosystem and its activities independently. We need to think about better involvement of various types of people who could be an integral part of the ecosystem and collaborate in the activities:

- academics, researchers and people with theoretical background,
- start-up companies' founders,
- SMEs founders,
- experts with the various kind of knowledge,
- employees with the long-term experience in corporate sphere,
- volunteers with different backgrounds who could initiate activities in the ecosystem,
- people working for the city and self-government,
- etc.

In the case of entrepreneurship ecosystem everybody who is enthusiastic, motivated and happy to volunteer can add value to creation of the ecosystem.

Based on our research for a better collaboration and knowledge sharing between the actors of the community we found out that following needs to be fulfilled in order to have effective and collaborative start-up ecosystem:

1. **Human capital** which will help startups to develop their business ideas, provide them consultancy in every phase of their start-up development and thus increase their potential success on the market. This can be only achieved by the involvement of as many people from the ecosystem as possible so they do not feel overwhelmed by the help they are providing and do not loose motivation to conduct such activities in future.
2. The efficient collaboration requires the establishment and maintenance of strategic **innovation management** processes. Community leaders have to take this role and facilitate processes in order to achieve satisfying results. Community leaders can act as community or relationship managers. They can be even paid for such a role. University or regional authorities should pay for such a role.

3. **Evaluation** of the process so we can assure all actors are satisfied and defined goals are achieved.

Based on our research and experiences we know if there is no willingness for collaboration the continuous effort of people will fail. We found the linkages between our findings and the barriers that were described in literature.

Barriers to successful collaboration mostly concern external challenges or inherent differences among collaborating stakeholders. External factors such as legal or policy change can be a real barrier that limits or challenges the collaborative arena.

Collaboration requires openness, trust, and interdependence; none of which goes along with acting in one's self interest. In addition, collaborating parties having a different perception of risk or an asymmetry in collaboration efforts and benefits can cause the collaboration to break down. Within an entrepreneurial ecosystem, any problem can solve an effective management and active engagement of community leader. This leader can have a substantial impact on the success of the ecosystem. His/her role is very important as he/she can coordinate all actions towards common goals.

We have to also ensure that everybody who is receiving any kind of help should act reciprocally and once they achieve success they should be contributing to community as well. Their advices will be very valuable for new entrepreneurs as they can avoid their mistakes. Successful entrepreneurs will be motivated to share their stories and feel more accomplished if they can contribute back to the society.

6 Conclusion

Start-up ecosystem in Zilina region has undergone a major and at the same time positive changes. Many start-up companies struggled to survive on the market. We thought that is it due to the lack of events, wrong composition of Startup program, lack of mentors, etc. We have been constantly changing the content of events as well as rebuilding the university subject. However, we found out that inviting new speakers for various events, asking new consultant to be a part of the network and share their knowledge with young motivated people who have unique ideas was fruitful as it brought new ideas and experiences to community. This approach has proven to be right. The collaboration and just-in-time continuous sharing of the knowledge was a key to success as well. Knowledge management and collaboration in co-creation of the products of startups was necessary in order to help them sustain on the market.

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Knowledge Transfer and Learning

Model-Driven Design of a Mobile Product Training and Learning System

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Abstract. The widespread presence of mobile devices and their deep anchoring in everyday life of people bring along various use cases and business opportunities. Mobile learning is one case of application for mobile devices. Hence, it can be inferred that companies need to investigate adequate mobile learning and training scenarios for educating their employees.

Activity-oriented mobile learning allows employees to satisfy individual demands for product knowledge anywhere and anytime in their working context. However, as mobile learning is relatively new, didactical approaches to effectively transfer product knowledge have to be explored and validated. Based on literature, a didactical model to design mobile product training and learning scenarios was established.

By combining four didactical approaches, which are individual or socialized just-in-case training based on pedagogy and individual or socialized just-in-time learning based on andragogy, with four mobile delivery formats, which are access content, capture information, compute response, and communicate with others, the framework supports the development of scenarios for the acquisition of product knowledge.

In order to empirically validate the model, a field study with a company from the information technology industry has been conducted. By being guided through the design process, employees had to identify and describe mobile product training and learning scenarios.

A triangulated qualitative research study, consisting of a focus group and individual follow-up interviews to gather opinions about the final results, was conducted.

This paper presents an empirically validated didactical model, which can be used as a basis to design mobile product training and learning scenarios.

Keywords: Mobile product training · Mobile product learning
Empirical research · Mobile computing · Didactical model

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1 Introduction

The mobile age has revolutionized the daily life of humans with gadgets such as smartphones and tablets as well as with technologies that enable online data transfer without time or location constraints [1]. Thereby, it induced behavioral, habitual, and procedural changes that transform the way how humans act and interact.

"Learning can no longer be dichotomized into a place and a time to acquire knowledge (school) and a place and a time to apply knowledge (the workplace)" [2].

Accordingly, corporate learning environments run through conceptual and contextual transformations.

Nowadays, employees increasingly demand precise just-in-time information about company products in order to solve complex problems at work, or at any other location where they perform tasks related to their job. Hence, work-based, informal and mobile learning in means of equipping the workforce with required knowledge and skills are gaining relevance over formal classroom training. The increasing application of mobile learning can be ascribed to the availability of unrestrained internet capacities, wireless communication and ubiquitous mobile devices [3, 4], as well as to the rising mobility of employees. Since more and more employees are travelling in the course of their job or interacting with teams spread over different continents, organizing classroom trainings with mandatory physical presence turns out to be challenging for companies.

Mobile devices already play an important role in our daily business and the market for those devices and their applications has been growing rapidly [5]. The integration of the technological developments in the field of mobile computing leads to a significant change of the way how people work and communicate. However, as mobile learning is relatively new, didactical approaches to effectively transfer product knowledge have to be explored and validated [6].

The central aim of the project is to empirically validate the developed didactical model which supports the design of scenarios for an enterprise wide mobile learning and training system in the workplace.

Thereby, the field of research is concerned with evaluating mobile learning didactics that enable employees to improve their knowledge of corporate products, which account for the core business and products of the company. The identified and described scenarios are the basis for the further implementation of the system.

2 Theoretical Background and Related Work

The development of work-based mobile learning didactics for transferring product knowledge requires a consideration of adult learning, which "is defined as the process of adults gaining knowledge and expertise. Additionally, the ideas that (1) learners universally want to have control over their learning process and (2) learning increases as a result comes from" [7–9] adult education.

2.1 Pedagogy and Andragogy

Andragogy is an adult learning theory that opposes pedagogy, as the following definition demonstrates:

"A distinction between the concepts of pedagogy and andragogy is required to fully grasp the concept of andragogy. The pedagogical model, designed for teaching children, assigns to the teacher full responsibility for all decision making about the learning content, method, timing, and evaluation. Learners play a submissive role in the educational dynamics. In contrast, the andragogic model focuses on the education of adults and is based on the following precepts: adults need to know why they need to learn something; adults maintain the concept of responsibility for their own decisions, their own lives; adults enter the educational activity with a greater volume and more varied experiences than do children; adults have a readiness to learn those things that they need to know in order to cope effectively with real-life situations; adults are life-centered in their orientation to learning; and adults are more responsive to internal motivators than external motivators" [7].

When it comes to practically implementing pedagogy or andragogy, both approaches differ in content and process. The pedagogical approach is a content model deployed in traditional education, in which the teacher chooses in advance what is taught. The teacher then structures the content into logical units and selects an appropriate transmission method to present the content, such as lectures, readings, or exercises. The anagogical approach, on the contrary, is a process model in which learners are provided with procedures and resources that help them acquiring knowledge and skills according to their needs. The andragogic instructor facilitates the learning process by guiding learners through eight phases: (1) prepare learners; (2) establish a climate that is supportive for learning; (3) involve learners in planning for their learning; (4) involve learners in diagnosing their own learning needs; 5) involve learners in formulating their own learning objectives; (6) involve learners in designing learning strategies; (7) help learners realizing their strategies with adequate techniques and materials; (8) involve learners in evaluating their learning outcomes [7]. When considering these differences, it can be implied that pedagogy applies to conventional product trainings, whereas andragogy rather supports work-based mobile learning.

2.2 Work-Based Mobile Learning Scenarios

Pimmer [10] created a framework for corporate mobile learning scenarios, in which they divide work-based mobile learning into four different scenarios:

- *Individual just-in-time learning* is based on human-computer interactivity. It implies that an individual employee acquires desired knowledge just-in-time by interacting with a learning object, the mobile device. Depending on the learner's input actions, such as a search request, the mobile device returns implicit or explicit feedback that is immediately relevant for ongoing work processes. Individual just-in-time learning scenarios may be performed through learning by doing, for example by viewing tutorials on how to repair a product while actually fixing it; or through experience reflection, for example by taking notes on how a product has been fixed in order to internalize it.
- *Individual just-in-case learning* is also based on human-computer interactivity. It implies that an individual employee interacts with a learning object, the mobile device, in order to learn just-in-case. Knowledge acquired in this way has potential value for future application, although it is fairly unpredictable whether and when it exactly will be needed.

- *Interpersonal just-in-time learning* is based on social interactions between humans. It implies that employees deploy mobile devices to engage in collaborative learning, teaching, or coaching in order to acquire desired knowledge just-in-time. Feedback received from or given to peers, mentors, or teachers has immediate relevance for ongoing work processes. Interpersonal just-in-time learning scenarios may be performed through learning by doing, for example when experienced peers show others how to conduct certain job tasks while working; through experience reflection, for example when employees interactively talk about job tasks while performing them; or through sharing new insights and learning with others, for example by communicating with each other through messages.
- *Interpersonal just-in-case learning* is also based on social interactions between humans. It implies that employees deploy mobile phones to interact with each other in order to acquire knowledge just-in-case. Feedback received from or given to peers, mentors, or teachers has potential value for future application.

According to Pimmer [10], individual just-in-case scenarios will be the prevailing form in corporate settings in the near future. Although delivering moderate benefits, they are relatively easy to implement. This will be followed by individual just-in-time learning. Interpersonal just-in-case learning is in the third place, whereas interpersonal just-in-case learning scenarios will become established at last due to more complex implementation procedures. Scenarios with social interactions potentially create more motivating learning environments due to possibilities for coordination, coaching and collaboration. Likewise, [11] points out that mobile learning is not only about content but also about communication. Hence, connecting the right people when and where needed is critical for creating useful mobile learning scenarios.

2.3 Mobile Delivery Formats

Quinn [11] determines four basic mobile delivery formats:

- *Access content* implies that learners can retrieve information through dynamic media such as audios or videos, or static media such as graphics, photos, or text. This may be performed to occupy idle time, or to retrieve contextual information, e.g. required product information while consulting with a client.
- *Capture information* enables learners to record temporary events with mobile device sensors such as camera, microphone, text entry, or GPS in order to make information storable or conveyable. This may be performed to share the context for communication and problem solving, e.g. by sharing pictures of a broken product with experts while repairing it at the customer's side to receive advices, or to record performance for later review and reflection.
- *Compute a response* implies that information captured by the learner can be processed into relevant data by the mobile device. Example applications in corporate settings could be entering parameters to identify hardware errors while troubleshooting or transforming collected data into graphs for evaluation.

- *Communicate with others* enables learners to connect with people through various channels such as calls, text or instant messages, or social networks. By doing so, learners may receive immediate problem-solving support from other experts or feedback from managers.

The four basic mobile delivery formats can be deployed to evaluate mobile learning use cases related to employee roles such as sales or marketing representatives. Thereby, defined role-specific mobile learning activities should be beneficial and result in performance improvements [11].

3 Didactical Model for Mobile Product Training and Learning

While mobile product training is conducted just-in-case to acquire knowledge and skills that have potential value for future application, mobile product learning takes place just-in-time in accordance with ongoing work tasks to acquire knowledge and skills that immediately contribute to work procedures. Both mobile product training and mobile product learning can be divided into two subcategories, which respectively can be conducted individually or in a socialized way.

Combining the educational applications of mobile technologies and the work-based mobile learning scenarios leads to the following classification:

- Individual just-in-case training is characterized by high communication distance between the learner and the instructor, as the learner walks through mobile product training by interacting with structured and well-prepared learning materials on a mobile device.
- Socialized just-in-case training is also characterized by high communication distance between learners and the instructor, as several learners deploy mobile devices to collaboratively run through mobile product training based on structured and well-prepared learning materials, or defined rules for group activities. The interaction mainly occurs among learners, while the instructor is responsible for facilitating the group's activities.
- Individual just-in-time learning is characterized by low distance between the learner and the instructor, as both closely interact with each other through mobile devices to engage in mobile product learning. They work on loosely structured or undefined content in order to acquire knowledge or skills for ongoing work tasks.
- Socialized just-in-time learning is also characterized by low distance between several learners and instructors, as all involved people collaboratively interact with each other by deploying mobile devices to engage in mobile product learning. Learners and learners, as well as learners and instructors work on loosely structured or undefined content or instructions in order to acquire knowledge or skills for ongoing work tasks.

Figure 1 summarizes the didactical model for mobile product training and learning.

	Pedagogy		**Andragogy**	
	• Instruction-focused • Teach knowledge and skills		• Self-directed • Help to learn knowledge and skills	
	Training		**Learning**	
	• Formal on-the-job training • Company-initiated • Highly structured • Content-oriented		• Informal work-based learning • Employee-initiated • Unstructured • Activity-oriented	
	Mobile Product Training		**Mobile Product Learning**	
	Individual Just-in-Case Training	**Socialized Just-in-Case Training**	**Individual Just-in-Time Learning**	**Socialized Just-in-Time Learning**
Communication Distance	High distance between learner and instructor	High distance between learners and instructor	Low distance between learner and instructor	Low distance between learners and instructor(s)
Content	Structured, well-prepared materials	Defined rules for group activity	Loosely structured or undefined content	Loosely structured or undefined instructions
Interaction	Between learner and content	Among learners, instructor facilitates	Between learner and instructor	Among learners, among learners and instructors
Knowledge	Potential value for future application	Potential value for future application	Immediate value for ongoing work tasks	Immediate value for ongoing work tasks

Fig. 1. Didactical model for mobile product training and learning

The didactical model for mobile product training and learning, depicted in Table 1, is based on the didactical approaches described in Fig. 1, and combined with the four basic mobile delivery formats. The four mobile delivery formats include access content, for example through a company-provided application, a website, or the company's intranet; capture information, for example by taking pictures or notes, or by recording audios or videos to make content reusable for later; compute a response, for example by using a search engine to retrieve responses to a question, or by using the calculator; and communicate with others, for example through phone calls, text or instant messages, or email to get in touch with peers or experts.

The didactical model enables a structured development of mobile product training or learning scenarios based on activities, or job tasks, related to specified employee roles. Once the activities are defined, one of the four didactical approaches can be assigned to each activity depending on whether it is more appropriate to acquire product knowledge or skills through just-in-case training or just-in-time learning, and individually or socially. Subsequently, a mobile training or learning scenario can be developed by taking involved learners and/or instructors as well as the use of mobile devices into consideration. After coming up with a scenario, the selected didactical approach can be amended with the involved learner and/or instructor roles, and the mobile delivery format can be further specified by explaining which mobile feature or functionality is used in the scenario.

Table 1 depicts concrete examples of scenarios based on the didactical model.

Table 1. Didactical model for mobile product training and learning scenarios

Activity	Mobile training		Mobile learning		Mobile delivery format			
Employee role: salesperson	Individual	Social	Individual	Social	Access content	Capture information	Compute response	Communicate
Get to know new product	Sales person				Mobile training app		Assessment feature	
Conduct sales pitch		Sales person, Man-ager				Text message		Phone call
Deal with new customer			Sales person				Simulation app	Instant message
Acquire new customer in region				Sales people, region experts				Phone call, instant message

4 Empirical Research

To identify and design scenarios, a triangulated qualitative research study was conducted which consists of four steps. Experts have been selected and invited to take part in the research process. The entire research process was planned, moderated and guided by two researchers.

4.1 Expert Selection

In qualitative research, experts are purposively selected based on specific characteristics or experiences that best inform the research topic. Accordingly, eight "information rich" participants were recruited within the researcher's informal university and professional network [12].

The major selection criterion was that participants have expertise at the intersection of information technology and business functions, specifically in the area of business software. The selected participants have gained their experience either through university or professional backgrounds. In addition, the experts were recruited based on their match with criteria in three subgroups:

- Subgroup 1 involved participants who have experience with employee trainings in the IT industry to ensure the didactical and practical applicability of the to-be-developed mobile product training and learning scenarios.
- Subgroup 2 involved participants who have experience with developing business or mobile software solutions to ensure the technical feasibility of the to-be-developed scenarios.

- Subgroup 3 involved participants who have experience in the area of informal learning, collaboration, or mobile user behavior to ensure that these aspects are considered in the to-be-developed scenarios.

4.2 Research Process

This section presents the research process used for the identification and design of the scenarios which are the basis for an enterprise wide mobile learning and training system.

1. Identify scenarios: A focus group was used to get a common understanding and derive scenarios on basis of the didactical model. All in all, 14 scenarios have been identified
2. Describe Scenarios in detail: Groups of experts (2 or 3 experts) were asked to design and describe the 14 scenarios in detail
3. Collect results: Researchers collected all results from the expert groups and brought them in a uniform format

The activities in the three steps are depicted in the following section:

Step 1: Identify Scenarios
In the course of the focus group, a predetermined group of eight experts interactively discussed the topic mobile product training and learning in enterprises. To balance breadth and depth of the participants' responses, the discussion was facilitated by the researcher herself as a moderator. The moderator employed two assistants, one to help with facilitating the collaboration process and another one to film the focus group. A non-threatening environment in a spacious seminar room was established to make participants feel comfortable to share their views without the fear of being judged. The aim of the focus group was not only to generate a broad range of insights on the research topic in one meeting, but also to create a unique type of data. The interactive group discussion allowed participants to "share their views, hear the views of others, and perhaps refine their own views in light of what they have heard" [12]. Thereby, they collectively developed mobile product training and learning scenarios that could not have been created through individual interviews [12].

Step 2: Describe Scenarios in Detail
After the focus group with all experts, the experts were asked to form small groups of two or three members in order to design the identified scenarios in detail. As a result, a description of every scenario should be available and submitted to the researchers.

Step 3: Collect Results
The 14 descriptions were collected by the researchers. In case of unclear or misleading phrasing the researchers asked the groups for further clarification. The descriptions were formatted in a consistent and uniform way by the researchers. Finally, all descriptions were provided to the experts.

Step 4: Individual Follow-Up Interviews
As the participants created a comprehensive understanding for the didactical model during the focus group and the further elaboration on the identified scenarios in small

groups, they were individually interviewed subsequently. Thereby, detailed in-depth information about the individual's perspectives and narratives on the suitability of the didactical model could be collected "During the group discussion participants share their views, hear the views of others, and perhaps refine their own views in light of what they have heard" [12].

4.3 Results

Based on the didactical model, fourteen mobile product training and learning scenarios for salespeople of business software companies have been developed by eight experts. After having become acquainted with the didactical model, the experts were asked to reflect their experiences and opinions in the focus group post-discussion and in subsequent individual interviews. This chapter aggregates the expert statements related to the didactical framework. Table 2 summarizes the results.

Table 2. Summary of results – considerations for the didactical framework

Dimension	Results
General benefits	• Accelerate employees' learning efforts with interactive, flexible, spontaneous, contextualized, individual or collaborative scenarios • Improve company's productivity and competitive advantages
Critical issues	• Avoid overload of channels for knowledge distribution • Create alignment with other education methods
Employee roles	• Evaluate economic reasonability for company-wide introduction • Define scope of product knowledge required in various roles to identify product-oriented roles, which should be provided with intense mobile product training and learning • Satisfy needs and maximize learning outcomes by serving different roles with different mobile tools and solutions • Consider other subject matters for non-product-oriented roles
Didactical approaches	• Consider both didactical approaches as interrelated • Align approaches with company culture and structure, and employees' demands for learning • Introduce mobile product training company-initiated first, and mobile product learning employee-initiated second
Mobile product training	• Transfer foundational product knowledge with company-set goals and provided training materials • Use to train new employees in existing products, existing employees in new products, large numbers of employees in a standardized way, or employees who prefer structured materials • Do not use to transfer comprehensive product knowledge, or to provide product knowledge for each and every situation
Mobile delivery formats	• Select devices context-specific (tablets rather for content-oriented training, and smartphones rather for activity-related learning)
Scenarios	• Enrich scenarios with gamifications and incentive systems to motivate and reward employees

5 Discussion

The didactical model used for this project allows both, the design of scenarios that comply with the characteristics of conventional product training as well as scenarios that comply with the characteristics of mobile learning and work-based mobile learning.

In the course of mobile product training, employees can acquire product knowledge just-in-case by pursuing a formal and structured pedagogical approach, which goes in line with conventional product training. Employees can pursue a self-direct the acquisition of product knowledge just-in-time by an informal and andragogic approach.

Moreover, the didactical model considers both individual and socialized mobile product training and learning scenarios. Thereby, employees can choose to acquire product knowledge either on their own by interacting with a mobile device, or collaboratively by interacting with other people with the support of mobile devices.

However, as mobile learning aims for acquiring knowledge on small devices and in short learning sequences, mobile product training and learning is not appropriate for acquiring comprehensive product knowledge at once.

To answer the central aim of the research project, it can be concluded that the didactical model allows for the development of didactically well-conceived mobile product training and learning scenarios that enable employees to continuously acquire product knowledge in alignment with situational contexts and individual demands. This involves the possibility for employees to accelerate their learning efforts, and for companies to improve their productivity and competitive advantages.

6 Outlook

As a qualitative approach was selected to collect empirical data, the results of this research are based on the experiences, opinions, and reflections of eight experts. A quantitative approach would have allowed collecting empirical data based on the opinions of a large sample.

The didactical model could be further developed towards various directions. It could be used in different companies to investigate further conclusions on practical applicability. Applying it on different products and industries is a further research stream to generalize the results and test its eligibility.

In terms of technology mobile and cloud computing are getting closer. Mobile Cloud Computing is a novel computing mode which provides cloud-based services to users through the internet and mobile [13, 14]. These developments can provide new opportunities in mobile learning and training. The potential effects of this technological shift on the didactical model have to be explored in turn.

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Exploring Knowledge Transfer in the Media Industry

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Abstract. In the upcoming years, many organizations will face the challenge of intergenerational knowledge transfer. This paper reports on a study that investigates this type of knowledge handover in a media company. We particularly focus on knowledge transfer processes, methods and procedures as well as factors influencing respective activities. Five retirees and five successors were interviewed. Results show that in the investigated organization best-practice knowledge management plays a rather tangential role, structured retention programs are missing, and supported knowledge transfer initiatives are rare. However, influencing factors do not differ from previous study results. Retirees transfer their knowledge relying on basic conversations, tandem learning and shadowing. Furthermore, they strongly believe in an informal learning-by-doing approach, while mentoring is completely absent. With respect to the knowledge transfer process, the study shows that although activities follow rather informal procedures, they may be explained by existing knowledge management theories such as Nonaka and Takeuchi's SECI model.

Keywords: Knowledge transfer · Knowledge retention
Intergenerational knowledge handover · Media industry

1 Introduction

Today, knowledge is considered an intangible asset, classified as a sub-part of intellectual capital (IC) and consequently a rather critical strategic resource [3, 47, 51, 62]. Knowledge is crucial for long-term organizational success and strong financial power [1, 21, 31, 50, 57, 59, 60]. Furthermore, does it count as a requirement for innovation, change and creation [6]. In short: *"Knowledge is power!"* [7]. Yet, the efficient handling of such a valuable resource requires an integrated and systematic management approach [16, 19, 20]. Whereas smaller proportions of enterprise knowledge are embedded in the so-called 'structural capital', in a company's culture, or in its processes, the bigger part is anchored in people's minds [11, 22, 32, 37], which makes organizations strongly dependent on their employees. That is, without their employee's intellectual capital, today's companies would merely be artificial constructs [18, 20]. This dependency keeps aggravating, given the current demographic development in which our population is aging, and birth rates are falling [39]. In 2020, half of Europe's

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citizen will be aged over 50, and in 2050, 40% will be over 60 [2, 25]. The retirement of organizational key players means an irreversible loss of crucial knowledge and experience [20, 52]. Consequently, companies either need to find employment models, which keep people in the work force beyond their legal retirement age, or effective ways of transferring knowledge from retirees to successors without losing essential parts in the process. The study presented in this paper explores the latter of these two options and by doing this focuses on a particular sector; i.e. the media industry. Section 2 discusses the relevant theoretical underpinning, concluding with a dedicated question guiding our research effort. Next, Sect. 3 describes the study setting and chosen research methodology, handing over to Sect. 4, which summarizes results and elaborates on concrete findings. Finally, Sect. 5 puts forward some concluding remarks, before Sect. 6 points to potential future work.

2 Theoretical Foundation

Previous research has led to more than 160 general Knowledge Management (KM) frameworks and over 100 km definitions [12, 27]. There is work which focused on Knowledge Transfer (KT), types of knowledge, transfer methods, supporting technologies and influencing factors like KT barriers and enablers [5, 38, 40, 48, 54, 58]. Yet, the retention of knowledge, and here in particular the activities, which support the transfer of knowledge between older experts and their younger successors, seems less researched [8].

For Holtshouse, who explored the current situation in the media industry, it is crucial *to "understand in depth how organizations will most likely go about preserving and retaining retiree knowledge that they decide is important to keep in the organization"* [31, p. 202]. The media industry seems particularly under-researched, although as a content creator, producer, carrier and distributor, the branch counts as a knowledge-intensive-industry [15] in which so-called 'knowledge workers' do have a significant influence on the organizational success [4]. As asserted by Puppis, Künzler and Jarren [46] media organizations are due to their unique organizational structure, their high reputation and their position in a democratic society very interesting objects of investigation. Even though many young and inexperienced individuals also hold critical knowledge (particularly in today's technology-driven society), Burmeister and Deller [8] as well as Joe et al. [33] state that knowledge retention including KT programs should concentrate mainly on retiring experts. Previous work refers to these individuals as 'deep smarts' [36], 'key players' or 'key organizational members' [29, 30]. It is the specific and broad range of knowledge in combination with long lasting experiences and competences that makes these people outstanding.

The literature points to a number of KT instruments that seem highly versatile and applicable to these type of expert-successor cases [31, 32]. Examples include *tandem learning* [43], *mentoring* [49], *storytelling* [61] as well as *communities of practice*. Previous studies have also identified 170 factors potentially influencing successful KT [27], yet their applicability to intergenerational cases lacks empirical assessment [8, 43]. Hence, trying to partially close this knowledge gap, our work was guided by the following question: ***How does knowledge transfer between experts and their successors happen in the media industry and what may be factors influencing employed activities and measures?***

3 Study Setting and Research Methodology

A local media company was selected as an investigation object. The company, which employs more than 1,400 people, classifies itself as a traditional and independent media house focusing on regional high-quality content. It is family owned and consists of several smaller businesses, which serve the secondary (i.e. print), tertiary (i.e. TV and radio) as well as the quaternary (i.e. Internet) media market. The daily newspaper, in its printed as well as in its digital version, has always been the company's core product.

To foster knowledge creation and knowledge exchange between employees, the organization relies on a flat hierarchy, a loose organizational structure and on an open *"failures are allowed"* culture. The management board is fully aware of the company's great dependence on their employees, especially when it comes to long-term experts and/or executives. Most of them belong to the so-called *Baby Boomers* generation (i.e. they were born between 1946 and 1964), for which their retirement is imminent. Yet except for sporadic informal mentoring sessions and the use of a number of stand-alone tools such as the CRM system, or single Excel and/or Word files, knowledge transfer is seemingly intransparent. A similar picture emerges in succession planning, where the human resources department together with the management board acts rather situational. That is, leaving employees are left alone with their KT activities. No methodological support is currently provided.

To better understand the above described, rather opaque KT situation, we conducted 10 semi-structured in-depth interviews with retirees and respective successors, focusing on their current and planned KT efforts. The sample consisted of three key players who retired during the last two years (R01–R03), two key players whose retirement is imminent (R04 and R05), and five respective successors (S01–S05). To demonstrate the diversity of the organization, selected interview partners held different positions and belonged to different departments including logistics, printing, editorial and accounting. Interviews lasted on average 25 min (min. 17 min, max. 32 min), were fully transcribed (note: denaturalized transcription was applied), anonymized, and subsequently analyzed using Mayring's summary approach to qualitative content analysis [41]. In doing so, our goal was to understand: (1) the employee's perceptions on the importance of organizational knowledge and its transfer, (2) the employed KT methods, processes and procedures, and finally (3) factors influencing KT activities.

4 Discussion of Results

4.1 General Perceptions on Knowledge and Knowledge Transfer

Importance of Knowledge. All study participants agree that knowledge is a primary source for the company's competitive advantage, performance and organizational success. Similar to [7], retirees R01, R02, and R03 as well as successor S04 explicitly stated that for them knowledge represents power, and that such generates an important sense of certainty and security. Retiree R04 additionally emphasizes that one has to make a difference between relevant and useless knowledge.

Importance of KT/KM. Regarding KT and KM strategies, several interview participants (e.g. R05 and S01) highlighted the necessity of staying up-to-date. It may even be perceived as one of the most critical tasks in daily operations (S03), especially in cross-divisional projects (R05) since it facilitates and improves everyone's work procedures (S04). For R05 *"it is crucial to share and to exchange knowledge, in order to run all processes smoothly, to avoid mistakes as well as to correct past failures"*. In other words, transferring knowledge seems to be perceived a win-win situation for all involved parties. Yet, although the organizations management claims to have realized the relevance of KT, particularly in job handover cases, employees currently do not have the impression that KT respective measures and initiatives are taken seriously.

4.2 Knowledge Transfer Methods, Processes and Procedures

Knowledge Transfer Methods. While previous work considers *tandem learning*, *mentoring*, *succession planning*, *storytelling* or *communities of practice* as appropriate KT methods [26, 43, 49, 61], our interview participants particularly highlight *informal tandem learning* and *shadowing* as highly effective for observing work procedures and routines.

Knowledge Transfer Processes. Previous work subdivided knowledge transfer in four different phases [55, 56]. Accordingly, the initiation phase includes everything which directly or indirectly leads to knowledge transfer. The subsequent transfer/implementation phase describes the use of different KT methods. Then, the ramp-up phase starts as soon as the recipient applies the newly obtained knowledge, and finally the integration phase deals with the constant combination and integration of knowledge. In the investigated organization, the retiring expert reaches out to his/her successor and initiates knowledge transfer activities. Later, both retirees and successors define relevant knowledge and choose an optimal transfer method. Some of our interview participants (i.e. R02, R03, R04, S03) highlighted that this self-initiated process allowed for the identification of concrete knowledge gaps. In addition, they would use special incidents, spontaneous ideas as well as daily tasks and operations to identify and showcase the application of knowledge and expertise (R02, R04, S02). Successors would then observe the activities and take notes to clarify potential uncertainties. This process was described as iterative where S01 and S02 stated that they were able to apply acquired knowledge right away.

Comparing the described knowledge transfer process to Nonaka and Takeuchi's SECI model (*socialization*, *externalization*, *combination*, *internalization*) [44] one may argue that the emphasized need for close collaboration and strong informal involvement supports the idea of a dedicated socialization phase. That is, retirees and successor do work closely together where the retiree passes on knowledge spontaneously, yet consciously. In addition to the mere exchange of tacit knowledge, retirees also reported on transforming tacit into explicit knowledge by writing down key knowledge elements. Such corresponds to the externalization phase described by the SECI model. While R01 regularly created text-files including special incident reports, S02 relied on Microsoft Excel whereas S03 did hand over his entire e-mail inbox. Also, all successors emphasized that once they had acquired and consequently internalized new knowledge, they combined such with pre-existing knowledge.

All in all, one may thus argue that our interview participants have undergone a KT process which is in accordance with the SECI model. Obtained knowledge is usually successfully absorbed, internalized and applied. Also, tacit knowledge is often converted into explicit knowledge and then transferred via face-to-face conversations. Existing documentations, however, seem to play a rather minor role.

Hand-over Procedures. According to the company's deputy-managing director, management has recognized the importance of defined handover process in cases of retiring key players, for which successors are appointed in good time (usually one year before an expert's departure). However, our interview participants noted that predefined, structured and standardized procedure to handle the handover are missing (R03, S01, S02). *"In most cases knowledge has been exchanged informally"* (S03). Such corroborates Holtshouse's study results [31], which show that companies often refrain from employing formal knowledge retention initiatives. Rather, is it the case that management considers KT among employees for granted and expects that employees would pro-actively occupy themselves with said job handover activities (S02). Supporting this assumption S01 stated that *"all in all we have been completely free in our handover […] the only noticeable action was a solicitation to start the handover"*. Overall interview participants described the whole procedure as open, flexible, spontaneous, and being a slow and strongly influenced by daily operations (R03, R05, S01, S05). Still, they seemed generally satisfied with the achieved results, contradicting McNichols [43] view that lacking structured initiatives should be considered a major barrier for KT. S05 even claimed, *"a more structured procedure and plan would not have been possible"* and that overly structured processes may be *"out-of-date"*.

4.3 Influencing Factors

Individual Influencing Factors. From our participants' perspective, indispensable prerequisites for an efficient and successful intergenerational KT are *mutual trust* (R01, R02, R03), *motivation and willingness on both sides* (R02, R03, R04, S03, S04), and an *open and honest personality* (R03, R05, S01). According to the literature both, *Baby Boomers* as well as people belonging to *Generation X* (note: all our successors were born between 1961 and 1981 and thus belong to Generation X) are characterized by an open attitude, which makes them a perfect knowledge transfer pair. Similar important aspects, especially with respect to current KT experiences, seem to be *attitude to work* (S05), *solidarity* (R02, R04, S05), *team spirit* (R01, R03, R05) and *reciprocal sympathy* (S05). As S05 puts it "*The chemistry has to be right*". These findings corroborate the results of previous studies by Davenport and Prusak [14], Brčić and Mihelič [9], Cyr and Choo [11], Christensen [10], Joia and Lemos [34] as well as Yun et al. [63].

Szulanksi [55, 56], on the other hand, argues that especially *arduous relationships* and *lacking motivation*, which both belong to the nine *"stickiness predictors"*, are complicit to occurring KT difficulties and thus have to be dealt with. Although scholars such as Hendriks [28], Disterer [17] or McNichols [43] have emphasized the important role of trivial aspects such as *sharing a common language* or *having sufficient time* [34], those factors were hardly discussed by our interview participants. It almost seems that they were taken for granted. Yet, two other often discussed factors, were mentioned. That is, participants regard *opposing personalities types* as well as *great age differences* as difficult to deal with (R02, R03, S02). Surprisingly, McNichols' intergenerational KT study focusing on Baby Boomers and Generation X did not report on any problems caused by age difference [43].

While one of our interviewee stresses the strong influence of the chosen *timing* and *speed* of knowledge transfer (i.e. S05), others think that strong *support*, *care* and an *interest in the successful transfer of knowledge*, are certainly conducive (R01, R04, S03, S04). Almost all our retirees reported that they want to facilitate their successors' start (R01, R02, R03, R05). Among psychologists, this positive attitude towards the handover of knowledge is known as 'generativity' and found particularly in family contexts [23].

From a successor's point of view, it is favorable if a knowledge recipient is already part of the department, preferably even the team. The close collaborations as well as existing, often long-established relationships clearly support the KT process (S02) [28]. Additionally, interviewee participants agreed on the importance of pre-existing domain related knowledge (S01, S02, S05). Furthermore, they highlighted that knowledge recipients should be eager and curious about the provided knowledge (S01). S02 points out that *"people who want or need to acquire knowledge, should commit themselves and be active"*. Furthermore, it is perceived crucial to have the *courage to ask questions* and to *scrutinize newly obtained knowledge* (S01). Finally, recipients have to be open and welcoming to the reception of new knowledge – only then said knowledge may be internalize it (R03, R04, S01, S04, S05). This importance of absorptive and retentive capacity has also been pointed out by previous work [14, 43, 55, 56].

Organizational Influencing Factors. Most of our participants agree with Davenport, DeLong and Beers [13], and Joseph and Jacob [35], who claim that corporate culture and climate are among the most powerful influencing factors. For them, the ideal environment for KT activities is based on *trust* (R01, R02, S01), *empathy*, *appreciation* and *respect* (S01). In other words, they desire an open, sociable and harmonic culture that fosters open communication (R02, R04, S03). Criticism should be allowed, feedback appreciated, and past failures accepted (R02, R05, S05). In other words, the organization needs to strive for a pleasant learning and working atmosphere (S03, S05). These findings are in line with previous results presented by McDermott and O'Dell [42], Olla and Holm [45] and Gold et al. [24].

Based on these results and referring to [49] who concluded that an open learning culture is essential for the intergenerational KT, and to McNichols [43] who stresses the crucial role of trust in intergenerational KT activities, we may confirm that also for the investigated media house culture and climate are factors which considerably influence intergenerational KT. Although from an organizational point of view loose structures are said to be beneficial for successful knowledge transfers [12], our interview participants highlight their preference for a clearly defined but at the same time flat hierarchy (R02, R03, R04, S01). Also, S05 believes that *"too much hierarchical thinking hampers knowledge transfer"* - an aspect which has already been stressed by Suppiah and Singh Sandhu [53].

5 Summary and Concluding Remarks

A high number of retiring key players is a great challenge for organizations. Since these so-called 'deep smarts' have acquired a multi-layered knowledge portfolio, they cannot easily be re-placed by inexperienced employees. Thus, organizations need to either convince retirees to work longer or they must proactively initiate knowledge transfer activities to retain precious knowledge. Our investigations have focused on one example of intergenerational KT between leaving experts and their successors. We conducted ten semi-structured in-depth interviews in a knowledge-intensive media organization and used Mayring's summary technique to analyze the resulting transcripts. Results show that knowledge transfer does happen, although informal lacking clearly defined methods and procedures. However, the behavior fits existing KT models.

With respect to Szulanski's [55, 56] process model, for example, we found that the investigated setting did not require for the identification of an explicit knowledge carrier, as sender and recipient were already predetermined. Furthermore, both identification of valuable knowledge as well as transfer initiation happened without explicit management support. As for Nonaka and Takeuchi's SECI model [44], we found that although *mentoring* and *communities of practice are* usually of great benefit during the socialization phase, both were of little importance in the investigated setting. Also, *metaphors*, *analogies* or *flowery language* during the externalization phase were not found. Furthermore, it is worth mentioning that most investigated successors refrained from using ICT tools during knowledge combination and reflection, and that written notes, which may support internalization of newly acquired knowledge, were rather circumstantial.

Confirming previous studies, most KT activities lasted between 6 and 12 months. Respondents described procedures as open, flexible, and spontaneous, relying mostly on informal knowledge exchange. Although both management and interviewees underlined the importance of knowledge, we did not find any holistic KM strategy. A systematic and structured approach for KT activities was missing. Yet, these deficits did not seem to cause any negative consequences. To transfer knowledge, retirees usually used observation methods such as *tandem learning* and *shadowing*. *Communities of Practice* and *storytelling* played a rather subsidiary role.

With respect to factors that may influence KT activities, our interviewee participants agreed that neither *age* nor *different personalities* impact a successful hand-over process. Only with respect to *organizational hierarchy and structure* we found somewhat controversial opinions. While some respondents preferred a clearly defined hierarchy so as to prevent chaos, others found that the hierarchy should be as flat as possible, and the structure should be loose.

6 Impact and Future Outlook

Our work shows practical insights into how retiring Baby Boomers in the media industry transfer their knowledge to employees from Generation X. We explored the handover phase, highlighting used knowledge transfer methods and influencing factors. In doing so our findings add to the somewhat under-researched areas of knowledge retention and intergenerational knowledge transfer. Furthermore, helped the investigated media organization (particularly its top management) identify a number of shortcomings, whose reformation may improve future knowledge transfer.

Given that research on knowledge retention, particularly in the media industry, is still limited, future work will aim to replicate the study in other media organizations, so that results may eventually be generalized. We also plan to expand our methodological portfolio to focus groups and observations in order to paint a more holistic picture of given settings.

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Knowledge and Service Innovation

Automated Monitoring of Collaborative Working Environments for Supporting Open Innovation

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Abstract. Open Innovation is a complex procedure that requires effective management and control along the different stages of the overall process. The automated monitoring of Open Innovation is the aim of a collaborative working environment designed, developed and tested in our research labs. This paper illustrates our solution and provides an assessment of the monitoring capabilities implemented. In particular, we propose a data model with a general approach for defining metrics and a list of metrics enabling automated monitoring with an evaluation of their informative power.

Keywords: Collaborative open innovation management
Collaboration, and innovation metrics
Frameworks and methodologies for large scale collaboration

1 Introduction

In a global and interconnected economy, Open Innovation (OI) is proposed as a promising paradigm shift in the context of innovation management. Even though there is no universal definition for OI [13], the basic idea behind it is that, in order to be successful, an organization has to open up the innovation process by incorporating both internal and external technology base and human expertise. Despite the wide attention being dedicated to studying innovative methodologies and best practices [13], limited work has been dedicated to translating these results into metrics for measuring the quality of an OI process, and very limited works have discussed the applicability of these metrics on data automatically generated by an Information System. Other studies have underlined the relevance of implementing an analytical attention on the *micro level*, i.e. the single interactions generated by the participants to the OI process, intersecting to the

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research on teamwork and group dynamics [17]. Collaborative working positively affects the innovation process. This is particularly true in the context of OI where cooperation with external entities compel organizations to specify the innovation process on an ongoing basis. It has been however demonstrated that, if on one side collaborative strategies improve the quality of the innovation process, on the other side they increase costs [19]. An empirical study of various Italian SMEs explains that organizations deploy various kind of innovation building mechanism, and among these methods, OI provides the maximum exploitation of external knowledge, even if it also requires the maximum utilization of resources [15]. Effective management depends on consistent monitoring of activities so that process can be controlled and adjusted. This point defines precise challenges for researchers interested in developing computer-supported environments for managing the OI process. We summarize these challenges into three main properties of such environments: (i) supporting flexible integration to the innovation process carried out by an organization; (ii) offering a comprehensive and a consolidated log of the interactions generated within an OI process; (iii) providing domain independent and automatically generated metrics to control the process.

Facing these challenges is the primary aim we have envisioned by the design of the Open Innovation Factory (OIF) [3]. Our tool has been tested by experiments that demonstrated effective results in fostering creativity and fast convergence of the working teams adopting it [9,21]. In this paper, we focus on the capabilities of supporting flexible integration and automatic monitoring of OI. Thanks to our tool, we are able to consolidate a log file recording the collaborative processes. Moreover, we define a formalization approach for defining metrics to monitor the process and we illustrate the results of an experimental evaluation of the informative power of an initial set of metrics.

The paper is organized as follows: Sect. 2 highlights related work, while Sect. 3 introduces the OIF. Sections 4 and 5 explain our data model along with a list of metrics for automated monitoring. Section 6 provides an overview of the results obtained by comparing the informative power of metrics. Final remarks are provided in Sect. 7.

2 Related Work

Collaboration and innovation are two interlinked paradigms [5], but in the literature, they are often addressed separately.

Collaboration Quality. The idea of capturing Collaboration Quality is implicit to all works dealing with group dynamics [23] and collaboration process [12]. From the general theories, the focus has progressively passed to measuring collaboration. This involved the definition of more fine-grained notions, such as collaboration activities and phases [11], interactions, or so-called patterns of collaboration [2]. Some works, such as [20] have focused on defining a coding scheme for classifying the communication units generated during collaboration. In particular, they adopt an interpretative approach where the transcripts of a collaboration activity are manually classified based on the interpretation of a team of researchers observing the process. The natural evolution is detecting patterns of collaboration by observing aggregation of communication units. For example, in [22], the authors have introduced the notion of idea trace to aggregate, around a single trace, semantically interdependent units.

In contrast to interpretative approaches, other contributions focused on quantitative indicators. For example in [1], the authors used a set (twelve) of quantitative statistical metrics for classifying student interactions in web forums. The interesting aspect of such an approach consists in establishing a relationship between collaboration and automatically detected metrics. In the work carried out by Damiani et al. [9], the interaction frequency is measured on the basis of information collected into the event log of an online collaboration environment. Measurements implemented in this work take into account parameters such as information handling, equal work division, and the interaction trend. An advantage of adopting quantitative indicators is that these indicators are domain independent. On the other side, limitations arise from the fact that the indicators do not provide any semantic information on the message contents.

Innovation Process Quality. The contributions in this field have focused on implications of knowledge acquisition in shaping the innovation process. The literature refers to Inbound OI, in presence of internal use of external knowledge, while to outbound OI with the external exploitation of internal knowledge [16]. An approach that is specifically focusing on measuring is [8] where ad-hoc metrics are defined on different aspects, as for example the output of the OI process, the internal or external time-to-market for new products and services, the performances evaluation in terms of potential 'false positive' and 'false negatives'. Another framework for measuring the OI process is proposed by Diamantini and colleagues in [10]. The authors underline that although innovation is largely perceived as a matter of creativity, a systematic monitoring and control of the actions performed during an innovation project is necessary to transform a great idea into a new successful product and to guarantee efficiency and effectiveness of the whole process. The work by Oman et al. [18] proposes a comprehensive list of metrics for measuring innovation. Other studies [14] have underlined that all the metrics used to monitor the process should be flexible to be implemented across various domains and scalable for varying degree of openness.

3 Open Innovation Factory

Open Innovation Factory (OIF) [6] is a collaborative working environment designed to support OI. It provides a complete environment which can be seamlessly integrated into an organization that wants to create an ad-hoc team, maybe in cooperation with other organizations, for developing an ad-hoc innovation project. A key goal of IF is accelerating the convergence of implicit-explicit and internal-external knowledge, by facilitating team members in tackling with common tasks and in adopting a shared terminology.

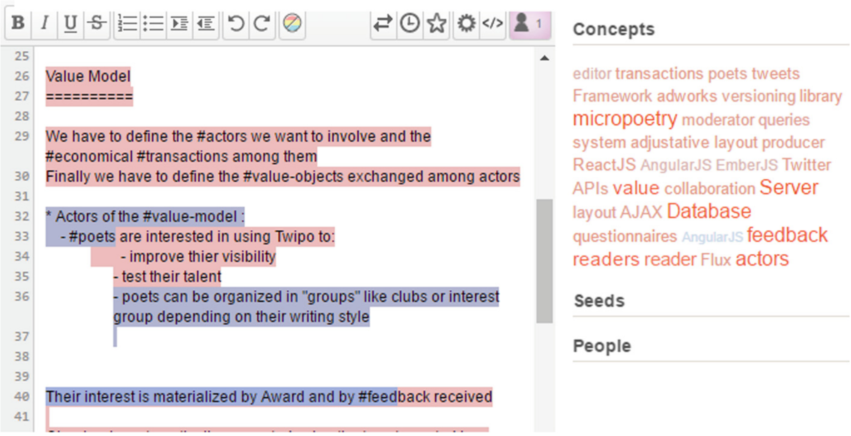

Fig. 1. A discussion on the SE is enriched with hash (#) tags. On the right side a Tag Cloud links this discussion to other resources available in the system.

There are three major components of OIF: a *Synchronous Editor* (SE), various *Support Tools*, and *Social Networking Tools* such as Blogs, Wikis, Forums and internal messaging. The SE operates as the core module because it converges users and resources around a discussion where ideas are collaboratively developed. Various *Support Tools* can be plugged in order to provide implicit input to the SE. For example, an Instant Messaging tool support users in coordinating their activities, documents can be uploaded into a shared Knowledge Base, and a Recommender System suggests those documents that are related to the discussion developed in the SE (matching term vectors extracted from documents and the text edited in the SE) (Fig. 1).

The notion of *topic of discussion* is central to the OIF environment. This notion includes any contribution, concept or proposition the team members consider relevant to the discussion. More importantly, topics are tracked along the whole process as users can identify them by simply adding a hash (#) tag in front of a term used in drafting a discussion in the SE. The system automatically includes these terms as entities of a vocabulary that is exploited to tag documents into the repository and Web resources. This way, hashtags serve as markers for providing recommendations, linking discussions, documents, and Web resources around a same reference topic. To make this mapping visual, hash-tags are organized in a Tag Cloud, continuously contextualized to the discussion developed in the SE and the resources made available to the system.

4 Tracking the Open Innovation Process

The collaboration workflow operated by the tool is driven around the reference topics that users adopt for tagging their contributions and for receiving a recommendation from the systems. These features make the OIF suitable for the automatic generation of a set of *Open Innovation Metrics* that are generated automatically, avoiding any manual or interpretative effort. Since the use of hash-tags is widespread in social media to identify a reference topic, users are already prepared to use this instrument to foster collaboration in various ways.

To support the automatic generation of metrics, the monitoring component of the OIF analyses the event generated by the collaboration environments and record them in a semantically enriched Event log. Event logs are generally produced by information systems to track the executed activities. In our environment events are associated with an interpretation of their value within the Open Innovation process.

Table 1. An excerpt of the log file generated by the OIF.

E	SID	ET	T	U	EC	RT	CA
1	2	Group chat	7/9/2013 8:26:36 AM	Igor Lisjak	What about donation over IPTV?	Donation	Drafting
2	4	Text	7/9/2013 8:00:37 AM	Samo Romez	Mobia has some potential	Mobia	Information knowledge
3	1	Poll vote	7/9/2013 8:26:36 AM	Nina Guljuk	FB campaign for IPTV?	IPTV	Option generation

Table 1 shows an excerpt of the Event log generated by the OIF. To clarify how an event is constructed we can follow Definition 1.

Definition 1. *An event is a quadruple* $e = (c, a, r, t) \in \mathcal{E}$, *it denotes the occurrence of an activity* **a** *in a Collaboration Flow* **c**, *by using the resource* **r** *at time* **t**. *The event universe can be indicated as the combination of all these elements:* $\mathcal{E} = \mathcal{C} \times \mathcal{A} \times \mathcal{R} \times \mathcal{T}$.

To fully exploit the information carried out in the event logs, events may be connected with other data available in the information system [7]. This is captured in our model by interpreting the elements that compose an event in terms of declarative predicates. The sets $\mathcal{C}$ and $\mathcal{A}$ are defined as unary predicates $P(x)$, where $\mathcal{A}$ describes the communication activities executed into a collaboration flow, based on *Origin* and *Type*. Origin refers to the tool used for generating the event, such as for instance the SE, the Instance Messaging or others. Type refers to their value as Communication Action. The set $\mathcal{T}$ includes timestamp values that order the sequence of events. The other data (e.g., linked documents, hash-tags, material and agents), that are in relationships with an even, are represented in the set $\mathcal{R}$, which includes conjunctive n-ary predicates.

For instance, Expression 1 describes an event $\mathbf{e} \in \mathcal{E}$ composed of activity CreateHashtag $\in \mathcal{A}$, included in Session$\mathbf{A} \in \mathcal{C}$ and involving a resource $\mathbf{r} \in \mathcal{R}$, where $\mathbf{r}$ is a Hashtag that is originated by user $\mathbf{u}$, and that the system will use to tag documents available in the knowledge base, such as for instance document $\mathbf{d}$.

$$e = (CaseA(c), CreateHashtag(a), Hashtag(r), originated(r, u) \\ UserA(u), tagged(d, r), Document(d)) \quad (1)$$

An overview of the attributes used in the Event Log to record an event is described in the followings:

- **Event ID (E):** event ID is a unique identifier of an Event, where an Event is an atomic occurrence of a collaboration activity.
- **Session ID (SID):** the events related to the same Collaboration Flow, and usually carried out by the same group of users along a defined period, are grouped in the same session. In other words, a session captures the collaboration flow generated by a group of users cooperating on the same project.
- **Event Type (ET):** the events recorded by the system can be distinguished according to the tool used to provide a contribution. In particular, we have: *Edit SE*, *Send Message* by Chat, *Generate Poll*, *Select Option* in Poll, *Select Hash-tag*, *Select Document*.
- **Time Stamp (T):** a timestamp is the time at which an event is recorded by the system.
- **Originator User (U):** each recorded event is originated by a specific user.
- **Event Content (EC):** events are specified by a content either (i) provided by the user, such as a text unit/thought unit included in the SE or in the Chat or (ii) by describing an element or option selected by the user.
- **Reference Topic (RT):** events can be connected with a topic of discussion or an idea that groups events interrelated to the same subject. Users express this connection by using hash-tags which are also exploited by the system to index documents.
- **Communication Actions (CA):** events can be connected with a Communication Action which represents the motivation justifying the creation of an Event Content, such as for instance *Agreement*, *Query*, *Proposition*, and others.
- **Resource (R)[1]:** resource is an optional attribute and refers to some artifact or specific information source accessed by the users.

Events sharing the same attribute value can be organized in traces, i.e. a finite sequence of related events, as stated in Definition 2. Clearly, not all traces have the same relevance. For example, the trace of all events implementing the same CA does not seem very significant in order to monitor the quality of the

[1] It is possible to have more than one optional attributes.

OI process, except for counting how many CA of the same type was generated. In this work, we are considering two type of traces. Traces representing the discussion around the same RT, that will be referred as σ_{RT}. Traces describing the behavior of a user participating in the discussion, that will be referred as σ_U.

Definition 2. *Trace. Let S be a finite set of events. A trace $\sigma \in S*$ is a finite sequence of activities.*

5 Defining Metrics

In this section, we illustrate how metrics can be defined by applying conditional operators, grouping operators[2], and aggregating functions[3]. In Expression 2 we present a generic definition for metrics:

$$f(A)^c_g; \tag{2}$$

where f is an aggregation function, A is an attribute of the Event Log, **c** is a Conditional expression, and **g** is an attribute of the Event Log on which Group By function is applied, **c** and **g** are optional. The aggregating function is applied to a set of events sharing the same values on the same set of attributes.

Example 1. In order to list all the events belonging to the same session and count their occurrence, we can group by `Session_ID` and apply a `COUNT` function. This may be formally expressed as $Count(E)_{SID}$.

Example 2. In order to identify how many users in a session generated events connected to the same Reference Topic and to a specific Event Content type, we can define the following expression.

$$Count(E)^{EC=\text{``}specified\text{''}}_{RT,U}$$

We now present a set of metrics we tested in monitoring the quality of a collaborative OI process. Table 2 enlists set of proposed metrics along with a brief description. For the sake of clarity, we illustrate metrics constrained on specific attributes. Expression 2, makes, however, clear that these metrics can be generalized by substituting attributes.

[2] Grouping operators partition events in the Event Log, based on their values among specified attributes. They function like a GROUP BY clause in SQL.

[3] Aggregating functions summary or aggregate the values recorded by events included in a group. The typical aggregating functions implemented in SQL are SUM, COUNT, AVERAGE, MAXIMUM and MINIMUM.

Table 2. Proposed set of the metrics

Proposed metrics	Description
Volume of Reference Topics $VRT = Count(E)_{RT}$	Total volume of events associated with a Reference Topic
Persistence of Reference Topics $PRT = (Max(t) - Min(t))_{RT}$	Lifetime (in minutes) a reference topic remained active
User Volume per Reference Topic $VU = Count(U)_{RT}$	Number of users associated with a Reference Topic
Reference Topic Frequency $RTF = AVG(T)_{RT}$	Time spent (in minutes) on a particular reference topic during entire process
Original Contribution $OC = Count(E)_{U}^{Timestamp=\text{“}MIN(T)\text{”}}$	Contribution in terms of unique events generated by Originator or Session (SID)
Communication Frequency $CF = \frac{Count(E)_{RT}^{EC=\text{“}EC-name\text{”},U}}{Count(E)_{RT}}$	Specific communication action taken by a user (e.g. group chat, forum post, or instant message
Convergence Index $CI = Count(E)_{RT} * Count(U)^{RT}$ With ***CI*** = Convergence Index and ***RT*** = Reference Topic	Usage frequency (popularity) of a particular reference topic
Discussion Quality $DQ = Sum(Count(E)_{CA} * Wt)$ With ***DQ*** = Discussion Quality and ***Wt*** = Weight assigned to each Communication Action	Quality of the discussion with respect to communication actions. It is obtained by computing the weighted mean of events associated to each communicated action
Openness Ratio $OR = \frac{Count(E)_{RT}^{U=\text{“}external\text{”}\ OR\ R=\text{“}external\text{”}}}{Count(e)_{RT}}$	How many events of the collaboration flow have involved external users and resources
Process Range Index $RI = Count(EC)^{type=\text{“}1...n\text{”}} * Wt$	Weighted contribution of Event Content in entire process, where weights are assigned to each EC with respect to its importance

6 Experimental Results and Discussion

The aim of our experimental evaluation is understanding which metrics are more informative in distinguishing the traces representing a discussion around an RT (σ_{RT}) or the behavior of a user participating in a discussion (σ_U). We then observe the variance in the domain of values produced by our metrics applied to the same trace instances. In particular, in Table 4 (σ_{RT}) we have metrics on traces identified by RT, while in Table 4 (σ_U) we have metrics on traces identified by U. The dataset adopted is the Event Log generated by the OIF during a session of collaborative design for a seasonal marketing campaign. It was produced for experiments already presented in our previous works [9,22] and it details the exchanges of 4 teams of 45 users that in total generated 4066 events and 110 unique topics of discussion. Table 3 offers an overview of the distribution of the domain of values generated by metrics, using descriptive statistics. Table 3 also presents results about *variants* of the metrics introduced in Sect. 5. These variants are generated by filters on the values of CA. For example, $VRT(Agreement)$ extracts the volume of RT that have CA equal to $Agreement$.

Table 3. Overview of the metrics computation on IF Event Log

	VRT	PRT	VU	VRT (Agreement)	VRT (Disagreement)	VRT (Knowledge Provision)	VRT (Knowledge Request)	IF	OC	OC (Knowledge Provision)	OC (Query)
	σ_{RT}							σ_U			
Standard deviation	5.03	1	1.72	2.70	0.51	0.94	0.66	−1.25	−2.98	−1.37	−2.58
Variance	25.33	1.27	2.97	7.27	0.26	0.89	0.43	1.57	8.88	1.88	6.65
Coefficient of variation	2.19	2.99	18.97	3.84	0.64	−1.80	2.42	9.41	−2.30	5.84	1.76
Min	−1.2	−1.10	−1.02	0.00	−1.00	−1.00	0.00	−2.75	−2.00	−2.67	−1.00
MAX	23.80	2.43	6.00	23.67	1.00	4.25	4.00	1.76	14.00	2.67	9.00
Mean	2.30	0.33	0.08	0.56	0.79	−0.55	0.27	−0.13	1.30	−0.23	1.46

Table 4. Eigenanalysis of the correlation matrix

	VRT	PRT	VU	VRT (Agreement)	VRT (Disagreement)	VRT (Knowledge Provision)	VRT (Knowledge Request)	IF	OC	OC (Knowledge Provision)	OC (Query)
	σ_{RT}							σ_U			
Eigenvalue	3.16	1.23	0.85	0.76	0.38	0.34	0.28	2.07	1.14	0.52	0.27
Proportion	0.45	0.17	0.12	0.11	0.05	0.05	0.04	0.52	0.29	0.29	0.07
Cumulative	0.45	0.63	0.75	0.86	0.91	0.96	1.00	0.52	0.80	0.93	1.00

The coefficient of variation of metrics provides us with a first measure of the information they carry: a higher variance implies the traces observed are partitioned into more groups. To go beyond the coefficient of variation we performed a Principal Component Analysis (PCA)[4]. To treat our data we normalized the values produced by metrics adopting an approach, based on median absolute deviation, described in [4].

For the first group of metrics (Table 5), the results of the PCA highlighted that the first component exhibits a maximum variance of 45% and, together with the next three components, it is responsible for the 84% of the overall variation.

We can interpret that first principal component has large positive associations with the metrics V RT, V RT (Agreement), V RT (Disagreement), V RT (V RT Knowledge Provision) and V RT (Knowledge Request), so this component primarily measures the collaborative activities. The second component has

[4] A GitHub repository including all the data about the PCA performed is available at https://github.com/muneebkiani/IF.

Table 5. Eigenvectors of the PCA of metrics with RT as common denominator

	PC1	PC2	PC3	PC4	PC5	PC6	PC7
	σ_{RT}						
VRT	0.421	−0.323	−0.294	−0.181	0.634	−0.259	0.362
PRT	0.134	0.637	−0.523	−0.515	−0.082	0.176	−0.001
VU	0.425	−0.341	−0.172	−0.175	−0.661	−0.420	−0.169
VRT (Agr.)	0.304	0.567	0.059	0.520	0.120	−0.530	−0.129
VRT (D. Agr.)	−0.275	−0.169	−0.767	0.540	−0.091	0.078	0.028
VRT (Kn. Prov.)	0.483	−0.129	−0.044	0.144	0.213	0.486	−0.667
VRT (Kn. Req.)	0.471	0.083	0.126	0.298	−0.294	0.449	0.615

large positive associations with the P RT and V RT (agreement) metrics, so this component primarily defines the relation between age of RT and RT on which there is a consensus. The third component has large negative associations with respect to PRT, VRT (disagreement), it primarily measures the age of RT and RT on which there is no consensus. The fourth component has positive associations with V RT (agreement), V RT (disagreement), meaning it primarily measures various patterns of argumentation.

Table 6. Eigenvectors of the PCA on metrics with U as common denominator

	PC1	PC2	PC3	PC4
	σ_U			
IF	0.638	0.031	0.001	−0.770
OC	0.353	−0.699	0.563	0.265
OC (Kn. Prov.)	0.589	−0.037	−0.644	0.486
OC (Query)	0.349	0.713	0.518	0.319

We performed a second PCAs on the second group of metrics (Table 6), namely IF, OC, OC (Knowledge Provision), OC (Query). The result of our analysis highlighted that the first two components are responsible for about 80% of the variation. In terms of Correlation, as shown in Table 6, first principal component has a large positive association with IF and OC (Knowledge Provision), so we can infer that this component is primarily responsible for goal-oriented discussions; the second principal component does not exhibit any visible associations while the third one has large positive association among OC and OC (Query), so it is responsible for consensus building within specific pattern of discussion.

7 Conclusion and Future Work

OI has been proposed as a promising paradigm. We then illustrated the functionalities of a Web-based collaborative environment designed at our labs. The Data Model we proposed is generic enough to be applicable to a wide set of collaborative working environment. Moreover, it allows defining a set of metrics providing useful insight into the overall collaborative process,

Of course, there are limitations associated with our proposal: for example, the accuracy of results obtained through automatic analysis compared against metrics which are primarily based on expert analysis can be considered poor. Another important limitation is the establishment of a broad consensus on the definition of various collaboration and innovation related activities. These activities are mainly based on social relationships among entities, which are subject to different interpretations in different contexts.

Future works include evaluation of metrics on a different dataset and text analysis to correctly specify the relevance and novelty of users' contributions.

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One Design Issue – Many Solutions. Different Perspectives of Design Thinking – Case Study

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Abstract. This paper compares chosen results of one design issue which was assigned to different groups of courses' participants (in different educational programs, given in this abstract in parenthesis): high school students (Creative Team Project course), university students (two separate groups: one group consisted of students from university in Poland and the second group consisted of students from different EU countries - Creative Semester Project course and Design Methods in Logistics and Transportation course) and adults who wanted to enrich their skills in the fields of creativity and entrepreneurship (Innovative Soft Skills and Entrepreneurship Training). Appropriate literature review, description of programs and used methodologies, relative results and findings and conclusion are also given in the paper. The paper also indicates the subjective thoughts of author on the covered topics.

Keywords: Design thinking · Problem based learning · Informal education

1 Introduction

Without any doubts, the wave of computerization that began in the late 70s of previous century necessarily raised many new issues in most of areas of people interest, also in education. It is clear that the new structures are created through the technology, which sometimes leads to public controversy that even affects trade unions. It was a statement of 90s of previous century and it is still actual, in era of Industry 4.0. However, we cannot forget that with software or without it, our own, human creativity is of immense power. Unlike the industrial society, which relied on a standardization and formalization of knowledge, the information society is the opposite – it trusts in informal education as the basis for modernization, Tully (1996, p. 32). As generations came to the conclusion, standardization and formalization, both separately and as a pair, lead to routine behaviors. On the other hand, information society is connected to visual technology in general and it generates mass consumption of visuals in what-you-see-is-what-you-get matter. It was stated then that if routine is a creativity killer, so is the blind use of modern technology. Therefore, this paper would not be connected to any digital tool except the software, in which it was typed or those used as a form of communication between people who worked on solutions mentioned in paper's title. Since creativity is discussed herein, it may be important to opt for informal education aspects.

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This paper covers the comparison of some results of one design issue which was passed on to different groups of people: high school students, university students (two separate groups: one group consisted of students from university in Poland and the second group consisted of students from different EU countries) and adults who wanted to enrich their skills in the fields of creativity and entrepreneurship. The author understood “design issue” as follows. Design issue should not consist of one task, the content of which results in obvious solution. The issue should convince course participants to think in different perspectives, to come up with various possible solutions, from abstract to actual ones. The design issue was defined herein as *Space beneath bridges. How to exploit the recreational potential of the space beneath bridges? What activities to lead there?* The search for a solution to the problem, formulated in this way, was proposed to the mentioned four different groups of participants. All of groups used chosen aspects and assumptions of design thinking method (assumptions of design thinking are e.g.: multidisciplinary teams – looking at issues from different perspectives, focus on the user – understanding ones needs, building and modifying prototypes based on feedback from users, experiments and tests of hypotheses; three aspects of design thinking, beyond mentioned assumptions, are as follows: human-centered research, collective and diverse teamwork and rapid prototyping). The term design thinking is in good currency in both academia and among practitioners and has produced a numerous of recent publications (e.g., Brown 2009; Cross 2011; Lockwood 2009; Martin 2009; Verganti 2009; Goldschmidt and Rodgers 2013).

Design thinking, in short, is an iterative process, which aim is to understand the user, challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might not be instantly apparent within initial level of understanding. It is a way of thinking and working, which cherishes multiple perspectives and rich frameworks of a problem (Dorst 2011) as well as a collection of hands-on methods. Nowadays, design thinking is identified as an exciting new method, sometimes called innovative, for dealing with problems in many professions, such as information technology (IT) (e.g. Brooks 2010) or business (e.g. Martin 2009), healthcare management (Roberts et al. 2016), entrepreneurship (especially it was put into usage in social entrepreneurship; Chou 2018) or even in sustainable development (Shapira et al. 2017), to mention only few of them. Author perspectives on this method are given in the fourth section of this paper.

2 Literature Review

Approaches on different groups of students (two groups of undergraduates students in industrial design and architecture and one group of PhD candidates) who used design thinking method has been the matter of comparison done by other authors e.g. Goldschmidt and Rodgers 2013. The difference between their research and the one presented in this paper is primarily the fact that they described effects of educated designers actions and the one presented here describe experiences of people who in general do not have any professional experience in design. The participants designed solutions connected to safety, promotion, services but most of all products which paper's authors considered obvious for this group. Does it mean that students of design were more or less creative than other students?

The research method compares ways to approach a given problem based on the team reports and by observing participants during the courses.

The design thinking method is originated of world renown North American universities. Developed in the 60s of the twentieth century, it has been successfully used for example at Harvard Business School, Sloan Management School, University of California (Chermack and Coons 2015) or Stanford University (some authors, as Dorst 2011, mentioned that the first call of "design thinking" name was exposed in the book of Rowe titled as "Design thinking", Rowe 1987).

IDEO (2016) defined design thinking as "a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success." Lockwood (2010) proposed a similar definition which states design thinking as "essentially a human-centered innovation process that emphasizes observation, collaboration, fast learning, visualization of ideas, rapid concept prototyping, and concurrent business analysis, which ultimately influences innovation and business strategy." However, Chermack and Coons (2015) situated design thinking as a set of uniquely human abilities that have historically kept humanity alive and brought humanity to where it is today, although the term itself has not been used.

As a result of the Top 500 Innovators and TransFormation.Doc programs (initiated by the Ministry of Science and Higher Education of Poland), interest in innovative and creative activities expressed by masses of young researchers and entrepreneurs has been noticed. As an extremely effective method, design thinking works well both in the education of students and the implementation of projects in enterprises. It might be stated, that design thinking expands or even spreads like a wildfire. The programs mentioned above initiated a series of events which aimed at popularization of the method, including: three editions of Design Thinking Week, the activities of the Rector's Team for Innovative Teaching Methods INFOX at the Warsaw University of Technology, few editions of Polishopa conference, Entrepreneurship and soft skills courses within the Open University of Warsaw University and other events. It is one of the innovative methods of project management and students education, alongside problem based learning (PBL), research based learning (RBL), work based learning (WBL), e-learning, massive open online courses (MOOC), etc.

3 Design Thinking Method

The design thinking method is based on developing creativity and searching for innovative, non-trivial and not obvious solutions to the problem (design issue). It consists of five phases: empathy (aiming at empathize with users), defining the problem (aiming at define users' needs, their problems, and design thinkers insights – by the name of design thinkers the author understood participants of any course which is tracked with design thinking method), generating solutions (aiming at ideation by challenging assumptions and creating ideas for innovative solutions), prototyping (aiming at solutions creation) and testing (aiming at solutions test). It allows for non-linear consideration of design issues, as it allows returns to previous phases, overhauling them, thus improving a designed solution (by a name of solution, it can be understood: physical product, service, applications or others) to which the recipients/customers/other stakeholders would be interested.

The design thinking method in the initial phases, i.e. empathy, requires from the implementers a maximum openness at the possibilities of understanding a problem (issues, challenges) and people affected by it. Through an interview (qualitative or quantitative), a questionnaire, a persona, an observation without an active observer's participation (or other tools), the empathy stage examines what the problem is, what it concerns and how. This phase is a proof of focus on the user – understanding of his needs.

During the typical courses, design thinkers have opportunity to create a qualitative interview or a survey addressed to the recipient interested in the implementation of the design issue. The proposed questions help to understand people, groups or institutions related to a design issue. Design thinkers are informed, that it is worth to consider who to ask these questions; considering aspects such as human, financial and time resources available for interviews.

Such understanding applies to a problem, a client's person and benefits expected from the solution. This is an extremely important stage when building a business idea and designing individual elements.

After this analytical phase, design thinkers enter a synthesis phase in which they work with a diverse group of participants to devise alternative ways of achieving preferred results. Only after the empathy phase, based on the gathered information, it is suggested to start thinking about definition of a true problem behind the design issue and describe a person of a user (so-called "persona"). At this stage, it is worth creating several versions of "persona".

In the third step, understanding of a problem and having specific people affected, design thinkers can move on to creating solutions, e.g. using a brainstorm tool (a popular tool – often recommended, but sometimes misused). It is advisable to take a creative approach and create solutions that go far beyond what is currently available and, at first sight, "unrealistic". Going far beyond the standard area of solutions can have a very positive effect on the final outcome of the discussion. At this stage, consulting children are often of very high cognitive value due to lack of thought patterns that are saturated with adults. Especially that, taking into account levels of design expertise, such as: "naive", "novice", "advanced beginner", "competent", "expert", "master" and "visionary", it is not so obvious that the most creative would be a person who is on visionary level. Most of all, a naive one could be the most creative and innovative because of simple reason: lack of experience which could yield unexpected solutions.

As the fourth step in design thinking method, prototypes are created, that is visualizations of a solution in a form that enables presentation of design issue's key aspects to people who do not participate in the creation process – users/clients, investors, partners, etc. Form of a presentation can be varied: if design thinking concerns the solution of a technological problem, it may be a device element mock-up, an image presenting main page of a website or, in the case of a business idea, it may be more or less formal model in a form of a business one. The business model can be represented using various templates, e.g. Business Model Canvas (BMC). It might be considered when a solution is good enough for implementation. As a generalization, it can be stated that the one which meets the greatest number of needs and can be accomplished within the constraints of budget and schedule.

Empathizing, defining problems, ideating, prototyping and testing are five core design thinking skills, Henriksen et al. (2017). Sometimes other authors, as Glen et al. (2015), call and organize phases differently, e.g. as problem finding, observation, visualization and sense making, ideation, prototyping and testing, and the design of a business model enacting the innovation. Lockwood (2009) calls them also differently, as: observation, collaboration, fast learning, visualization of ideas, rapid concept prototyping and concurrent business analysis. As most of course designers and instructors, the teams used a specific design thinking framework – the Stanford design thinking model. However, it is not suggested that the Stanford model is the best approach available. Design thinking method is not rigid, it enables to propose a process of design in many ways, sometimes unpredictable.

Some design schools separate thinking from acting in design thinking, Mintzberg et al. (2008). It is difficult to agree with, especially that scenarios of acting may become a kind of prototypes, and thinking in every mode (phase, stage) of design thinking is subject of introduction to be as such. Design thinking method is actually a draft, which may be treated in different ways, which may be significantly expanded, and in the case when every stage of it is different, even unpredictable methods and tools can be used, adequately to necessities and expectations of stakeholders or tutors.

4 Description of Educational Programs

The aim of this paper is to present the observations of participants who took part in four courses: Creative Semester Project (hereafter CSP), Creative Team Project (hereafter CTP), Design Methods in Logistics and Transportation (hereafter DMLT), Innovative Soft Skills and Entrepreneurship Training (hereafter ISSET). Three of them were conducted at the Warsaw University of Technology, as a part of educational trainings and workshops arranged by the Rector's Team for Innovative Teaching Methods INFOX. The last one was conducted at the University of Warsaw. The first course – CSP is a key educational program of INFOX run by academic teachers from various faculties of the Warsaw University of Technology for 6–10 students (per one team) who also study at different faculties and from different years and degrees of university education. Course takes one academic semester each time. While CSP is a course for university students, CTP is conducted for secondary school students. So far the course was executed once. In case of the third, DMLT course, it was designed for international students, as part of the Erasmus + program in the Faculty of Transport at the Warsaw University of Technology. The fourth course was a part of the Entrepreneurship and Soft Skills Development course realized in the Open University Program at the University of Warsaw. Every of team taking part in any mentioned course was ready to implement the project after theoretical preparations (short lecture at the beginning of particular course). The mentioned courses are discussed very briefly below.

The CSP is an additional course for students which is implemented at the central level of the Warsaw University of Technology. Central level implementation means that every student can take part in it, no matter whether he/she is at the beginning or at the end of his/her university education and no matter which faculty he/she studies at. The course is executed every half a year since 2015. During the course, 1st and 2nd degree students (and sometimes 3rd degree students) from various faculties of the Warsaw University of Technology realize open project tasks (design issues) in small groups (in general, 5–8 students per team). The problem based learning and design thinking are base methodologies that are used in the process of education, however the course is not limited to only these two methods (the decision is in hands of a team tutor and a team itself). Topics that are realized, usually are defined by external entities, including business and local government partners of the INFOX. Taking part in this course allows students to acquire the features required by the employers today - teamwork skills, creativity, courage, honesty, non-schematic kind of thinking and simultaneous deepening of substantive knowledge and developing analytical skills. As it was mentioned, the course is implemented in teams of 5–8 students, who study various specialties and faculties. The work of each team is monitored by a tutor who is an academic teacher – in most cases a member of the INFOX. The implemented project usually includes the following stages: planning, research, creating a concept, decisions making, prototyping (manual or computer aided design and development), testing of prototypes. The mentioned stages are strongly associated with practical learning experience and team collaboration. Activities are carried out in cooperation with the socio-economic environment, thereby entering the so-called third mission of the university (Loi and Di Guardo 2015) and are elements of the long-term strategy of the university to support students in acquiring relevant competences.

The CTP was commissioned to the INFOX by Young Scholars Foundation. The CTP was connected to high-school students activities under tutors' (one member of the INFOX and one teacher per a team) tutelage which aim was to solve the actual problem with use mainly of problem based learning method and other methodologies if required. High-school teachers were responsible for students recruitment. It was also occasion for them to learn new options within the scope of informal education. Presumptions in case of this course were similar to the presumptions of the CSP. However, the course duration was shorter: three months. The work in case of this course was divided into two stages: a research project which aim was to develop knowledge and skills in a specific subject matter (connected to specified design issue) and a local action project – semi-implementation of solutions in the local environment (which encouraged high-school students to cooperate with out-of-the school environment in the process of education).

The third course was Design Methods in Logistics and Transportation. This course has been implemented in the Faculty of Transport at WUT in Erasmus + Program. Purpose of the course was to acquire knowledge and basic designing skills and creativity within chosen logistics or transportation systems and processes. Students working in multinational teams realized their design issues according to the main structure of design thinking method with elements of other kind of innovative didactic methods such as research-based learning, project based learning etc. The aim of the course was to familiarize students with the new ways of projects implementation with use of dedicated education method due to boost their work-in-group abilities and creativity potential with the ability of self-directed learning. Problem based learning is a student-centered pedagogy in which students learn through the experience of solving an open-ended problem. Problem based learning enriches the students with abilities of self-directed learning, strengthens their intrinsic motivation and gives the basics for effective problem solving and independent thinking under external supporting and tutoring. Moreover, this method leads to development of teamwork and effective collaboration skills. Design thinking is a practical method of creating innovative solutions for problems with a strong focus on users' needs and discovering the real-life problems. It introduces phases of empathy, defining a problem, defining potential solutions, prototyping, prototype testing.

The last course was the Entrepreneurship and Soft Skills Development Training realized as a part of the Open University Program at University of Warsaw. The course was directed at adolescent participants interested in matters introduced in the course title. The ISSET course was prepared and guided by group of fifteen scholars from different parts of Poland, representing different fields of research. The aim of the course was to provide knowledge about methods, techniques and tools which support:

- communication and teamwork,
- creation of innovative scientific and social projects or other solutions with potential for applications,
- creation of high-quality presentations,
- acquiring funds for the implementation of projects,
- commercialization of the results of development and implementation works, including entrepreneurship and communication with business.

The course aims to develop practical skills in communication, innovation, presentation, project implementation and entrepreneurship by testing methods, techniques and tools during project implementation in small (maximum 5-person), interdisciplinary teams without any inter-team tutor supervising. The course was focused on a practical solution to real, socially relevant problems (from ideas generating to specific action programs realization). In addition, the aim of the course was to develop the competence of creative thinking, self-assessment of participant himself/herself work or teamwork in the context of adopted and assessment of implemented roles in a team. The course covered eight broad thematic blocs and was based on workshops and project work. The thematic blocks were as follows: introduction to subject matter and group work, creativity and concept creation, project management, communication, mediation and negotiations, group and leadership, entrepreneurship, project promotion, summarizing speeches. The course aims to promote multi-branch cooperation. Participants have the opportunity to acquire practical skills in the field of project development, management, entrepreneurship and communication. In addition, the course was an opportunity to cooperate within an interdisciplinary team that created innovative projects under the supervision of a team of lecturers representing various disciplines of science. The part of the course concerning creativity and concept creation is the topic of interest in this paper.

5 Comparison of Solutions for the Given Design Issue

The comparison of some aspects connected with teamwork in the case of every course is presented in Table 1, prepared based on students reports and on observation of participants' behavior. The reports were written by students and other participants and are stored in the private archives of the paper's author. Observation were documented as short notes, photographs, and records realized during the final presentations of solutions. Due to the restrictions of the law connected to image protection these photographs are not presented in the paper. In case of long descriptions appearing in the Table 1, the arguments are continued under the table. Some results and findings connected to empirical work are also given in the next section.

6 Results and Findings

The author understands that the quantities of participants in teams, described in this paper, are not reliable. Due to the fact, that this kind of observation limitations are too differential in terms of experience, age, cardinality of participants, the future outcomes will be conducted in teams of similar characteristics.

Design thinkers are expected to constantly challenge the boundaries of known solutions and venture to unchartered territories. Yet most of them (three of four groups) started to build a bridge mock-up rather than develop ideas around it as imaginative object.

Most of participants did not plan their processes at first or did so to a very limited extent. In the case of three courses (the CTP, the DMLT, the ISSET), it was proposed by tutor/mentor due to the fact that it was the first such experience for participants with the project process and short period of its realization. Only in the case of the ISSET, participants did follow a linear process. Participants of other courses went back and forth and iterated a lot between one activity and another. They were also consequent, starting from the logo or team-name which sometimes were connected to the design issue (it also caused the integration of some teams). It is not surprising that the longer any course was, the more sophisticated solution occurred. There was also a reason for it in brainstorming efficiency. More ideas in ideation phase served to more complex solution. An interesting fact is, that most of teams started their prototype with constructing of the themed bridge (three of four groups). But not all of them. One of the team used a table in classroom as a bridge model and another team, completely outstanding in that matter, decided to leave out the bridge and propose a prototype which is more universal, more general, which can be used in any other place – a recycle tree.

Recycle tree would act as a garbage container divided into glass bottles, plastic bottles and other garbage. Differently from an ordinary garbage container because it encourages a potential garbage holder to throw the garbage inside, which would ensure cleanliness near the Vistula river. In case someone does not have any garbage to throw away, but he/she notices any lying on the ground, he/she would take care of environment and cleanliness, and approach the tree. Gratification would have a visual and gift form – there would be lights that would hang on a tree instead of leaves – as soon

Table 1. Comparison of teamwork effects

Assessment factor	CTP	CSP	DMLT	ISSET
Duration of the course	3 months (6 meetings)	5 months (20 meetings)	5 h (2 meetings)	2 months (5 meetings)
Level of education	High-school students	University students	20–50 years old participants	Students (international)
Team name	AKANA (team members names initials)	Nic na siłę (nothing by force)	N/A	Bridge Designers Co.
Chosen solution	Theme bridges network	Recycle tree	Various solutions for entertainment or area maintenance	Pedestrian platform under the bridge
Quantity of prototypes	2	1	4	2
Ways and effects of participants' integration	Team integrated before the course (students from one class)	Integrating lectures and exercises during the first three meetings	Lack of integration (lack of participants willingness)	Team integrated in result of discussion on "how not to conduct classes"
Application of technology in the course	Communication - a group on Facebook	Communication (Trello, e-mail, Facebook)	N/A	Communication (e-mail, Facebook), prototyping (Catia)
Logo referring to the project	Yes	No (unobvious solution)	N/A	Yes
Brainstorming	High efficiency	Low efficiency	Medium efficiency	High efficiency
Tutor/mentor as a course leader	Mentor	Tutor	Not such a function	Tutor
Number of participants	5	7	4 groups, 5 participants each	6
Focus on bridge as main part of prototype	Yes	No	Use of a table in the classroom by one group	Yes

as the trash is thrown into the tree, a mechanism would activates the lights. There would be as many lights on as many trash is thrown into the container. An additional profit for a person, who would throw into a container, are goods exchangeable coupons (therefore, it can be reconsider as a kind of gamification).

In turn, the most complex idea consisted of theme bridges network (in author subjective opinion, the most integrated solution). The proposed ideas was to arrange several bridges as broad concept of the CTP. Every bridge would have its own theme, as follows:

- the Gdański Bridge – sport "by bicycle to Gdańsk" (gym with a view of the Vistula River, training bikes, treadmill, etc.),
- the Poniatowski Bridge – culture and art (an outdoor gallery, a mini stage for performances, a book rental and an outdoor reading room),
- the Siekierkowski Bridge – freedom of speech (a kind of London's Hyde Park),
- the Grot–Rowecki Bridge – relax "Grotto of Relaxation" (romantic music on one side of the Vistula and silence on the other – loungers, poufs, a place to relax),
- the Maria Skłodowska–Curie Bridge – intellectual development "Intellectual Maria" (an open–air science reading room, computer stands, scientific advice and experiments),
- the Łazienkowski Bridge – "Łazienkowska Entertainment" (a place of entertainment events – dances, concerts, films, shows),
- the Śląsko–Dąbrowski Bridge – safety + emotions of the "light side of the force" (a point for legal, police and municipal guards… a meeting place with psychologists, therapists, etc.).

Finally, and perhaps surprisingly, the most important source in collecting information for all students was not the Internet as they are generally accused. They were discussing matters in their teams and with audience outside a team, they sought information from their peers. The Internet is just a platform that simplify this process. "The majority of the respondents in these studies reported that their lecturers and peers had been very important factors in finding information resources, since they had given them some directions, or suggestions", Lacović (2014).

Some issues are still in question here. Do educators teach students adequately to take risks, to be original and think "outside of the box"? Do educators ask students to go to extremes and explore entirely new directions of thought, as is often required today? These are questions of future outcomes. One thing is certain: educators should set an example for students. It seems that we should encourage our students to devote more time and effort to explorations, and certainly not focus so much attention on preparing final presentations (especially in very compressed exercises) or using technology.

The presented courses aim is to connect the hard skills together with soft skills in innovative way (by use of design thinking method, new knowledge and skills are created in participants' minds – the potential of it is individual and depends of their degree of involvement). Many authors top the importance of linking together the soft skills, the hard skills and the innovativeness of knowledge (Hendarman and Tjakraatmadja 2012; Holberg-Wright and Hribar 2016). The research presented in this paper confirms importance of those above. The best technology attractions will not bring any significant success without the well-combined triple: soft skills, hard skills and innovativeness of knowledge.

7 Conclusion

Taking into account the age and the experience of participants, some specific attitude of older participants in the case of the third course was observed. On the one hand, it was the most problematic group – they did not catch the idea of cheap and fast prototyping based on human-centered process, their minds were focused on the aim with only one potential horizon of events without any branches in different directions. The reasons for that is that the course was too short and lack of concepts based on real life companies were presented (lack of success stories storytelling during the introduction lecture). On the other hand, Glen et al. (2015) experienced confusion and frustration when engaging students in design thinking projects for the first time. Thinking outside the box can be a real challenge, as people naturally develop patterns of thinking that are modeled on the repetitive activities and commonly accepted knowledge. Creativity is considered as one of the most important thinking skill of 21st century (Mishra and Mehta 2017). Contrary to expectations, many people are hesitant to self-identify as "creative" or are uncomfortable with intellectual risk-taking and open-endedness (Weisberg 1986). A prototype of a chosen solution usually is made from materials which can be found in an average household, for instance: scissors, paperboard or glue. Not only they have the advantage of being inexpensive, but they also enhance the creative ability of a team, both as group and as individual. Some people do not catch the idea, they keep on thinking about that kind of prototyping as of kindergarten play. There may be some reasons for that kind of thinking. However, this kind of thinking requires opening on our own imagination. It enables us to push any idea a little bit further, to make a solution beyond "conventional expectations". The design thinking approach, combined with problem based learning and other informal ways of education, is a special case of more general movement in education away from an over-dependence on passive teaching approaches, towards more active problem-based learning. "Journey is more important than destination" – these are words of one student who took part in one of mentioned courses. It is the most beautiful and accurate statement about that kind of education. There is still a lot to do in the matter of education. Education presently needs a lot of changes. For now, it is no more professor-oriented, it is more passion, self-study and experience-based. Therefore, students highly expect introducing some innovative forms. As Erasmus + students of the DMLT course said, it is quite a new method of learning for them and they plan to practice it after the course. Let us continue the journey then, let this idea spread.

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A Survey of Existing Evaluation Frameworks for Service Identification Methods: Towards a Comprehensive Evaluation Framework

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Abstract. Service identification is one of the main challenges in developing services for Service-Oriented Architecture (SOA). A large number of Service Identification Methods (SIMs) have been proposed to simplify service identification. Therefore, many evaluation frameworks are available in the literature for comparing the existing SIMs. This paper aims to identify and analyze the existing evaluation frameworks for SIMs. Moreover, it aims to propose comprehensive evaluation criteria that address most aspects of the existing SIMs. A review of 23 evaluation frameworks for SIMs built the foundation for deriving a comprehensive set of 16 criteria, namely SOA lifecycle coverage, approach, input artifact, technique, types of services, service description, service quality attributes, service granularity, comprehensive, systematic, availability, tool support, adoption of existing practices, validation, configurability, and domain. The proposed criteria set can be used as a first step towards a comprehensive evaluation framework for SIMs.

Keywords: Service-Oriented Architecture · Service Identification
Service Identification Method · Evaluation Framework · Criteria
Survey

1 Introduction

Due to the importance and complexity of Service Identification (SI) phase in the development process of Service-Oriented Architecture (SOA), many Service Identification Methods (SIMs) are available in the literature to facilitate SI. Therefore, a number of evaluation frameworks have been proposed to compare the existing SIMs. However, a survey on theses evaluation frameworks is still lacking.

We conducted a literature review exploring the existing evaluation frameworks for SIMs that have been proposed between 2007–2016. The review can help the researchers and practitioners to select a suitable evaluation framework that fits with their specific needs. With the objective of developing a comprehensive evaluation framework for SIMs, in this paper, we address and answer the following two research questions to achieve our research objective:

1. What are the existing evaluation frameworks for SIMs?
2. What are the evaluation criteria that represent the most significant characteristics of existing SIMs?

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This research provides the following contributions:

- Providing a general overview of the existing evaluation frameworks for SIMs.
- Proposing comprehensive evaluation criteria that address most aspects of existing SIMs.

The rest of the paper is structured as follows. The existing evaluation frameworks for SIMs are introduced in Sect. 2. Section 3 describes the proposed evaluation framework for SIMs. Finally, Sect. 4 concludes the paper and forecasts future research.

2 Existing Evaluation Frameworks

2.1 Overview

Table 1 gives an overview of the existing evaluation frameworks for SIMs. It shows the number of criteria and methods for each evaluation framework.

Table 1. An overview of the existing evaluation frameworks for SIMs.

Evaluation framework	Year	No. of criteria	No. of methods
Kohlmann and Alt [1]	2007	9	6
Klose et al. [2]	2007	8	10
Ramollari et al. [3]	2007	8	10
Kim and Doh [4]	2009	5	4
Boerner and Goeken [5]	2009	42	5
Kontogogos and Avgeriou [6]	2009	6	7
Birkmeier et al. [7]	2009	13	13
Kohlborn et al. [8]	2009	9	30
Gholami et al. [9]	2010	34	1
Gu and Lago [10]	2010	6	30
Nikravesh et al. [11]	2011	3	9
Gu and Lago [12]	2011	23	12
Cai et al. [13]	2011	4	41
Svanidzaitė [14]	2012	4	5
Mohamad et al. [15]	2012	6	6
Jamshidi et al. [16]	2012	14	10
Alahmari [17]	2012	8	25
Vale et al. [18]	2012	13	30
Zadeh et al. [19]	2012	1	48
Kazemi et al. [20]	2013	8	5
Huergo et al. [21]	2014	14	105
Leopold et al. [22]	2015	4	27
Amiri et al. [23]	2016	6	13

2.2 Evaluation Criteria and Examined Methods

In this section, we provide for each evaluation framework: evaluation criteria, the basis used to define the criteria, and a brief description of the examined methods.

Kohlmann and Alt [1]. *Criteria:* Business-driven SI, technical-driven SI, examination of service cut, domain analysis, visualization with service landscapes/maps, service clustering, service specification, alignment with process model, alignment with sourcing strategy. *Basis:* The criteria represent the features of an overall approach for service modeling. *Methods:* Focus on service modeling (i.e., SI, service clustering) methodologies.

Klose et al. [2]. *Criteria:* Background and starting point, employed SOA concept, service hierarchies and classification scheme, covering of SOA design phases, documentation of the method, proposal of IT criteria for SI, application of process models for SI, regard to stakeholders for SI. *Basis:* The criteria represent the features of a generalized and consolidated approach for identifying services. *Methods:* Some SOA development methodologies include all SOA lifecycle phases, while other methods focus on early SOA phases (e.g., SI, service design).

Ramollari et al. [3]. *Criteria:* Delivery strategy, lifecycle coverage, degree of prescription, availability, process agility, adoption of existing processes/techniques/notations, industrial application, supported roles. *Basis:* Not mentioned. *Methods:* Some Service-Oriented Software Development (SOSD) methodologies cover the complete SOA lifecycle, while other methodologies focus on Service-Oriented Analysis and Design (SOAD) phases.

Kim and Doh [4]. *Criteria:* Background and starting point, service classification scheme, covering of SOA design phases, characteristics, application of process models for SI. *Basis:* The criteria were taken from [2] to compare a proposed SIM with some existing methods. *Methods:* Some SOA development methodologies include all SOA phases, while other methods focus on early SOA phases (e.g., SI, service specification).

Boerner and Goeken [5]. *Criteria:* Basic characteristics (industry sector, understanding of services, service hierarchy, granularity, SOA paradigm, direction of analysis, tools, types of categorization), Business aspects (consideration of strategic aspects, legal compliance, internal policies/IT governance, service level agreements, goal, supported object, SOA lifecycle/governance, functional similarity), Technical aspects (orchestration vs. choreography, customer interaction, employee interaction, criteria of information technology, call frequency), Economic aspects (value creation, maintenance and operation costs, testing effort for new functionality, vendor dependency, demand-oriented QoS levels, customer satisfaction, individualization of products and services, specialization in core competencies, increase of the product range, internal services offered to external customers, scalability, time-to-market, SOA controlling), Components of method engineering (activities, SOA-roles, results, techniques, sequence of activities), Principles of design science research (documentation, research rigor, method evaluation). *Basis:* Some criteria have already been used by other researchers (e.g., [24]), while other criteria have been added to complement the existing ones. *Methods:* Focus on SI phase.

Kontogogos and Avgeriou [6]. *Criteria:* Service description, behavior specification, lifecycle coverage, detail, adaptability, industrial application. *Basis:* The criteria represent the academic characteristics of the selected SOA methodologies. *Methods:* Some SOA development methodologies cover the full SOA lifecycle, while other methodologies focus on SOAD phases.

Birkmeier et al. [7]. *Criteria:* Service definition, degree of formalization, development process model, direction, optimizing approach, model views, consideration of existing structures, consideration of system dependencies, differentiation of service hierarchies, differentiation of predefined service types, tool support, quality assertions, evaluation. *Basis:* Generic criteria, which characterize systematic design methods in general, were derived for building a classification framework. Then the generic criteria were refined to compare SIMs in particular. *Methods:* Focus on SI phase.

Kohlborn et al. [8]. *Criteria:* SOA concept, delivery strategy for SOA, lifecycle coverage, degree of prescription, accessibility and validity, adoptions of existing techniques/processes, regards to stakeholders, service classification and clustering, additional characteristics. *Basis:* The criteria in three research papers (i.e., [1–3]) were consolidated based on a clustering process to provide a comprehensive set of criteria for comparing service analysis methods. *Methods:* Focus on service analysis-related service engineering methods.

Gholami et al. [9]. *Criteria:* Development process (clarity and consistency of definition; coverage of the generic development lifecycle activities; support umbrella activities; smooth and seamless transition between phases, stages and activities; requirements as a basis (functional and non-functional); tangibility of artifacts, and traceability to requirements; manageability of complexity; extensibility, configurability, flexibility and scalability; practicability and practicality; application scope; evolutionary or revolutionary; language or technology); Modeling language (support for different model views; analyzability; providing techniques for tackling model inconsistency and managing model complexity; preciseness; simplicity to learn and use); Service-oriented activities (business modeling; SOAD; service quality attributes; service provisioning and consuming; service testing; service versioning and evolution; adaptable with legacy systems; cost estimation); Service-oriented umbrella activities (service level agreement monitoring; support of governance; people management; distributed software development techniques); Supportive features (architecture-based; service agility; process agility; maturity level; tool support). *Basis:* The generic criteria (i.e., development process, modeling language) were taken from existing evaluation frameworks for the object-oriented, agile and agent-oriented methodologies, while the specific criteria (i.e., service-oriented activities, service-oriented umbrella activities, supportive features) were defined based upon previous researches (e.g., [3]), Service-Oriented Software Engineering (SOSE) literature, SOSE challenges, SOA concepts, and prominent features of existing SOSD methodologies. *Methods:* One methodology (i.e., mainstream SOA methodology) focuses on SOAD phases.

Gu and Lago [10]. *Criteria:* Type of input, type of output, output format, strategy, technique, validation. *Basis*: The criteria represent the basic elements (e.g., inputs, outputs, and processes) of SIMs. *Methods:* Focus on SI phase.

Nikravesh et al. [11]. *Criteria:* Identification strategy, service quality evaluation, automation. *Basis:* The criteria represent the objectives of a proposed SIM, called 2PSIM. *Methods:* Focus on SI phase.

Gu and Lago [12]. *Criteria:* Generic aspects of SOSE methodologies (objective, lifecycle, artifacts, notations, procedure, principles, formality, specialization, tool, maturity, management, integration), Service-specific aspects of SOA methodologies (open-world assumption, service definition, the creation of services, development roles, association of roles to activities, architectural change, runtime activities, non-functional requirements, variability, perspective, multiple organizations). *Basis:* The generic criteria were derived based on selected process-related properties defined in [25], while the service-specific criteria were derived using seven differences between SOSE and traditional software engineering identified in [26]. *Methods:* Some SOSE methodologies cover the entire service lifecycle, while other methodologies focus on specific phases (e.g., SOAD, service development).

Cai et al. [13]. *Criteria:* Activity, approach, description, artifacts. *Basis:* In order to explain how SI should be carried out, the existing SIMs were examined to extract shared high-value activities that were analyzed in terms of their inputs, artifacts, and how they work. *Methods:* SOA methodologies with a focus on SI phase.

Svanidzaitė [14]. *Criteria:* Delivery strategy, lifecycle coverage, degree of prescription, adoption of existing techniques and notations. *Basis:* Based on previous researches (e.g., [3]). *Methods:* SOA methodologies with a focus on SOAD phases.

Mohamad et al. [15]. *Criteria:* Based on business process modeling, top-down approach, bottom-up approach, step-by-step guideline, enterprise software, device consideration. *Basis:* The criteria represent the objectives of a proposed systematic SI guideline for developing distributed embedded real-time systems. *Methods:* Some methodologies cover the complete SOSD lifecycle, while other methods focus on SI phase.

Jamshidi et al. [16]. *Criteria:* Degree of automation, employed technical metrics, utilization of model driven approach, identification approach, identification technique, identification strategy, applicability, type of identified services, employed assets, reusability of the method, degree of formalism, tool support, input model, principal thesis. *Basis:* Based on [8]. *Methods:* Focus on service modeling (i.e., SOAD) methodologies.

Alahmari [17]. *Criteria*: Delivery strategy, technique, lifecycle coverage, service types, modeling input, modeling output, quality aspects, granularity. *Basis:* Some criteria were adapted from relevant literature (i.e., [2, 3, 5, 8]), while two criteria (i.e., modeling input, modeling output) were adopted from [10]. *Methods:* Focus on service modeling (i.e., SOAD) methodologies.

Vale et al. [18]. *Criteria:* Service granularity, understanding of services, direction of analysis, input artifacts, output artifacts, techniques/activities, orchestration vs. choreography, research method, research rigor, business/economic aspects, industry sector, reuse, variability. *Basis:* Some criteria were identified from four studies (i.e., [2, 4, 5, 10]), while two criteria (i.e., reuse, variability) were proposed by experts through a survey asking about the most significant criteria. *Methods:* Focus on SI phase.

Zadeh et al. [19]. *Criteria:* Input type. *Basis:* Different types of inputs were collected from the existing SIMs. Then a set of proposed criteria based on Small Medium Enterprises (SMEs) (i.e., machine readability, interaction details, goals coverage, possibility to decomposition, clarity, choreography, easy to achieve by SMEs) was used to evaluate the applicability of each input type for SI in SMEs. *Methods:* Focus on SI phase.

Kazemi et al. [20]. *Criteria*: Business goals, design metrics, identifying strategy, automation, scalability, formality, input, architect interference degree. *Basis:* Some criteria represent the goals of a proposed SIM, called ABSIM. *Methods:* Focus on SI phase.

Huergo et al. [21]. *Criteria:* The proposed classification scheme (participant concerns, context of transactions, service value to the business, service description, behavior model, information model, service granularity, service dependency, type of conversation, quality attributes elicitation), The criteria proposed by [13] (technique, delivery strategy, description, artifacts). *Basis:* The proposed classification scheme, which includes different service perspectives, was derived based on the OASIS' reference architecture (i.e., OASIS' views and models) for SOA [27]. Moreover, the existing SIMs were classified based on high-value activities (i.e., identification techniques) proposed by [13]. *Methods:* Focus on SI phase.

Leopold et al. [22]. *Criteria:* Main input, automation, type, phases. *Basis:* Not mentioned. *Methods:* Focus on SI phase.

Amiri et al. [23]. *Criteria:* Strategy, technique, input, standards, multi-aspect, automation. *Basis:* Some criteria (i.e., strategy, technique, input) were taken from [10] to compare a proposed SIM with some other common SIMs. *Methods:* Focus on SI phase.

2.3 Analysis

As shown in Table 1, the evaluation framework proposed by [5] has the highest number of criteria (i.e., 42), while the framework proposed by [19] has the lowest number of criteria (i.e., 1). In regards to the number of examined methods, the framework proposed by [21] has the highest number of methods (i.e., 105), while the framework proposed by [9] has the lowest number of methods (i.e., 1).

According to the basis used to define the criteria in the existing evaluation frameworks, the criteria defined in four frameworks (i.e., [2, 3, 5, 10]) built the foundation (totally or partially) for the proposed criteria in other seven frameworks (i.e., [4, 8, 9, 14, 17, 18, 23]). According to the examined methods in the existing evaluation frameworks, most of the frameworks (i.e., 65.2%, 15 out of 23) specifically focus on SI phase. Moreover, SI phase is a part of SOAD phases that are covered in the remaining frameworks.

Besides evaluating and comparing the existing SIMs, five evaluation frameworks (i.e., [8–10, 12, 18]) have been proposed to guide the organizations in the selection among SIMs according to their needs.

3 Proposed Evaluation Framework

To develop a comprehensive evaluation framework for the existing SIMs, first we identify the characteristics that are of great importance to SIMs, then we define comprehensive evaluation criteria based on these characteristics. In the following, first we present a comprehensive set of criteria to evaluate the existing SIMs, then we compare the existing evaluation frameworks for SIMs using the proposed criteria.

3.1 Proposed Evaluation Criteria

The proposed evaluation criteria are defined to address most aspects of the existing SIMs in order to develop a comprehensive evaluation framework for comparing and selecting SIMs. We identify the rationale behind using the proposed criteria as follows:

- A review of the existing evaluation frameworks for comparing SIMs built the foundation to develop appropriate and comprehensive evaluation criteria that address most aspects of SIMs.
- Some significant criteria (e.g., comprehensive, configurability) are obtained from SI challenges [28] to complement the criteria set.
- Some criteria are defined (e.g., adoption of existing practices) to fully utilizing the SOA maturity level, which is identified by Welke's SOA maturity model [29], in order to guide the organizations in selecting a suitable SIM that helps to reach the desired SOA maturity level and fits with their specific needs [30].

Below, we present the proposed comprehensive evaluation criteria besides their description.

C1 SOA Lifecycle Coverage. This criterion shows the phases of SOA development lifecycle that are covered in each method. Some proposed methods support the complete SOA lifecycle, while other methods focus on specific phases (e.g., SI, service design) [2].

C2 Approach. This criterion identifies the analysis direction used by each method to derive services. The analysis direction follows three approaches: top-down (business-driven), bottom-up (technical-driven), and meet-in-the-middle (hybrid) [31].

C3 Input Artifact. This criterion provides information about the type of input (e.g., business process, legacy system) that a SIM starts from to identify services. It affects the decision about which identification approach to use [17, 18, 32], also the business or technical orientation of any SIM is determined based on its input types [33].

C4 Technique. This criterion describes the way (e.g., analysis, guidelines, and algorithm) used by a SIM to identify services.

C5 Types of Services. This criterion evaluates whether a SIM identifies different types of services. Some SIMs generally identify services (e.g., composite service, atomic service), while other SIMs distinguish specific types of services (e.g., business process service, business service, and software service) [2, 7, 34].

C6 Service Description. This criterion explains the way (e.g., list of services, service model) used by a SIM to describe its output (i.e., identified services).

C7 Service Quality Attributes. This criterion evaluates whether a SIM adopts certain quality attributes (e.g., coupling, granularity, and reusability) to assess the quality of the identified services during SOA design.

C8 Service Granularity. Service granularity refers to the service size and the scope of functionality implemented and exposed by a service [35, 36]. This criterion evaluates whether services are identified using different levels of granularity (e.g., fine-grained, coarse-grained).

C9 Comprehensive. This criterion evaluates whether a SIM includes all the activities of SI process. According to [37], a comprehensive SIM should cover four phases (i.e., preparation, identification, detailing, and prioritization) to achieve a close business and IT alignment.

C10 Systematic. This criterion evaluates whether a SIM provides detailed guidance to describe its process. SIMs vary from the most prescriptive ones (i.e., provide lots of details) to the less descriptive ones (i.e., provide less detail) [14].

C11 Availability. This criterion evaluates whether the documentation (i.e., detailed description) of a SIM is available to the interested public and can be easily accessed. According to this criterion, SIMs can be classified into openly available, partially available, or proprietary.

C12 Tool Support. This criterion evaluates whether a SIM provides software tools to support certain activities (e.g., service modeling, service selection, and service deployment) in its process. According to this criterion, SIMs can be categorized into fully automated, semi-automated, or completely manual [2].

C13 Adoption of Existing Practices. This criterion evaluates whether a SIM utilizes well-known practices (e.g., processes, techniques, and notations) that can establish the foundation for the method, and also can help in its application.

C14 Validation. This criterion describes the way (e.g., project, case study, and solid example) used by a SIM to evaluate its correctness and its applicability in practice.

C15 Configurability. This criterion evaluates whether a SIM is independent on its context so it can be configured and reused to accommodate different situations of the projects at hands.

C16 Domain. This criterion describes the context (e.g., finance, healthcare, and automotive insurance) where a SIM is applied.

3.2 Comparison of Existing Evaluation Frameworks Using the Proposed Evaluation Criteria

Table 2 shows the mapping between the existing evaluation frameworks for SIMs and the proposed evaluation criteria.

Table 2. The mapping between the existing evaluation frameworks and the proposed criteria.

Evaluation framework	Proposed evaluation criteria																No. of criteria
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Kohlmann and Alt [1]	□	■	▣	▣	▣	■	□	□	□	□	□	□	□	□	□	□	5
Klose et al. [2]	■	■	■	□	■	□	■	□	□	■	□	□	□	▣	□	□	7
Ramollari et al. [3]	■	■	□	▣	□	□	□	□	□	■	■	□	■	■	□	□	7
Kim and Doh [4]	■	■	■	□	■	□	□	□	□	■	□	□	□	▣	□	□	6
Boerner and Goeken [5]	▣	■	▣	■	■	□	■	■	□	▣	□	□	▣	■	□	■	11
Kontogogos and Avgeriou [6]	■	□	□	□	□	□	□	□	□	■	□	□	□	■	□	□	3
Birkmeier et al. [7]	□	■	▣	▣	■	□	▣	□	□	▣	□	■	□	■	□	□	8
Kohlborn et al. [8]	■	■	■	■	■	□	□	□	□	■	■	□	■	■	□	□	9
Gholami et al. [9]	■	□	▣	▣	□	□	■	□	□	■	□	■	□	□	■	■	8
Gu and Lago [10]	□	□	■	■	■	■	□	□	□	□	□	□	□	■	□	□	5
Nikravesh et al. [11]	□	■	□	□	□	□	■	□	□	□	□	■	□	□	□	□	3
Gu and Lago [12]	■	□	▣	■	▣	■	▣	□	□	■	□	■	■	■	■	▣	12
Cai et al. [13]	□	■	▣	■	▣	■	□	□	□	□	□	□	□	□	□	□	5
Svanidzaite [14]	■	■	□	▣	□	□	□	□	□	■	□	□	■	□	□	□	5
Mohamad et al. [15]	□	■	▣	▣	□	□	□	□	□	■	□	□	□	□	□	□	4
Jamshidi et al. [16]	□	■	■	■	■	□	■	□	□	▣	□	■	□	□	■	■	9
Alahmari [17]	■	■	■	■	■	■	■	■	□	□	□	□	▣	□	□	□	9
Vale et al. [18]	□	■	■	■	□	■	□	■	□	□	□	□	□	■	□	■	7
Zadeh et al. [19]	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	1
Kazemi et al. [20]	□	■	■	▣	□	□	■	□	□	▣	□	■	□	□	□	□	6
Huergo et al. [21]	□	■	▣	■	■	■	■	□	□	□	□	□	□	□	□	□	6
Leopold et al. [22]	□	□	■	□	■	□	□	□	■	□	□	■	□	□	□	□	4
Amiri et al. [23]	□	□	■	■	□	□	□	□	□	□	□	■	■	□	□	□	4
No. of frameworks	10	16	19	17	13	7	10	3	1	13	2	8	7	10	3	5	

■ Criterion fulfilled
▣ Criterion partially fulfilled
□ Criterion not fulfilled

The criteria can be fulfilled either fully (i.e., explicitly) or partially (i.e., implicitly). For example, the framework proposed by [7] fulfills eight criteria, four criteria (i.e., approach, types of services, tool support, and validation) are fully fulfilled and the other four criteria (i.e., input artifact, technique, service quality attributes, and systematic) are partially fulfilled. The approach criterion is fully fulfilled by [7] using one criterion (i.e., direction), while the input artifact criterion is partially fulfilled by [7] using two criteria (i.e., model views, consideration of existing structures).

In regards to the number of criteria that are fulfilled by each framework, the framework proposed by [12] fulfills the highest number of criteria (i.e., 12 out of 16, 8 fully, 4 partially), while the framework proposed by [19] fulfills only one criterion (i.e., input artifact). To a certain extent, the frameworks (i.e., [5, 8, 12, 16, 17]), which fulfill a high number of criteria, are considered comprehensive frameworks since they address most aspects of SIMs. It is worth noting that the framework proposed by [8] can be considered the most comprehensive framework since it has the highest number of methods (i.e., 30) compared to the other frameworks (i.e., [5, 12, 16, 17]).

According to the number of frameworks that address each criterion, the input artifact criterion is ranked as the top criterion since it is addressed by most of the existing frameworks (i.e., 19 out of 23, 11 fully, 8 partially), while the comprehensive criterion is addressed by only one framework (i.e., [22]). Moreover, the criteria set (i.e., approach, input artifact, technique, types of services, and systematic) is addressed by most of the existing frameworks, while the criteria set (i.e., service granularity, comprehensive, availability, and configurability) is addressed by few frameworks.

4 Conclusion and Future Work

In this paper, we provide an overview of the existing evaluation frameworks for SIMs. Based on a literature review, 23 evaluation frameworks were identified that serve as the foundation to propose comprehensive evaluation criteria, which address most aspects of SIMs. The review would help to find the gaps in the current evaluation frameworks for SIMs and it suggests directions for future research. Future work would include:

- Validating the proposed criteria by researchers and practitioners in SOA to determine their significance level.
- Evaluating the existing SIMs, which will be identified from a comprehensive literature review on SIMs, against the proposed criteria in order to develop a comprehensive evaluation framework for SIMs that provides the organizations with a comprehensive guidance in the selection of appropriate SIMs.

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A Literature Review on Service Identification Challenges in Service Oriented Architecture

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Abstract. Service Identification (SI) is an important phase in Service-Oriented Architecture (SOA) lifecycle. Many SI challenges have been claimed in the research community that call for research efforts. This research aims at exploring and identifying the claimed challenges of SI in SOA by conducting a literature review to gain insight into the existing SI challenges as published to date. Furthermore, this research aims at collecting the existing claimed causes for each identified challenge. The literature review explored SI challenges that have been claimed between 2005–2016. This paper presents the results of the literature review in identifying 8 claimed SI challenges, namely from the top: service quality attributes, business-IT alignment, systematic SIM (Service Identification Method), comprehensive SIM, tool support, validation, input artifact, and configurability of SIM. The results of this review also revealed that service quality attributes challenge (specifically service granularity) needs more attention in the research community since it is considered the top challenge.

Keywords: Service-Oriented Architecture · Service Identification
Service Identification Method · Service Identification Challenges
Service Quality Attributes · Business-IT Alignment

1 Introduction

Service Identification (SI) is an important phase in Service-Oriented Architecture (SOA) lifecycle since it establishes the foundation for the later phases in the development of SOA [1]. Moreover, it is one of the main challenges in designing and implementing an SOA [2]. SI must support SOA promises of improving business agility, promoting business-IT alignment, and increasing the return of investment [3]. Service Identification Method (SIM) aims at identifying high-quality services based on desired SOA design principles [4]. Several SIMs have been proposed from both academia and industry [5].

Many SI challenges have been claimed in the research community that demand research efforts. A comprehensive overview of the existing SI challenges could help to establish a research agenda on SI. We could not find any literature reviews that explore the challenges related to SI in SOA; hence a comprehensive overview of the existing SI challenges in SOA is still lacking. This research study tries to answer the following main research question:

What are the claimed challenges of service identification published in the literature?

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The main contribution of this research is to identify the main challenges of SI in SOA by conducting a literature review. The review can be very valuable when researchers and practitioners need to get a holistic view of the existing challenges in SI. To the best of our knowledge, there is no previous research that identifies the challenges in SI based on a literature review.

The rest of the paper is structured as follows. The conducted literature review is described in Sect. 2. Section 3 presents and analyzes the results of the review. The service identification challenges are described in Sect. 4. Finally, Sect. 5 concludes the paper and forecasts future research.

2 Literature Review

A literature review is defined in [6] as "a written appraisal of what is already known – existing knowledge on a topic– with no prescribed methodology". The aim of this literature review is to identify the claimed SI challenges being recognized in the research community in order to present the state-of-the-art of SI challenges. Moreover, the review aims to provide the existing claimed causes, which are collected from the relevant literature, for each identified challenge.

We conducted a literature review exploring SI challenges that have been claimed in scientific studies published between 2005–2016. Table 1 provides a brief overview of the defined review protocol (i.e., plan). In this review, 46 primary studies are selected from 54 relevant studies to identify 8 SI challenges.

We apply the following rules to count the number of primary studies for each identified challenge:

1. A study is counted if it clearly proposed or faced a challenge during SI.
2. A study is not counted if it only cited a challenge that was proposed by another study.
3. Only one study is counted if a challenge was proposed by the same author(s) of different published studies.

Table 1. An overview of the defined review protocol.

Search string: *"service identification" AND (challenge OR limitation OR problem OR shortcoming OR lack OR issue OR concern OR matter)*
Electronic database: Scopus
Search fields: Title, Abstract, Keywords
Language: limit to English
Document type: exclude conference review
No. of retrieved studies: 133
No. of relevant studies after reviewing the abstract or the full-text: 21
No. of relevant studies after conducting a cross-reference checking by reviewing the related works: 54

Table 2 shows the distribution of the selected 46 primary studies based on publication year (i.e., 2005–2016) and source (i.e., journal, conference, book chapter, technical report, and thesis). The growing number of studies in each year indicates that SI challenges have been receiving significant interest in the research community. In regards to the source of the studies, the highest (i.e., 24) and lowest (i.e., 2) number of published studies belong to conferences and technical reports respectively. Moreover, the first two studies (i.e., [37, 39]) are from book chapters published in 2005, while the last two studies (i.e., [20, 45]) are from journals published in 2016. According to the publication year, the highest number of published studies (i.e., 8) belong to 2009. It is worth noting that most of the studies (i.e., 31 studies) were published in the years (2007–2009, 2013, and 2014).

Table 2. Distribution of primary studies based on publication year and source.

Year	Source					Total
	Journal	Conference	Book chapter	Technical report	Thesis	
2005			[37, 39]			2
2006	[28]	[27]	[17]			3
2007	[22]	[13, 25, 30, 36, 41]				6
2008		[21, 23, 29, 42, 51]			[40]	6
2009	[9, 32]	[14, 19, 33, 35]		[7]	[15]	8
2010		[26, 50]				2
2011		[1, 46]				2
2012				[4]	[10]	2
2013	[8, 16, 38, 49]	[12, 44]				6
2014	[11, 43]	[18, 24, 48]				5
2015	[34, 47]					2
2016	[20, 45]					2
Total	14	24	3	2	3	46

3 Results and Analysis

Table 3 presents the results of the literature review by providing a list of challenges in SI. The list is created by collecting the challenges from existing scientific research in the literature. Moreover, the list is ranked and sorted by the descending number of research studies that proposed each challenge. Based on the literature review, we identify 8 claimed SI challenges, namely from the top: service quality attributes, business-IT alignment, systematic SIM, comprehensive SIM, tool support, validation, input artifact, and configurability of SIM. The results further discover that service quality attributes challenge (specifically service granularity) is the top challenge.

Figure 1 shows the distribution of SI challenges that were proposed for the first time based on publication year. It can be observed that the first challenge (i.e., business-IT alignment) was first proposed by [37, 39] in 2005. We also observe that the highest number of challenges (i.e., 3) were first proposed in 2006, one challenge (i.e., service quality attributes, specifically service granularity) was first proposed by [17, 27, 28], while the other two challenges (i.e., systematic SIM, comprehensive SIM) were first proposed by [27]. Moreover, validation challenge was first proposed by [21] in 2008, while configurability of SIM challenge was first proposed by [50] in 2010. In 2011, tool support challenge was first proposed by [46], while input artifact challenge was first proposed by [16, 49] in 2013. It is worth noting that the challenges were claimed between 2005–2013, also the researchers did not claim or identify new challenges after 2013.

Table 3. Challenges in service identification.

No.	Challenge	References	No. of studies
1	Service quality attributes (QAs)	[7–21]	15
1.1	Service granularity	[10, 11, 14, 17, 22–28]	11
	Service QAs & service granularity	[7–28]	22
2	Business-IT alignment	[9, 35–44]	11
3	Systematic SIM	[11, 20, 27, 29, 30, 32–34, 45, 51]	10
4	Comprehensive SIM	[1, 4, 11, 20, 27, 29, 30, 35, 36]	9
5	Tool support	[4, 8, 16, 20, 34, 45, 46]	7
6	Validation	[8, 20, 21, 47]	4
7	Input artifact	[16, 48, 49]	3
8	Configurability of SIM	[43, 50]	2

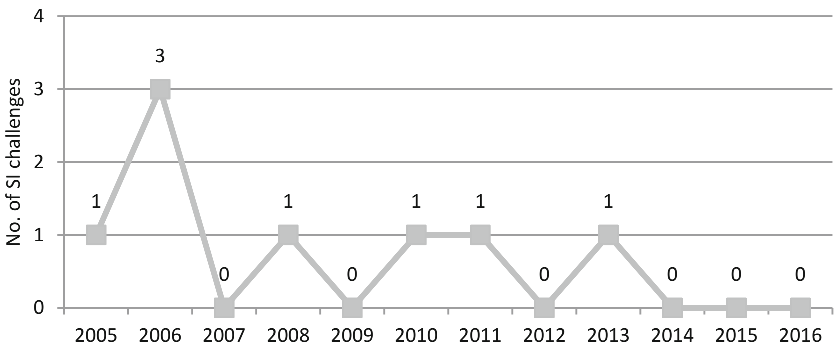

Fig. 1. Distribution of SI challenges that were proposed for the first time based on publication year.

4 Service Identification Challenges

This section provides a description for each identified challenge in SI. Furthermore, this section presents the claimed causes for each challenge.

4.1 Service Quality Attributes (QAs)

A quality attribute is a feature that influences the quality of software systems [52]. Service quality is considered as an important factor since it is used by a service consumer to select from competitive services that deliver similar functionalities [9]. QAs can be categorized into two categories: external and internal attributes [53]. The external QAs (e.g., reusability, flexibility, and maintainability) represent the goals and promises of SOA. On the other hand, the internal QAs (e.g., coupling, cohesion, and granularity) represent the design principles that should be supported and fulfilled in the design of SOA to achieve its goals and promised benefits. The assessment of service QAs is essential to check if the identified services align with SOA goals, and also to enhance the quality of the identified services besides the SIM itself [43]. In the following, we provide the claimed causes, which are collected from the relevant literature, for service QAs challenge:

1. The difficulty of finding the right SOA-based metric model that can be applied early in the development of SOA systems to quantify their overall quality [19, 54].
2. The role of QAs when architecting Service-Oriented Systems (SOSs) has not been vastly studied yet [12].
3. Lack of a comprehensive quality measurement for service-oriented design [18].
4. Lack of mature processes to determine the business values and also translating them to QAs. Furthermore, there are many research efforts in how to deal with QAs in the overall lifecycle management of SOSs [13].
5. SI is a multiple objectives optimization problem [21]; hence service designers need to balance the trade-offs between various QAs, which are somehow mutually exclusive, to identify appropriate services [4, 10, 20, 21].
6. More than 50 challenges (i.e., quality-related issues) have been identified in engineering SOSs [9].
7. Almost all SIMs usually do not evaluate their quality, also only a small number of SIMs address service QAs [11, 14, 43].
8. Current SIMs focus on a few QAs [7, 8].
9. Lack of mechanisms in the existing SIMs to evaluate service QAs [43].
10. Lack of comprehensive and systematic SIMs that consider service QAs [11].
11. Lack of empirical studies that examine the QAs in practice [8, 12].
12. QAs lack precise definitions [19].
13. The designers need a consolidated understanding of the definitions and measures of the identified services' QAs [14].
14. Only very few software metrics have been proposed for SOSs. Furthermore, some of the existing metrics lack empirical evaluation to validate them [15].
15. Lack of formal transformation from qualitative QAs (e.g., flexibility, reusability, and composability) to measurable indicators over a solution design [19].
16. Measurement of service QAs still has not been fully developed [20].
17. Architects face difficulties on how to establish criteria for measuring QAs, such as granularity and reusability [17].

18. Previous SIMs are often prescriptive (i.e., propose principles or guidelines); hence the quality of the identified services is mainly dependent on the architect's experience that result in non-optimal designs since they do not use technical metrics for measuring service QAs [4, 14, 16, 55].
19. Current SIMs ignore the required managerial (i.e., reusability, maintainability) and technical (i.e., coupling, cohesion) performance metrics that represent the goals of SI [21].

Service Granularity. Service granularity refers to the service size and the scope of functionality implemented and exposed by a service [28, 56]. Service granularity is considered a crucial design issue in designing a qualified SOA [4, 14, 24–26, 28]. Moreover, it has many direct and indirect effects on promises of SOA [26]. Service granularity is also pointed out as a quality attribute [11]. The level of service granularity (e.g., fine-grained, coarse-grained) impacts the service QAs, such as coupling, cohesion, complexity, reusability, and performance [10, 11]. In the following, we provide the claimed causes for service granularity challenge:

1. There is no theory-founded method for determining the right level of service granularity [27, 56].
2. Service-oriented analysis and design methods lack on providing a quantitative and comprehensive model to evaluate whether services are identified with the right level of granularity [14, 26].
3. Managing service granularity is considered a primary concern that affects design decisions. Moreover, identifying the right level of service granularity is a difficult task since granularity is highly dependent on an application context [28].
4. The developers of service-oriented applications face difficulties on how to determine the right level of service granularity to identify appropriate services [10, 11, 22–27, 56].
5. Lack of concrete guidelines to define the appropriate level of service granularity [57].
6. Architects face difficulties on how to establish criteria for measuring service granularity [17].

4.2 Business-IT Alignment

A close business-IT alignment is considered as one of the main valuable benefits of service-orientation [35]. Business-IT alignment requires the cooperation of the business community and the IT community [9]. Service-oriented software engineering methods should systematically move from business requirements to IT solution in order to align business with IT [58]. IT is used by leading CIOs as an amplifier of business and innovation [59]. In the following, we provide the claimed causes for business-IT alignment challenge:

1. Business-IT alignment is considered a key challenge even before SOA solutions [38].
2. Defining a suitable scope for business-IT alignment is considered as one of the challenges to migrate legacy applications to SOA [44].

3. Lack of alignment between the business and IT standards [40].
4. The need of integrating business architecture with IT architecture has been widely agreed [37, 39].
5. Information systems community requires the development of methods to vest service-orientation with business concepts for business-driven deployment of SOA [41].
6. The implementation of e-businesses requires the integration of business and technical aspects that imposes an enterprise applications integration problem at the technical level [42].
7. Only recently, business-related challenges (i.e., issues that have to deal with by enterprises due to SOA adoption) are getting more attention in the research community due to the growing need for business-IT alignment [9].
8. The existing SIMs lack on analyzing both business and IT perspectives to identify business and software services [43].
9. Lack of comprehensive and systematic SIMs that combine or address both business and IT domains [11, 35, 36, 43].

4.3 Systematic SIM

Systematic SIM refers to the method that provides detailed guidance for SI [20]. It is difficult to apply any SIM that does not provide detailed guidelines to identify appropriate services [34, 51]. In the following, we provide the claimed causes for systematic SIM challenge:

1. Lack of systematic SIMs that propose detailed guidelines [31, 33, 34, 45, 51].
2. Due to the short time since the development of systematic SIMs is in the focus of research, no one of the existing systematic SIMs was so far able to become widely accepted and dominate the others [32].
3. Lack of comprehensive and systematic SIMs [20, 27, 29, 30].
4. Lack of comprehensive and systematic SIMs that integrate business-driven and technical-driven SI [11, 35, 36, 43].

4.4 Comprehensive SIM

Comprehensive SIM refers to the method that includes all the activities of SI process. In the following, we provide the claimed causes for comprehensive SIM challenge:

1. Lack of comprehensive SIMs that include all the activities of SI process [1, 4].
2. Lack of comprehensive and systematic SIMs [20, 27, 29, 30].
3. Lack of comprehensive and systematic SIMs that integrate business-driven and technical-driven SI [11, 35, 36, 43].

4.5 Tool Support

Most of the existing SIMs do not provide any tool support for implementing or evaluating their processes [8]. The lack of automation refers to a large amount of manual work that is required by many SIMs to identify a set of services [34]. SIMs can be classified based on tool support into three categories: prescriptive, semi-automated, and fully automated [4, 16, 46]. In the following, we provide the claimed causes for tool support challenge:

1. Prescriptive SIMs are difficult to apply in practice, also they are hard to comprehend by the architects who may cope with a limited degree of complexity [4].
2. Limited support of automation in the existing SIMs [8, 16, 20, 45, 46, 55].
3. Lack of a comprehensive automated SIM that fully automates all the activities of SI process [16, 20, 34, 55].
4. Lack of human supervision in the fully automated SIMs [46].

4.6 Validation

Validation describes the way (e.g., case study) that can be used to evaluate the applicability of a SIM in practice. In the following, we provide the claimed causes for validation challenge:

1. Lack of practical research and evidence for the applicability of SIMs [8].
2. The current research is lacking empirical evaluation of SIMs at enterprise levels [21, 47].
3. Most of the existing SIMs have not been validated using case studies [20].

4.7 Input Artifact

Input artifact describes the type of input that a SIM starts from to identify services. SIMs have different types of inputs (e.g., business process, database, source code, etc.) that can be used to identify a set of services. Selecting the suitable types of inputs is considered a critical decision since the business or technical orientation of any SIM is determined based on its input types, also the process of preparing the input is considered timely and costly [49]. In the following, we provide the claimed causes for input artifact challenge:

1. Selecting suitable types of inputs in a clear and step-by-step form is still in its infancy [49].
2. The task of identifying services from various inputs has not been sufficiently solved yet [48, 60].
3. Lack of SIMs that use business process models (e.g., BPMN, activity diagrams) given by standard modeling languages [16, 55].

4.8 Configurability of SIM

Configurability of SIM is considered a critical attribute in situational method engineering that offers a flexible adaptation of methods [50, 61, 62]. New SIMs have to be configurable to accommodate different situations of the projects at hands in order to improve their applicability [1, 11, 20, 43, 50, 61–63]. In the following, we provide the claimed causes for configurability of SIM challenge:

1. Most of the existing SIMs do not address method configurability [43, 50, 61].
2. Lack of mechanisms in the existing SIMs to configure a new SIM according to the development situation [43].

5 Conclusion and Future Work

According to the results of the review, 8 claimed SI challenges were identified from the selected 46 primary studies, namely from the top: service quality attributes, business-IT alignment, systematic SIM, comprehensive SIM, tool support, validation, input artifact, and configurability of SIM. The findings of this review discovered that service quality attributes challenge (service granularity in particular) needs further attention in the research community since it is considered the top challenge. The identified challenges would help to find the gaps in current research and also suggest future research directions. Future work would include:

- Analyzing the claimed causes of each identified challenge in service identification to provide possible solutions that address the identified challenges.
- Conducting a survey for confirmation of the identified challenges from researchers and practitioners in SOA.
- Developing a new SIM that considers the identified challenges for resolving the shortcomings of the existing SIMs.

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Design Thinking Application Methodology for Pediatric Service Innovation

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Abstract. Design Thinking is defined as a methodology that facilitates the generation and implementation of innovative ideas contributing to competitiveness in the current dynamic context.

The aim of this article delves into the concept of Design Thinking, its potential application in the health sector and presents a methodology designed from theoretical contributions for innovation in the service experience of pediatric patients in a hospital.

The present study shows excellent results about the implementation of Design Thinking in the Health Sector, specifically in a Pediatric Department. The contribution of the Design Thinking methodology was the Hospital Classrooms and the development of a videogame for the understanding of Acute Lymphoid Leukemia that could help the wellness and the quality of life of pediatric patients.

Keywords: Design thinking · Health · Innovation · Service experience

1 Introduction

The current context is characterized by constant technological developments, globalized markets, and changes that are difficult to interpret and predict [1]. Organizations face challenges related to low cost competition, the urgency to develop sustainable economic models generating social development and, even more relevant, the need to establish trusting relationships. In this dynamic, innovation is a fundamental factor in achieving competitiveness in global markets [2]. In these contexts, organizations are required to be agile, strengthen their innovative capacity and remain passionate about creative ideas [3]. These facts justify the need for new innovation management strategies that respond to the unexpected challenges posed by the current dynamics [4]. It implies an organizational transformation that is based on a creative, iterative, practical and human-centered approach [5].

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Design Thinking is a methodology for innovation that helps motivate the development of these strategies in organizations. This methodology is inspired by the way in which designers develop their projects and is based on the human approach to innovation. This has a great interest within the administrative sciences [6–9] justified as a different proposal to the traditional logic of innovation management models by contributing to strategic innovation, integrating the needs of users and members of the organization in each of its stages to generate new products as result, services, experiences and business models [10–12]. Design Thinking motivates: flexibility about compliance, questioning about answers, critical thinking about assumptions, collaborative work on rigid organizational structures, focus on the solution more than focus on the problem [13] and finally, a practical guidance [14]. Organizations need to use Design Thinking to facilitate the incorporation of creativity in all organizational levels, to differentiate themselves in the market and to approach their users through a deep understanding of their needs [15], so its implementation in business models is a strategic priority [16, 17]. Actually, the process of implementing innovation initiatives constitutes a complex challenge that could involve transformations in the behavior of employees and changes in the organizational culture to ensure that innovation is adopted as a new way of working [18–21].

Specifically, in the health sector, Design Thinking has been integrated as a methodology to face the challenges of the current context [22], where the demand for service increases every day, where resources are limited [23] and where innovative strategies to address the challenges posed by the World Economic Forum for the health care industry are required [24]. Among the main challenges facing the health sector in the world are: making health systems more efficient and equitable, ensuring that health is a priority in the design of economic policies of the countries, developing economically effective projects that integrate the needs of users, encourage the mobilization of resources for health from government budgets and finally, improving the management of information in organizations [25]. The development of these strategies is especially important in emerging countries as Colombia, where the improvement in quality, coverage and design of organizational strategies to manage the dynamics of transformation of the health sector is crucial [26]. Specifically, Colombia faces challenges associated with: the poor management of information in the system, the deterioration of the public hospital network, the absence of sufficient universal coverage for the population; and finally, the absence of quality and opportunity in the provision of services [27]. Where, from a theoretical perspective, knowledge about health innovation is supported by fragmented research [28] and from a practical perspective, it is evident that organizations continue to be inefficient to respond to the needs of their patients and their stakeholders [29]. In this line, the integration of the Design Thinking in the Health sector would contribute to the development of significant strategies for the improvement of the service users' experience and the redesign of technologies that support these processes.

2 Methodology

There were three phases as illustrated in Fig. 1: (1) The Design Thinking implementation in organizations, (2) The Design Thinking methodology designed for the health sector in Colombia (3) the implementation of the Design Thinking methodology in the Pediatric Service at the Hospital.

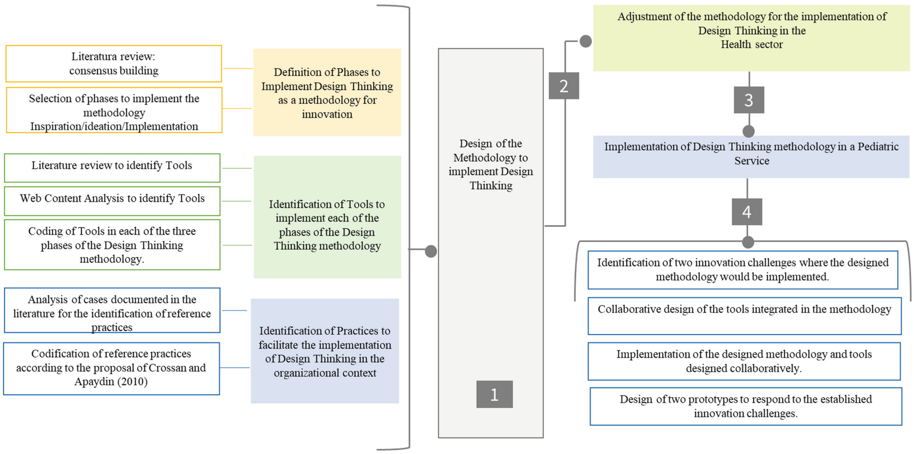

Fig. 1. Research methodology

2.1 Design of the Methodology to Implement Design Thinking

The methodology used to implement Design Thinking in the organizational context were defined in different phases, tools and practices. In order to define these elements, a literature review and web content analysis was used. As a result of this review, a methodology composed of 50 tools categorized into 3 phases was designed: inspiration, ideation and implementation [30]. This methodology was complemented with more than 60 reference practices that facilitate the integration process of Design Thinking in organizations. Finally, in the process of reviewing the scientific literature, the advantages and challenges of the implementation of Design Thinking in organizations were identified and codified in categories using the qualitative analysis software NVIVO10®.

2.2 Design Thinking Methodology Designed for the Health Sector in Colombia

First, a literature review was carried out, which contributed to the understanding of the concept “innovation in health” from an integrating perspective. (For further details of the methodology and the result see Álvarez-Pulido et al. [31].)

Second, to identify the determinants of innovation in the health sector [32]. In this study, 50 determinants that facilitate or prevent innovation in the health sector were identified.

This 50 determinants were grouped in 5 categories: (1) characteristics of the socio-political context (normativity and characteristics of the patients) (2) characteristics of the organization, integrating aspects related to the personnel who make decisions, (3) characteristics of the people who implement the innovation, associating here the capacities of the personnel, their knowledge and the support they perceive from their colleagues (4) characteristics associated with how innovation is perceived in the organization (5) resources needed to implement the innovation.

Then, the most appropriate Design Thinking tools and practices were selected to address these determinants and facilitate the innovation process in this sector. The Design Thinking methodology designed for the health sector was composed of 3 phases: inspiration, ideation and implementation with more than 30 tools and practices for its implementation.

2.3 Implementation of Design Thinking Methodology in a Pediatric Service

The inclusion criteria for a health organization to be involved in the Design Thinking methodology were: (a) To have more than two venues in Colombia (b) To have a Research Innovation and Development Department (c) To have developed previous initiatives associated with innovation (d) to have human resources with time and talent. The organization selected was The Fundación Cardiovascular de Colombia (FCV) where through meetings and semi-structured interviews with hospital managers, the current and future challenges of the organization were analyzed.

The Pediatric service at the hospital was selected to implement the Design Thinking methodology. During a month of observation, analysis and synthesis, two innovation initiatives were selected with the work team of the Pediatric service: (1) How could we re-design the hospital's classroom to improve the service experience of the pediatric patient and his family? and (2) How could we design a strategy to stimulate the pedagogy of the disease in the hospital's classroom?

For the integration of the methodology the study of Durugbo and Pawar was considered as a referent [33]. The objective to use this methodology was to facilitate the interaction and collaboration between the actors (Hospital's Workers and Users) [34, 35]. The tools implemented to integrate Design Thinking were redesigned for innovation in the Pediatric Service, specifically in the pediatric patients and their families' experience. The purpose of the redesign of the tools was to optimize the time of interaction with the users, to simplify the language for pediatric patients and their relatives and finally, to establish the appropriate moments to apply the tools.

3 Results

The improvement in the service experience was addressed through two innovation initiatives. First, associated with the redesign of the hospital's classroom as a space for continuing the learning for hospitalized children. For this initiative, 120 innovation opportunities and 60 insights were identified.

Second, the design of strategies that increase the understanding of the disease by pediatric patients. For this second innovation initiative, 32 innovation opportunities and 20 insights were identified.

The main results of the implementation process were made tangible in two prototypes that integrated more than 700 ideas generated by the internal and external work teams of the hospital that participated in the project. The first result was the Hospital Classroom's plants that integrate the contributions of pediatric patients, their families and the external work teams made up of students and entrepreneurs (See Fig. 2).

The second result is a videogame for the understanding of Acute Lymphoid Leukemia, one of the most common diseases of patients who are in the pediatric unit of the hospital (See Fig. 3). The purpose of this videogame entitled "bataLLA", pretend to improve the understudying of pediatric patients about their illness and the treatment it requires. This videogame: allows children to have fun while they learn and motivate the pediatric patient to follow up the procedures to improve their health, also to explain parents the changes caused by the disease or its treatment.

Fig. 2. Plans for the redesign of the hospital classroom. (Own source).

Fig. 3. Functional prototype of the videogame “bataLLA” (Own source)

4 Discussion

The present study shows excellent results about the implementation of Design Thinking in the Health Sector, specifically in a pediatric Department. The contribution of the Design Thinking was the Hospital Classroom and the development of a videogame for the understanding of Acute Lymphoid Leukemia that could help the wellness and the quality of life of pediatric patients.

The integration of Design Thinking into organizational practice requires the creation of a knowledge structure that synthesizes the previous research on the topic [36–38]. Also, it is important from the academic perspective to conduct empirical research that integrates the scientific rigor to evaluate and validate the effectiveness of the application of Design Thinking in practice [39–41].

This study evidenced that the main advantages obtained from the implementation of Design Thinking were related to the consolidation of an innovative culture in the organization, where experimentation, collaboration, empathy with users and discovery of opportunities were motivational for innovation and for the generation of solutions with social impact. The Design Thinking had significant challenges, considering that traditional management strategies limit the positive results that the methodology could deliver to organizations. These challenges were associated with transformations in planning processes, changes in decision making for the allocation of resources, design of new management indicators that integrate a human and social vision, new flat and collaborative organizational structures that work in participatory teams, and finally, a vision of design as a distinctive capacity and not only as an activity associated with aesthetics.

Future research is needed to focus more on facilitating the validity of the Design Thinking methodology from an empirical approach.

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Knowledge Creation

Knowledge Hub: A Knowledge Service Platform to Facilitate Knowledge Creation Cycle in a University

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Abstract. In the internet era, faculty and students in a university could access various digital contents that their library may not purchase. On the one hand, this challenges a university library that conventionally plays the role as a content aggregator and distributor. On the other hand, this drives a university library to redefine its value proposition in knowledge service by leveraging its acquired resources. In this study, we present a living case of an initiative of knowledge service platform, Knowledge Hub (K-hub), developed by the Library of National Tsing Hua University (NTHU), Taiwan. K-hub aggregates intellectual outputs of faculty members to build knowledge maps and collaboration networks, and then each faculty can receive the recommended articles from the journals the university subscribes. Moreover, the library can promote the university by presenting the statistics of publications for the institutes in the university. Moreover, the library can refer the publications of a faculty to corresponding scholars in different research institutes around the world. We take the perspective of Service-Dominant Logic to elaborate the formation of the knowledge service system by integrating value from different stakeholders to co-create value, which represents the core value of a university library in knowledge management. The extended applications of K-hub are also discussed at the end of this article. The lesson learned from this case study benefits other universities in transforming their role for knowledge service.

Keywords: Knowledge service · Knowledge Hub · Service-Dominant Logic Service science

1 Introduction

Academic libraries face challenges while the world moves into the Internet era. In universities, students could search and obtain digital contents via internet; for example, Google Scholar is the most common channel for academic resources. It reflects that a university library may adjust its main services on content acquisition and circulation to include additional value-added services in order to sustain in the Internet era. A collective imagination via survey was conducted by the Association of College and

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Research Libraries [4] to identify 26 scenarios based on an assessment of current trends of all types of academic and research libraries for 2025. The scenario space was divided by two dimensions presented as x- and y-axis: probability and impact. Nine scenarios were adjudged by the survey participants as both high impact and high probability. Four scenarios of them are anticipated to have higher speed of change in future. They are “increasing threat of cyberwar, cybercrime, and cyberterrorism,” “meet the new freshman class,”, “right here with me,” and “scholarship stultifies.” It indicates that academic libraries need not only to cope with the digital services for netizens but also to serve for the conventional scholarship. The academic institutional rewards of faculty members continue to favor conventionally published research. The scenario “the academic culture that values tradition both benefits (by maintaining the status quo) and threatens (by reinforcing stereotypes) the library,” creates an opportunity and also a challenge for academic libraries to stay on its relevancy with knowledge creation activities in their parent institutes.

Information systems used for an academic library mainly serve for cataloging, searching, institutional repository, and circulation tasks. Many libraries may also offer mobile access of these information systems besides accessed on site. However, it is still in an infancy stage for a library to offer the service of knowledge management for its parent institute. Some publishers offer information systems for a university to aggregate their faculty members’ publications in order to summarize the academic productivity for performance evaluation. For example, Elsevier’s Pure could be used by research managers to assess their faculty members’ outputs. Since this type of information service aims to reduce the research managers’ load in a university to collect the outputs from faculty members, it accesses the publication list from the publishers’ databases. It turns out that this type of system is favored by the research division of a university, rather than the library, which aims to serve its patrons in learning and knowledge creation. Therefore, it demands a new service platform for a university library to facilitate the life cycle of research in its campus.

Based on the SECI knowledge creation model [3], in which SECI represents the knowledge conversion in tacit and explicit statuses. Figure 1 denotes the cycle of knowledge conversion, in which traditionally, libraries serve the role to acquire externalized knowledge in the forms of books, journals, etc., accessible for patrons to combine various externalized knowledge. Then, patrons can internalize the knowledge and practice it in their social contexts that grow their tacit knowledge. In academics, the rewards from publications, such as promotion and reputation motivate researchers to externalize their research outcomes as explicit knowledge to circulate in the academic communities. In industries, patterns are used for protecting the interests for R&D outcomes of enterprises, so that companies are willing to publicize their knowledge, in terms of new inventions. While the channels of circulating externalized knowledge are getting open and free, the role of gateways performed by library is challenged. It inspires library to perform the active role in facilitating the knowledge conversion from tacit to explicit and from explicit to tacit, by which the relationship between a university library and faculty members is changing.

A university library performs an active role in knowledge management that facilitates researchers to access relevant research literature and data to boost up their abilities in creating new knowledge via their hands-on practice. Then, the socialization of knowledge networks in collaboration could facilitate the growth and application of tacit knowledge in solving the problems. The solutions in the form of published papers, books, or patterns externalize the knowledge that library serves as a major market place in academic world.

In this article, we take an initiative in knowledge management to facilitate knowledge creation process by the Library of National Tsing Hua University (NTHU) as an example to elaborate the objectives and process of this service innovation. We take the Service-Dominant Logic (S-DL) which views the world in system view in which value is co-created by involved stakeholders to describe the development of the knowledge service platform, called Knowledge Hub (K-hub). We anticipate the findings and lessons learned from this case will inspire other academic libraries to innovate their knowledge service system to enhance the performance of knowledge creation activities.

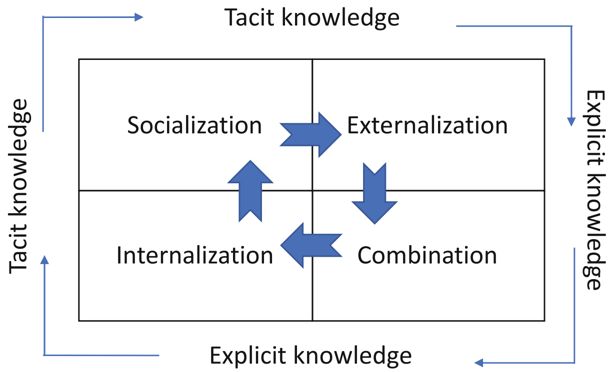


Fig. 1. Knowledge creation cycle: SECI [3]

2 Theoretical Foundation

In this article, the development of Knowledge Hub service platform was guided by the principle of Service Dominant Logic and conducted by the Double Diamond Model of service design. We introduce them in following subsections.

2.1 Service-Dominant Logic

Service-Dominant Logic (S-DL) serves as the fundamental theory for service science, an interdisciplinary study of service systems. S-DL was proposed by Lusch and Wargo, and then generalized in [5]. S-DL proposes a set of axioms and foundational premises listed in Table 1. Service is treated as a fundamental basis of exchange, which implies that one service is used for exchanging the other service owned by the counterparts, respectively. Thus, value is cocreated by actors involved in the service system always including beneficiary. It also indicates that value cannot be created by a service provider, rather it proposes the value proposition to attract other actors to join the value cocreation activities that generate the value perceived by involved actors. Moreover, value is always uniquely and phenomenologically determined by the beneficiary. The value cocreation process is coordinated in institutional settings that integrate resources especially operant resources to form the service systems to conduct business processes as routines to sustain value cocreation relationships.

Table 1. S-DL axioms and foundational premises (FP) [5]

Axiom/FP	Description
Axiom 1/FP 1	Service is the fundamental basis of exchange
FP 2	Indirect exchange masks the fundamental basis of exchange
FP 3	Goods are a distribution mechanism for service provision
FP 4	Operant resources are the fundamental source of strategic benefit
FP 5	All economies are service economies
Axiom 2/FP 6	Value is cocreated by multiple actors, always including the beneficiary
FP 7	Actors cannot deliver value but can participate in the creation and offering of value propositions
FP 8	A service-centered view is inherently customer oriented and relational
Axiom 3/FP 9	All social and economic actors are resource integrators
Axiom 4/FP 10	Value is always uniquely and phenomenologically determined by the beneficiary
Axiom 5/FP 11	Value cocreation is coordinated through actor-generated institutions and institutional arrangements

In this study, we view a university library as an actor to integrate the operant resources owned by the library and faculty members in departments. The knowledge service platform, K-Hub, serves as a distribution mechanism for service provision of involved actors.

2.2 Service Innovation with Double Diamond Model

By taking the system view to know the involved stakeholders, it is essential for involved actors to join the service innovation process. In this study, we follow the general design process, called Double Diamond Model, generated by British Design Council [1] (Fig. 2). It is an outside-in and inside-out iteration which is also a diverging and converging iteration by exploring the field to discover and define problems, utilizing brain storming to create and test prototypes, and then realizing the prototype to solve the problems. The common practices, such as design thinking derived by IDEO, follow the similar process to generate viable products or services.

In this study, we aim to develop a knowledge service platform to facilitate knowledge creation process for faculty members in a university. We adopt double diamond design process to start with discovering faculty pain points in knowledge creation activities, and bring lead users into the design process to define the problems faced. We then integrate resources from various entities within and outside the university to develop the platform. The detailed process will be specified in Sect. 3.

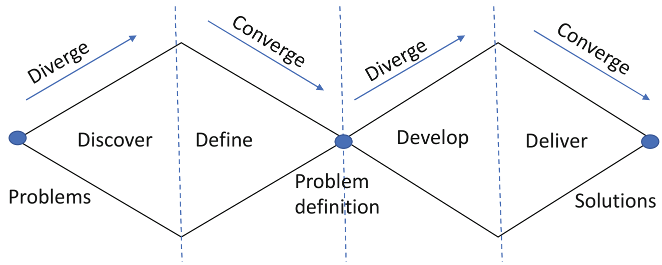


Fig. 2. Double diamond design process [1]

2.3 Knowledge Management for Interdisciplinary Collaboration

A university itself consists of multiple disciplines. It should be the best place to connect different research domains to tackle complex problems by integrating the efforts from different disciplines. However, due to the rewarding system conventionally implemented in the academic societies, the effectiveness of interdisciplinary collaboration was far behind the expectation. The ideal knowledge management cross different disciplines could be envisioned as Fig. 3 illustrates. An individual as a knowledge worker possessing knowledge in external and internal components, in which external components are explicit knowledge externalized to the outside world, similar to the externalization of the SECI model. The internal component consists of two parts: accessible and private, in which accessible knowledge can be acquired by asking the one who owns the knowledge to share; however, the private part is a secret for an individual who may not be willing to share. The individual along with others may come from different groups in different organizations. Through the Mnemonic functions, consisting of knowledge allocation, social network updating, knowledge maintenance, and collaborative knowledge retrieval, the organizations can benefit cross-organizational, single, and double loop learnings.

The knowledge creation activities, such as forming research teams from different disciplines, informing people from different disciplines new research findings, etc. may utilize knowledge map and transactive memory system, and then update them accordingly. In this study, departments for different disciplines could be viewed as different organizations explained by Fig. 3, in which faculty members possess the knowledge created or retained could be reached in three modes: external component, and internal component, *i.e.,* accessible and private. The knowledge sharing across departmental boundaries in a university is usually achieved by courses for students to access instructors' domain knowledge, projects for researchers and graduate students to socialize in order to generate and capture knowledge, conferences or seminars for researchers to share their knowledge in a formal way, or informal gathering to exchange knowledge in a prompt and flexible manner. These count for the knowledge activities within academic contexts mainly in a university campus.

To facilitate knowledge creation and dissemination in academic settings, cross departmental knowledge map generation and maintenance for faculty members and the formation of transactive memory system to perform Mnemonic function are essential capabilities expected from the knowledge service offered by a university library while facing the challenges in the Internet era.

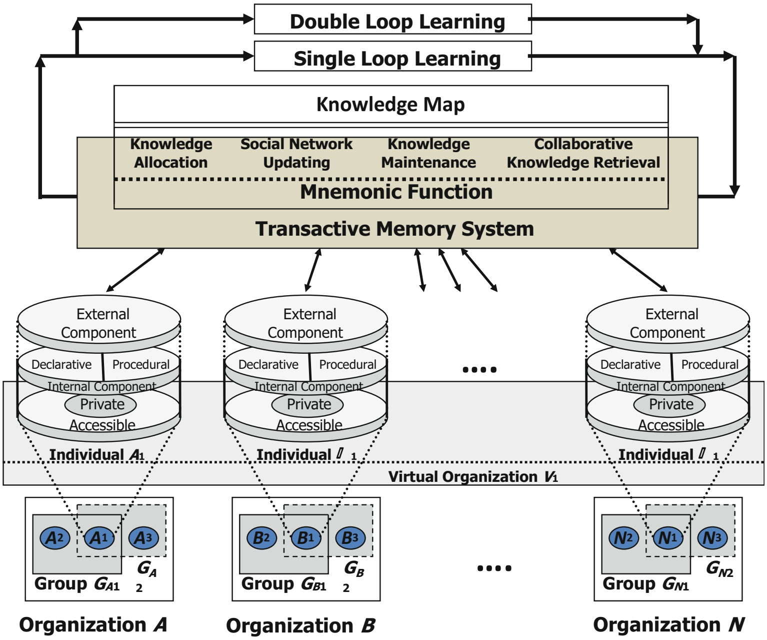


Fig. 3. Knowledge management across organizations [2]

3 Case Study: Knowledge Hub

3.1 Service Innovation for Knowledge Service in NTHU

The Library of National Tsing Hua University was located in the newly built learning center in 2013. Since it doubles the floor size of the previous one, an automatic space management system was installed to reduce the human costs. Moreover, it launched the Knowledge Hub project in July 2015 after signing a cooperative contract with an information system development company in Taiwan. According to the contract, NTHU library would provide the library service know-how and the integration of different academic institutes and administrative offices as the value proposition to exchange for the system development efforts spent by the partner software company. It is a realization of service system and value co-creation practice guided by S-DL, in which value is co-created by involved stakeholders as beneficiary (FP6), value co-creation activities are coordinated through actor-generated institutions and institutional arrangements (FP11) and all social and economic actors are resource integrators

(FP9). In K-Hub project, we in NTHU collaborate with the Office of R&D and the Computer Center which host data for related administrative offices to aggregate necessary individual information.

Starting from July 2015 to November 2016, we employed the Double Diamond Model to innovate the service system. We formed a service design team in library to work with the partner software company to launch the service design process based on the Double Diamond Model. We conducted a series of sessions to invite lead faculty members from different colleges to join the service design tasks. The service design team visited lead faculty institutes to experience their academic environments including learning and research activities, and interview them. Based on the insights obtained from the interviews, the service design team identified pains and gains of these lead faculty members, which were derived to the value propositions that the K-Hub aims to create. Then, the service design team work with the partner soft company to define the data schemes and operational flows as prototyping service modules. Then, the service design team worked with lead faculty members to verify the prototyping service modules. Tasks such as the development of operations, databases, user interfaces were iteratively performed taking data and operations of these lead faculty members as testing inputs; meanwhile, librarians in NTHU library transferred and edited all faculty information into the database ready for the Beta-test started from November 2016 to March 2017. In March 2017, K-Hub was announced to the university faculty members and seek additional feedbacks from users; meanwhile, the college liaison librarians work tightly with faculty in different departments and colleges to promote K-Hub. In 2018, K-Hub will formally launch to offer knowledge service to facilitate knowledge creation activities in NTHU.

3.2 The Service System of NTHU Knowledge Hub (K-Hub)

The service system of Knowledge Hub (K-Hub) is illustrated in Fig. 4. In a university, individual faculty members affiliating with various academic institutes, such as departments, research centers, or colleges, are major knowledge creators. NTHU library hosts its institutional repository to retain faculty publications available on internet. Moreover, the library acquires digital contents, such as academic journals, databases, etc. to serve its patrons. Thus, the K-Hub embedded knowledge service system consists of individual faculty members, affiliated departments, research centers, colleges, and related service providers, such as library, office of research and development, office of academic affairs, etc.

Based on the insights obtained from the service design process, we implemented the K-Hub to fulfill the knowledge management for interdisciplinary collaboration. NTHU K-Hub consists of four main modules: *aggregation, navigation, networking*, and *marketing*. Figure 5 snapshots K-Hub main page seen for the general public. Figure 6 illustrates its screen mainly performing aggregation function. K-Hub aggregate individual faculty academic records from different information sources, such as university personnel office for individual profile, office of R&D for research projects and awards, office of academic affairs for courses offered, outside data bases, such as

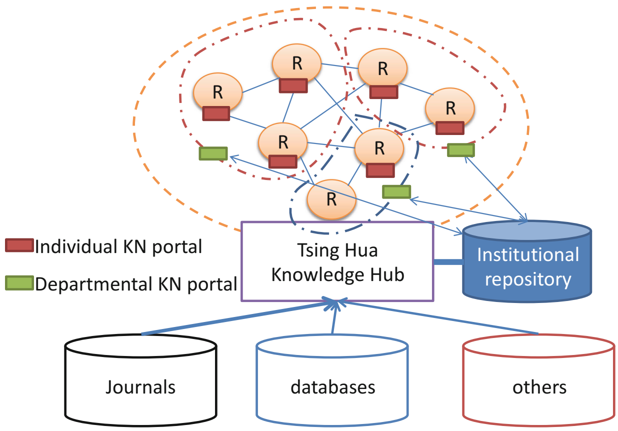


Fig. 4. The Service system of Knowledge Hub

Scopus and Web of Science, to allocate individual publications and patent information. K-Hub also aggregates individual faculty data to present as an organizational aggregated data.

The navigation function of K-Hub was implemented with text mining techniques which take the aggregated individual academic information, such as publications and patents, to generate individual knowledge map. Then, by search arrival articles from the subscribed journals to match the incoming articles with individual knowledge map to recommend relevant articles to corresponding faculty members. By doing this, this navigation enables individual faculty to know what they may not know by referring new arrival articles contrast from the used way that users submit keywords to search for things they know they don't know. The navigation extends individuals' search space and increases the utilization of resources the library acquired. Figure 7 shows the snapshot of the new arrival article recommendation screen.

The networking function of K-Hub was demonstrated by the illustration of relationships between an individual faculty and his/her project collaborator, co-authors, and advisees. Figure 8 illustrate the snapshot of co-authorship and project collaboration networks. Finally, the marketing function of K-Hub takes individual knowledge maps as the index to match the needs of stakeholders within and outside university. For example, the industrial collaboration relationship can be established by matching industry needs with faculty domain expertise by matching individual knowledge maps with products, technologies, and services demanded by industries. The K-Hub can forward faculty publications to other scholars within or outside university, who may have similar domain backgrounds or be interested in the research topics. Figure 9 demonstrates the statistics of the publications of an institute in NTHU, so that the research outcomes could be recognized by the general public.

Fig. 5. The main page of Knowledge Hub (http://khub.nthu.edu.tw)

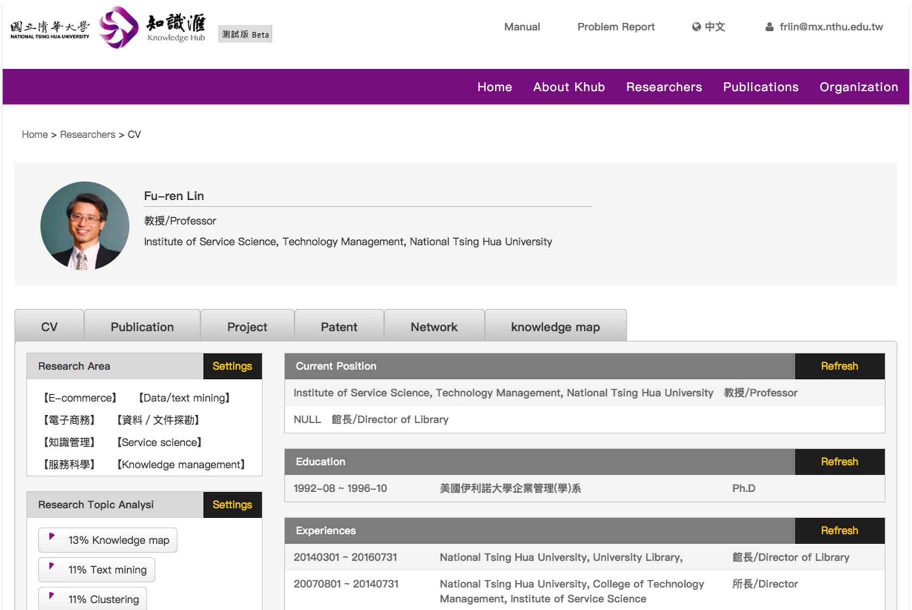


Fig. 6. A snapshot of K-Hub screen displaying a faculty academic records

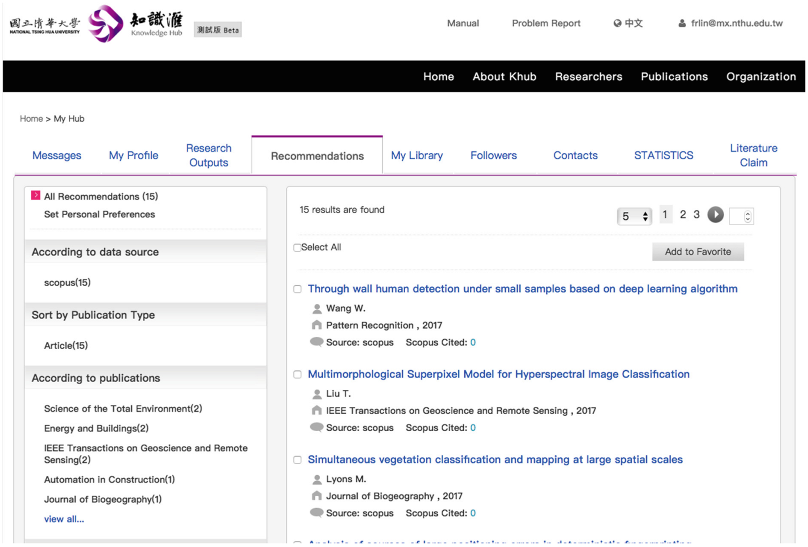
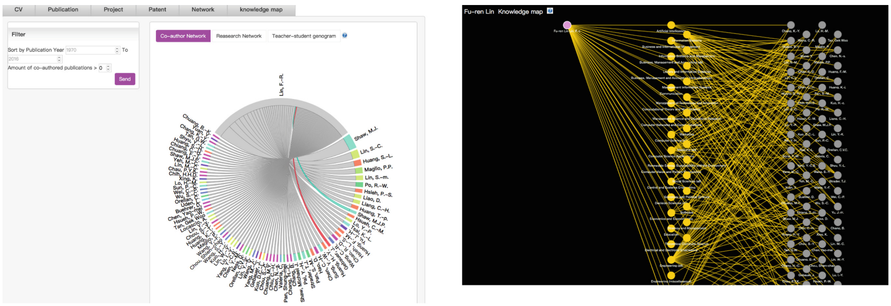


Fig. 7. A snapshot of the new arrival article recommendation screen



Co-authorship Project collaboration networks

Fig. 8. A screen snapshot of the co-authorship and project collaboration networks

3.3 The Extension of K-Hub

The K-Hub platform was built originally for aggregating researchers' information to facilitate users to access recommended articles, view the academic networks, and marketing the institutes. During the service design process, through the engagement of faculty members in different institutes, gradually we discover additional contributions of the K-Hub. First, the K-Hub can serve as the foundational data to facilitate industrial- academic cooperation. An industrial liaison program established in NTHU is going to use the K-Hub platform as the university intelligence system to connect to its industry client service system in order to leverage the comprehensive domain and research information existing in the K-Hub.

Second, the K-Hub becomes a knowledge base for subject librarians to access subject knowledge maps in order to keep update with scholars' academic status, by which subject librarians can better understand their patrons in different domains. Thus, subject librarians can allocate resources to better serve their patrons in different disciplines. Since the role a subject librarian changes, we call this type of service providers as knowledge service librarians to highlight their uniqueness in knowledge management.

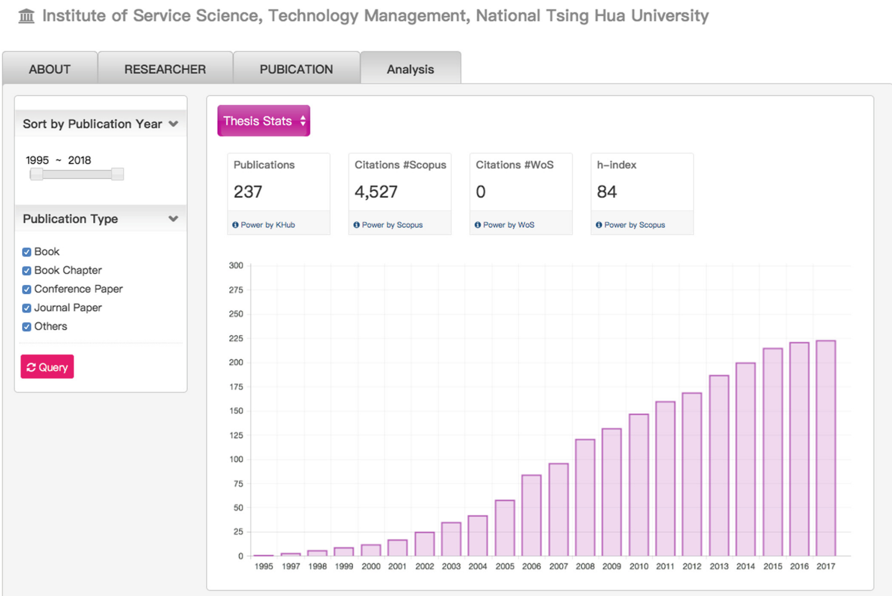


Fig. 9. The snapshot of the publication statistics of an institute in NTHU

4 Discussion

As an academic library, while struggling to continue creating its value to higher education and knowledge creation in the Internet era. The Knowledge Hub as a platform for information technology enabled and knowledge intensive service offers the value proposition in aggregation, navigation, networking, and marketing to attract stakeholders within and outside the university to co-create the value in knowledge creation. In this case, NTHU library works with the Office of R&D and Computer Center within the campus to initiate the project. Moreover, the engagement of different institutes and faculty members to work as domain experts in the data and operation modeling for the K-Hub. The value proposition also attracted a software company as a partner to develop the information system. Using Service-Dominant Logic, the progressive outcomes of this project rely on the collaboration among different actors, which in turn, form a new service system.

The major contributions of this case study are mainly on taking the knowledge service platform development as an example to highlight the approach using service design process to co-create a service system with its stakeholders to realize the value proposition that a university library issued. With this practice of value co-creation, NTHU library is able to extend its service system to include additional partners in serving its industry clients, and also enable a new knowledge service facilitated by knowledge service librarians.

The lessons learned from this K-Hub initiative are summarized as follows. First, it created a unique cooperation mode between the library and the software company by which both share the common goals in completing the system development. The library can utilize it for knowledge service while the software company can package it as a product for the emerging market of knowledge management in universities. Thus, the collaboration relationship between the library and the software company demonstrates the FP8 (a service-centered view is inherently customer oriented and relational) of S-DL. Second, despite the existing free service for scholars to access information, such as ResearchGate, Google Scholar, etc. the knowledge management system utilized by a university benefit the interaction of faculty members from different institutes to achieve interdisciplinary collaboration.

5 Conclusion

The study took the case of knowledge service platform enabled by text mining techniques to highlight its marginal contributions to knowledge creation activities in a university. The K-Hub project demonstrates the value co-creation process utilizing S-DL and service design process. This new approach establishes the relationship between the library and its stakeholders, such as academic institutes, administrative offices, and outside industries. Therefore, this study sheds the light on the usage of IT-enabled and knowledge-intensive service to enhance the role of a university library plays for knowledge management.

Acknowledgement. The authors are grateful for the joint efforts of involved faculty members in academic institutes and staffs of administrative offices, and librarians within the university, and the partner software company to complete the Knowledge Hub project.

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Economic Growth and Gross Domestic Expenditure on R&D in G7 Countries with Some Benchmarking with BRICS Countries: Long-Run Comparative Synergy Analyses

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Abstract. Background: This paper's focus is on the synergy in GDP (Gross Domestic Product) and GERD (Gross Expenditure Research and Development) interaction in G7 countries. It allows us to present an explorative analysis of the relationships between key variables (in this case GDP and GERD). Further, it allows a critical synergy analysis on the long-run dynamics of economies. In this article, we demonstrated the methodological power of combining synergy analysis and conventional benchmarking analysis.

Method: This study is based on statistical synergy methodology. Data about the G7 countries (USA, Canada, Germany, France, UK, Japan and Italy) was collected from the World Bank. Research question: How can the decree of synergy and trade-off between GERD and GDP impact innovation and knowledge management at a macroeconomic level.

Results: The benefits of the synergy methodology include that it provides essential information for economic and social policy-makers. It is a new tool for sustainability analysis. The evaluation of a synergy/trade-off proposed in this paper indicates only a possible and potential causality. However, it does not infer a causal relationship between the variables.

Conclusions: Normally, experts and decision-makers expect that there is positive synergy between GERD and GDP. However, finally it is a purely empirical question to evaluate. Synergy dynamics is different among G7 countries. The United Kingdom has the highest synergy level and Japan has the lowest. UK, France and USA have the highest long-run synergy levels among G7 countries. Almost all countries have improved synergy levels between GDP and GERD in the long run which indicates harder competition in the field of global innovation ecosystems.

Keywords: Knowledge management · The G7 countries
Statistical synergy methodology · GDP–GERD interaction · R&D investments
Economic growth

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1 Introduction

Firstly, we will present the introduction of the paper. The paper is about synergy analysis and provides a clear picture of global GDP (Gross Domestic Product) and GERD (Gross Expenditure Research and Development) in G7 countries. This article offers a demonstration of the use of a synergy analysis method based on the analysis of GERD and GDP. This paper's research questions are: What is the impact of the decree of trade-off and synergy between GERD and GDP, and how does synergy impact innovation and knowledge management at a macroeconomic level.

Secondly, we will describe the theory and the methodological background of synergy analysis. Methodologically, the analysis is based on a new assessment tool developed for the analysis of synergies and trade-offs between selected development trends. Understanding trade-offs and synergies is needed in smart management and decision-making [6–8]. In order to explore synergies and trade-offs between different trends, we need to provide definitions for the terms. There is synergy between two factors, when their combined effect is greater (or smaller) than the sum of their separate effects. We define trade-offs as a balance achieved between two desirable but incompatible features. Trade-offs can also be defined as a situation where the selection of one feature results in the loss of another feature.

In addition to synergy and trade-offs also de-linking can describe the situation between the variables. In this case, the increase or decrease of one variable does not have an effect on the other variables [6].

Thirdly, we will present the methodology part of this study. The methodology is based on synergy analysis of GDP and GERD data. The study is based on World Bank data [14]. In most cases, the data covers the years 1996–2015. However, in some cases, the data covers the years 1997–2015.

Further, we will show the results of this paper. This study analyses and focuses on the synergy of the GDP–GERD interaction in G7 countries. Synergy analysis of the study includes trend analyses of GDP and GERD data, the average conventional and long-run analyses in the G7 countries and finally the analysis of long-run synergy levels. We also present a demonstration on benchmarking analysis between G7 and BRICS countries.

Finally, we will present the conclusions of synergy dynamics among G7 countries. The United Kingdom has the highest synergy level and Japan has the lowest. UK, France and USA have the highest long-run synergy levels among G7 countries. Almost all countries have improved synergy levels between GDP and GERD in the long run which indicates harder competition in the field of global innovation ecosystems.

2 Theory: Methodological Background of the Synergy Analysis

This study is based on statistical synergy methodology. Data was collected from the World Bank about the G7 countries (USA, Canada Germany, France, UK, Japan and Italy) and the BRICS countries (Brazil, Russian Federation, India, China and South

Africa). The methodology of this study is based on synergy analysis of GDP and GERD data from the World Bank.

This paper proposes the evaluation of a synergy/trade-off and indicates possible potential causality. However, it does not infer a causal relationship between the variables.

2.1 The Benefits of the Synergy Methodology

The synergy analysis is based on a new assessment tool developed for the analysis of synergies and trade-offs between selected development trends.

The synergy methodology provides essential information for future-oriented economic and social policy-makers, policy-planners and decision-makers. It is a new powerful tool for sustainability analysis.

The synergy tool can be used to analyse simultaneously the synergy between many variables. The synergy tool was developed to analyse the synergy between two different trends [8, 9, 12].

In this study, we calculate a conventional index number of synergy and the average long-run synergy index [8]. In Fig. 1, we have presented 3 basic forms of synergy between two variables.

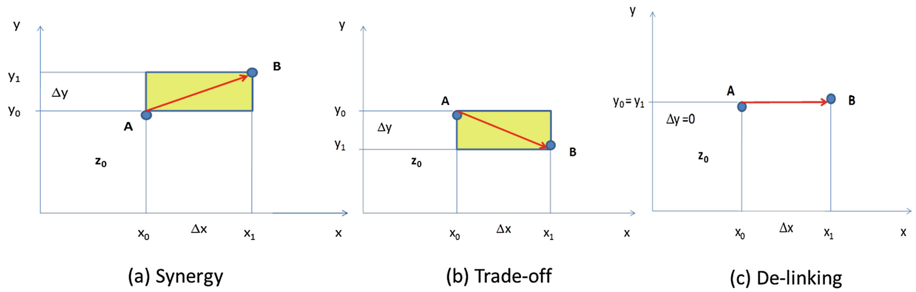

Fig. 1. The alternatives of synergy level between two variables, x and y.

2.2 The Alternatives of Synergy Level Between Two Variables, x and y

(1) Maximum synergy can be obtained when relative changes Δx and Δy are equal.
(2) In case the change in y, i.e. Δy, is larger than changes in x, i.e. Δx, the quotient must be inverted to estimate a potential synergy ratio.
(3) Therefore, potential synergy/trade-off between two variables can be measured between −1 to +1.
(4) Where a negative sign indicates a trade-off between two variables.

Decision-makers are able to present explorative analysis of the relationships between key variables with the synergy analysis. Synergy analysis allows for the critical analysis on the long-run dynamics of economies [1–3]. Thus, there are possibilities to create win-win policies from trade-offs.

The smart adaption to on-going economic growth and urban population trends may be impossible without detailed trade-off analyses [7, 11]. Thus, empirical verification of trade-offs is important for sustainability politics and analyses [4–7, 9, 10, 12, 13, 15].

3 Method

The methodology of this study is based on synergy analysis of GDP and GERD data from the World Bank. This study is about synergy analysis and provides a clear picture of global GDP and GERD in G7 countries. The study is based on World Bank data [14]. The study covers the years 1996–2015. Synergy analysis of the study includes trend analyses of GDP and GERD data in the G7 countries and BRICS countries, the average conventional and long-run analyses in the G7 countries and finally the analysis of long-run synergy levels. Further, this study shows the average GDP–GERD synergy levels and compares synergy levels within the G7 and BRICS countries.

4 Results

Firstly, this paper's focus is on the synergy of a GDP–GERD interaction in G7 economies. First, we will present trend curves of GDP (in current prices, PPP) in the G7 countries (Fig. 2).

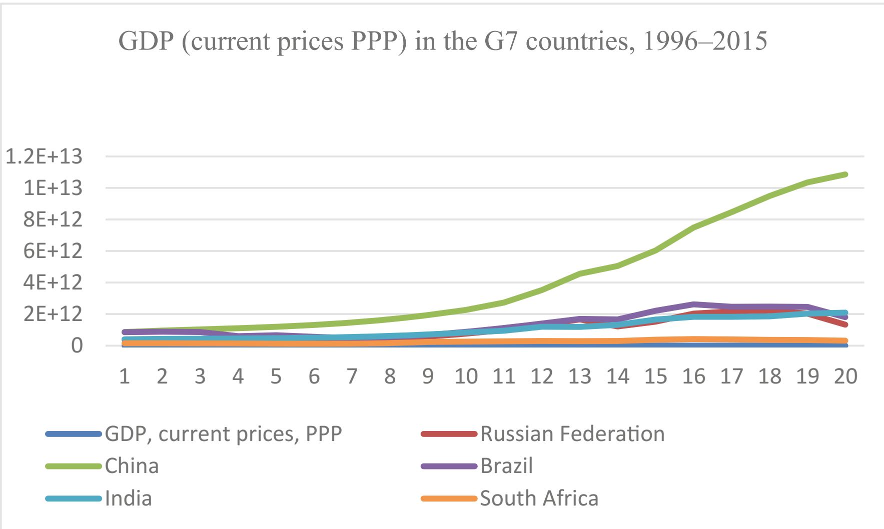

Fig. 2. GDP (current prices PPP) in the G7 countries, 1996–2015. (Horizontal axis: years 1996–2015. 1 = 1996 …20 = 2015, Vertical axis: current prices PPP). Source: World Bank 2017.

The trend curves allow us to present an explorative analysis of the relationships between key variables (in this case GDP and GERD). Further, it allows a critical analysis on long-run dynamics of economies. Normally, decision-makers expect that there is positive synergy between GERD and GDP. However, finally it is a purely empirical question to evaluate.

Secondly, we present the trends of GERD (in current prices, PPP) in Fig. 3.

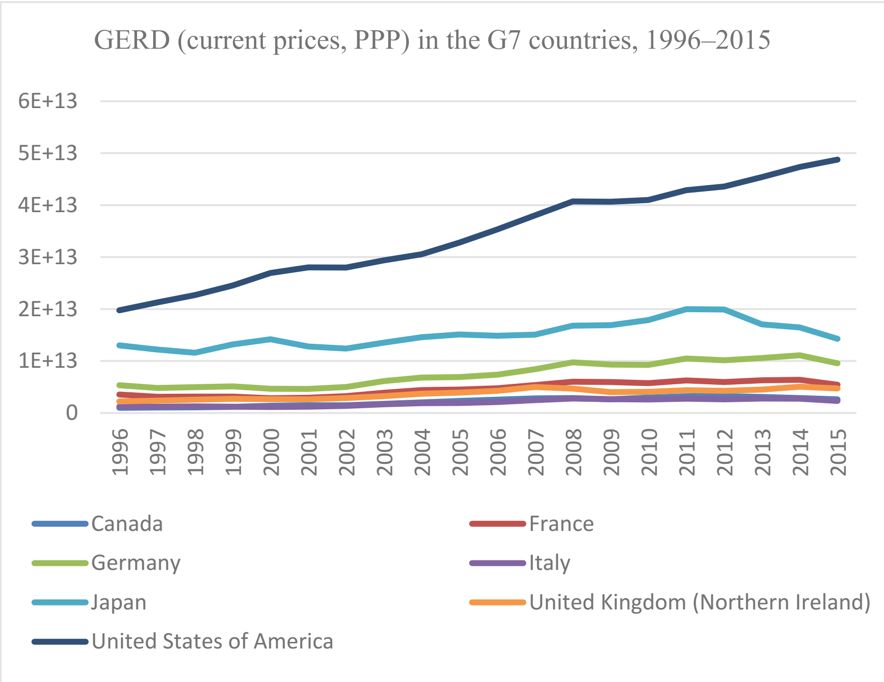

Fig. 3. GERD (current prices, PPP) in the G7 countries, 1996–2015. (Horizontal axis: years 1996–2015, Vertical axis: current prices PPP). Source: World Bank 2017.

These two variables presented in Figs. 2 and 3 (GDP and GERD) are typically expected to have positive synergy. The straightforward logic of such expectations is that the more the government invests in R&D, the bigger GDP figures will be achieved in the future.

In Fig. 4, we have calculated synergy levels of GDP and GERD. The results inform us that synergy is not always positive between these two strategic indictors. We can gain more information, knowledge and critical understanding by calculating synergy levels of these two variables.

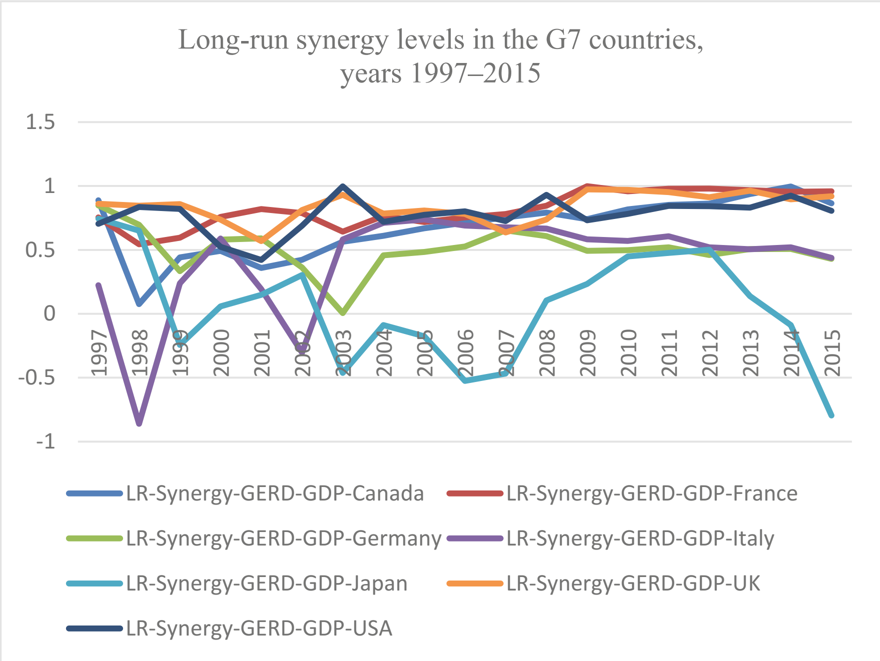

Fig. 4. Long-run synergy in the G7 countries, 1997–2015. (Horizontal axis: years 1997–2015, Vertical axis: long-run synergy index). Source: World Bank Data 2017.

In Fig. 5, we report EU member countries' (France, Germany and the United Kingdom) synergy levels during the years 1997–2015.

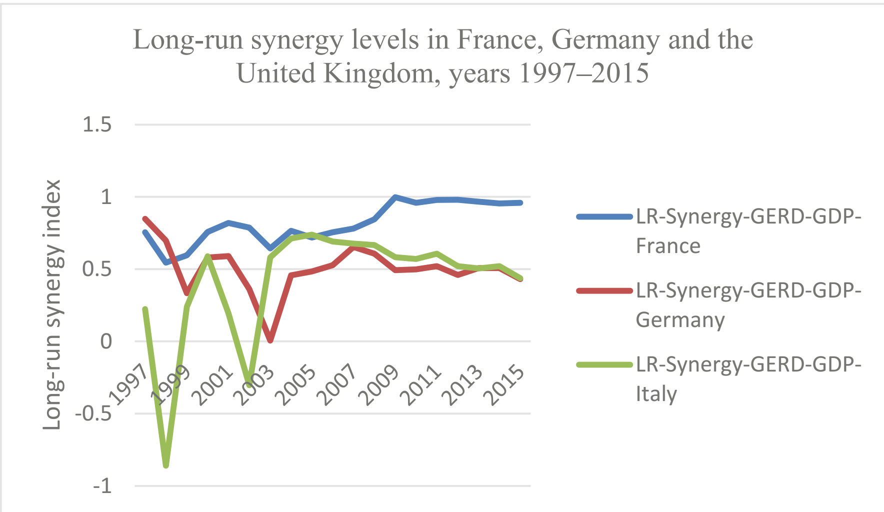

Fig. 5. European perspective: Long-run synergy levels in France, Germany and the United Kingdom, years 1997–2015. Source: World Bank Data 2017.

Figures 4 and 5 inform us that G7 countries had different levels of synergy during 1997–2015. In Italy, there have been big variations in synergy between GDP and GERD, while in the United Kingdom, the synergy level has been more stable.

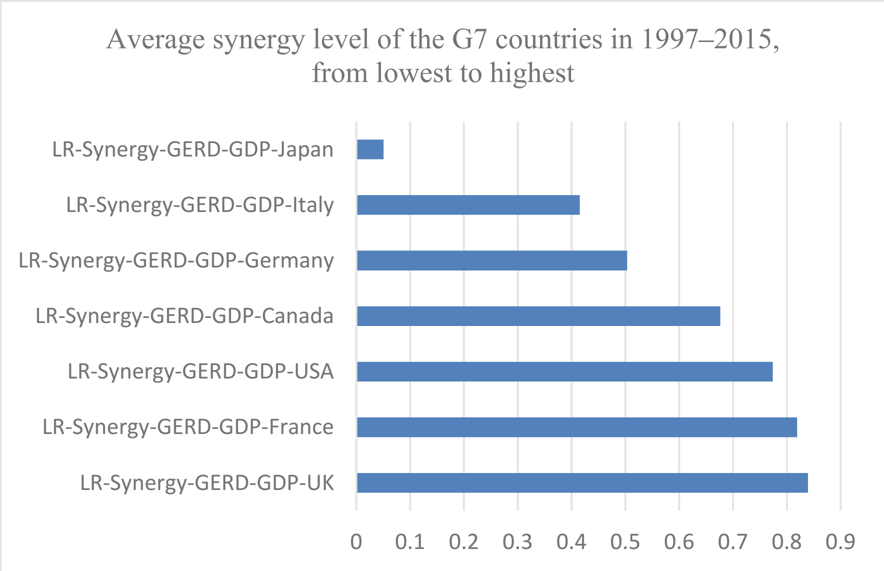

Fig. 6. Average synergy level of the G7 countries in 1997–2015, from lowest to highest. (Horizontal axis: synergy levels, Vertical axis: G7 countries). Source: World Bank Data 2017.

In Fig. 6, we report average synergy levels of the G7 countries.

Figure 6 reveals that the highest synergy level can be observed in the United Kingdom and the lowest in Japan. The UK, France, USA and Canada are the leading G7 countries in synergy creation. Problems in synergy creation seem to occur in Japan, Italy and Germany.

In Fig. 7, we have presented the average long-run synergy of G7 countries in 1997–2015. The linear forecast of the average long-run synergy of G7 countries has an upward curve, which indicates that the average synergy of the G7 countries is improving. It is very interesting to note that after 2011, the trend has been breaking and the average synergy level of G7 countries has started to go to downwards breaking the trend-line in 2014.

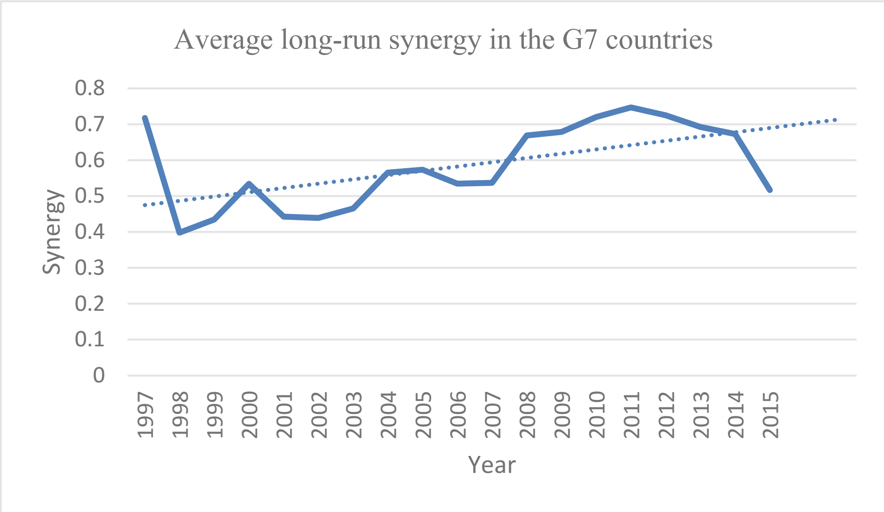

Fig. 7. Long-run average synergy in the G7 countries, 1997–2015. (Horizontal axis: years 1997-2015, Vertical axis: average long-run synergy index). Source: World Bank Data 2017.

In Fig. 8, we have presented the variance of synergy levels and range (max-min values synergy observations). Figure 7 informs us about the challenges of G7 countries to keep their mutual coherence in their R&D policies. The very latest observation of range is historically quite high and during 1997–2015, it was in the highest range. Also the variance of yearly observations was high.

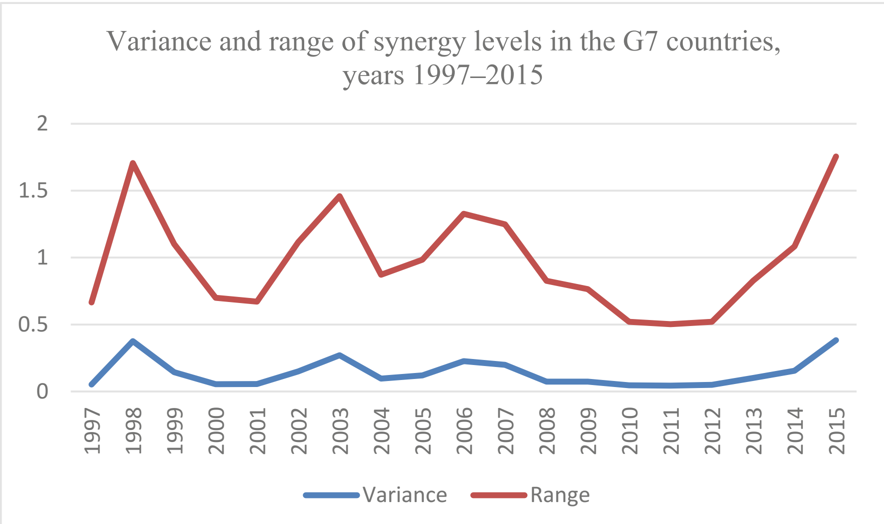

Fig. 8. Variance and range of synergy levels in the G7 countries, (Horizontal axis: years 1997–2015, Vertical axis: variance and range of synergy levels). Source: World Bank 2017.

5 Benchmarking G7 Countries with BRICS Countries

5.1 The Long-Run Synergy Levels

To make an interesting benchmarking analysis using the synergy method, we calculated also the BRICS countries' average synergy levels. The results of this synergy benchmarking analysis are reported in Figs. 9 and 10.

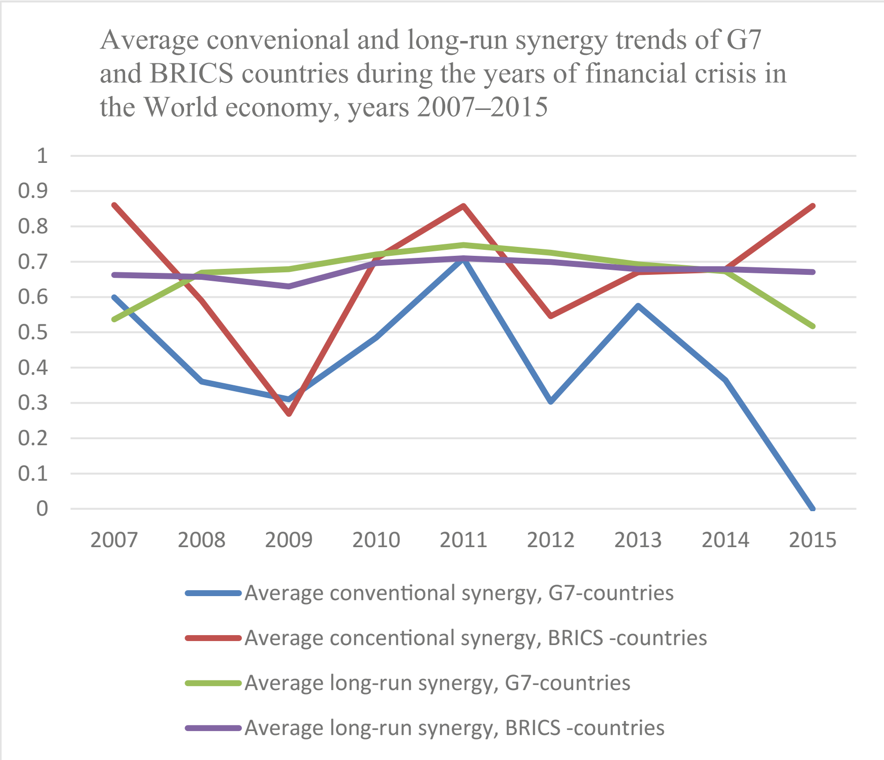

Fig. 9. Average conventional and long-run synergy trends of G7 and BRICS countries during the years of financial crisis in the world economy. (Horizontal axis: years 2007–2015, Vertical axis: average conventional and long-run synergy index trends). Source: World Bank 2017.

In Fig. 9, both the conventional and long-run synergy indicators are reported for G7 and BRICS countries.

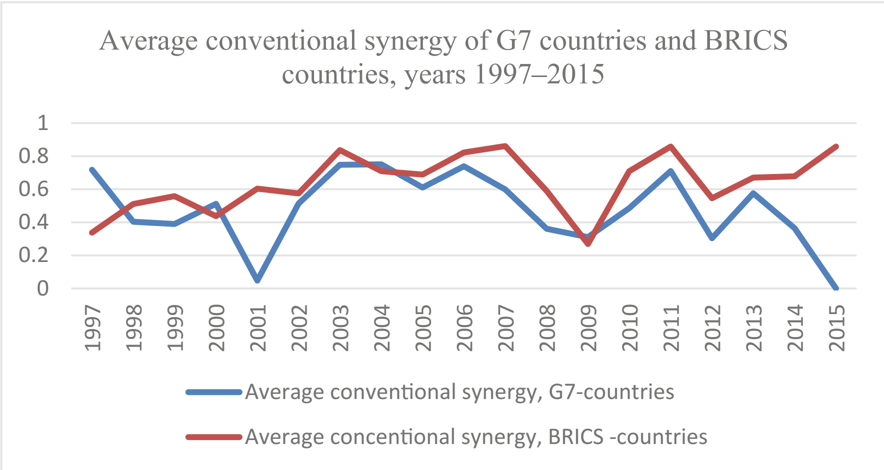

Fig. 10. Average conventional synergy of G7 countries and BRICS countries, (Horizontal axis: years 1997–2015, Vertical axis: average conventional and long-run synergy index trends). Source: World Bank Data 2017.

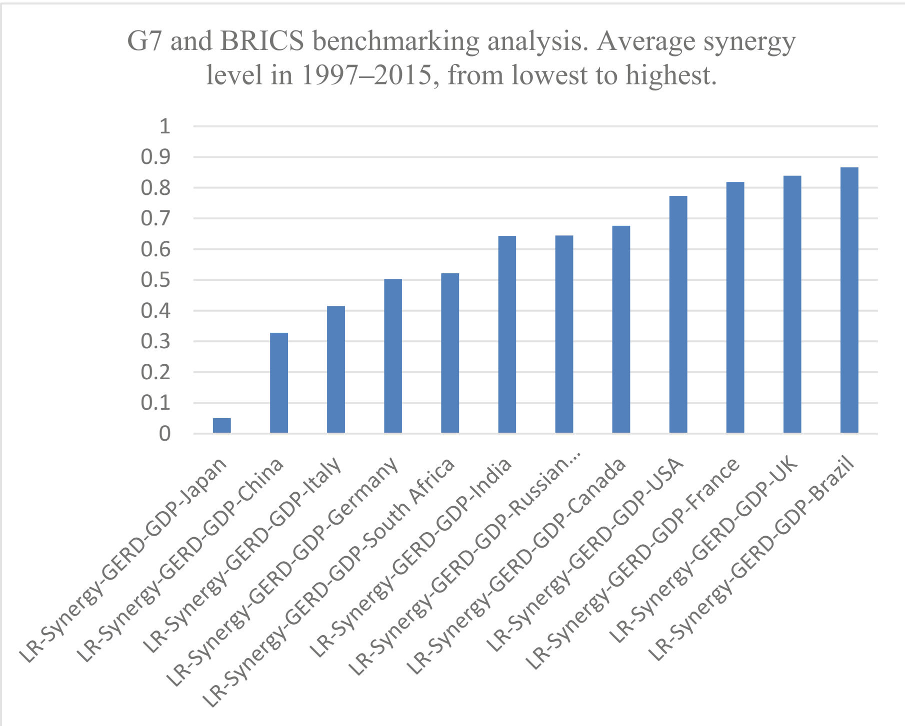

Fig. 11. G7 and BRICS benchmarking analysis. (Horizontal axis: average synergy level in 1997–2015, from lowest to highest in G7 and BRICS countries, Vertical axis: average synergy level). Source: World Bank Database 2017.

6 Conclusions

Synergy analysis provides interesting perspectives and insights into global innovation ecosystems. Methodologically, synergy analysis is based on a new assessment tool developed for the analysis of synergies and trade-offs between selected development trends. Understanding trade-offs and synergies is needed in smart management and decision-making [6–8].

The synergy tool was developed to analyse the synergy between two different trends. Furthermore, it can be used to analyse simultaneously the synergy between many variables [8, 9, 12].

Synergy factor analysis is easy to use and clear to interpret. Calculations may be performed through Excel programmes. The synergy method can be applied to datasets of any size, however small. Synergy factors can be applied to primary or summarised data, e.g. published data. It can be used with any type of susceptibility factor [2].

In this paper, we analysed and reported average GERD–GDP synergy levels, which inform global decision-makers about the success but also the failures in synergy levels. Normally, the decision-makers expect that there is positive synergy between GERD and GDP, but finally it is an empirical question to evaluate. Our study indicates that in some economies, there are periods when there is also negative synergy. Synergy levels vary in time.

Synergy dynamics is different among G7 countries. The United Kingdom has the highest synergy level and Japan has the lowest. UK, France and USA have highest long-run synergy levels among G7 countries.

Figure 11 reveals that in BRICS countries, Brazil has had the highest average synergy level between GERD and GDP. The synergy level has been the lowest in Japan, China and Italy.

Among European G7 group members, France had the most positive LR synergy level performance in 1997–2015, Italy showed two negative LR synergy breaks in 1998 (LR-SI −0.86) and 2002 (LR-SI −0.30), but it has showed better performance after this year (Average LR-SI +0.60 in 2003–2015).

Almost all countries have improved the synergy levels between GDP and GERD in the long run which indicates a harder competition in the field of global innovation ecosystems.

In this article, we demonstrated the methodological power of combining synergy analysis and conventional benchmarking analysis. This article was focused on the synergy analysis of GERD and GDP variables. We can apply this synergy method to all statistical variables in the field of knowledge management.

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Knowledge and Organization

The Impact of Knowledge Management and Change Readiness on the Effectiveness of Russian Private and State-Owned Organizations

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Abstract. This research evaluates the hypothesis that knowledge management in the organization should be developed in conjunction with change management. The ability to implement change is a critical factor in creating value based on knowledge and consequently in effectiveness of organizations. The empirical dataset includes 95 Russian private and state-owned organizations. Results of modeling confirm that knowledge management and change readiness are both important for private organizations, but for state-owned organizations, knowledge management is not a factor affecting effectiveness. This means that state-owned organizations reproduce the Soviet bureaucratic style of management at the present time.

Keywords: Knowledge management · Change readiness
Effectiveness of organization · State-owned organizations

1 Introduction

In the second half of the twentieth century, developed countries began the transition from industrial production, oriented to mass demand, to a new economy, which is characterized primarily by the satisfaction of individual needs, the prevalence of services, and the emergence of companies whose main resources are intangible [1, 2]. According to [3], the share of intangible assets in the value of public companies, which in the mid-1980s was 40%, increased to 75% in 2002. Many researchers and management practitioners proclaim that knowledge of consumer needs and knowledge of how to build an effective partnership network, knowledge of the latest scientific achievements and knowledge how to implement them in products and technologies become the only significant resource. Companies that rely on traditional factors of production - capital, cheap labor and natural resources, are forced out to the economic periphery.

However, studies of management practices [4, 5] show that knowledge management (KM) is not frequently used management tool, moreover, many managers have difficulty in determining how KM can be adapted and included in their activities [6–9].

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Many researchers believe that the organization's knowledge is closely related to innovation and, consequently, changes [10–14]. Therefore, change management [15] should be considered in conjunction with knowledge management, the ability to implement change is a critical factor in creating value based on knowledge and determining the effectiveness of KM processes [16].

This paper presents the results of an empirical study of the impact of knowledge management and change readiness on organizational effectiveness. The survey was carried out on 95 Russian organizations. The results showed that there is a significant difference in organizations with private and state ownership.

2 Research Literature Review

According to [17], the main goal of knowledge management is the improvement of business processes. However, Gao et al. [18] believe that the range of goals achieved with the use of knowledge is much broader. Consider these goals in more detail according to the Choo classification [19], who notes that organizations use knowledge to achieve three different but complementary goals: detecting changes in the external environment, the initiation of innovations, and support of the decision-makers.

The first goal corresponds to the view of the organization as an information mechanism, according to which it processes information coming from external sources, to adapt to new circumstances. This concept is connected with the concept of an adaptive enterprise [20]. Hsu and Sabherval [13] also indicate that the knowledge is associated with the organization's dynamic capabilities, which are determined by its potential to detect and exploit the opportunities that open and to appropriately transform and reconfigure organizational resources and operational routines [21]. A model linking dynamic capabilities and knowledge management is offered in [11]. Note that the control of transformation is an integral element, without realizing the changes, the positive effect of the knowledge will not be obtained.

The second goal is not only to change the ways of thinking and acting, but also to actively influence the external environment through changing the principles of organizational design, the creation of new products, the generation of new business models, i.e. various innovations. Hamel and Breen [22] distinguish four levels of innovations, in order of increasing complexity of their implementation and the duration of the benefits they provide, such as:

- operational innovations (improving business processes),
- product innovations (improving existing and creating new products and services),
- strategic innovations (creating new business models) and
- management innovations related with changing key principles of the organization's functioning.

At the same time, the most important factor is the ability of the organization to manage changes, the effect of innovations will be obtained only after their implementation in practice.

The relation between KM and innovations has been confirmed in many theoretical and empirical works (see, for example, [10, 12, 13]).

The third goal of using enterprise knowledge according to [19] is to provide decision-makers with the information they need. However, the knowledge also provides other mechanisms for creating value. For example, Penrose [23] noted that the knowledge of employees allows the more efficient use of the company's material resources. Brynjolfsson and Saunders [24] view organizational capital as a unique combination of firm practices that include the distribution of decision-making powers, incentives, knowledge and skills, relationships with suppliers and consumers, and so on. Unlike physical assets, it cannot be acquired on the market, but it also requires investments to create and develop.

Hsu and Sabherval [13] note that the three listed factors (dynamic capabilities, innovation, and internal efficiency) are mediators that provide the influence of enterprise knowledge on improving the company's productivity. It can be said that knowledge is the main source of organizational changes in a broad sense, including both evolutionary (incremental) and transformational (radical) processes, managerial and technological innovations, changes initiated by top management and at the operational level, covering both the organization as a whole, and its subsystems. From this point of view, the most important factor is not only the organization's ability to receive and accumulate knowledge but also to implement the investments in the changes. Therefore, change management [15] should be considered in conjunction with knowledge management, the ability to implement change is a critical factor in creating value based on knowledge [16].

Change Management (CM) also refers to critical management technologies, as the modern business environment is highly turbulent, therefore, a successful organization must respond to emerging challenges in a timely manner [25]. CM can be defined as "the process of continuous updating of the management tools, structure and capabilities of the organization to meet the constantly changing needs of external and internal consumers" [26]. Organizational changes vary in frequency of occurrence, source, and scale [25]. Burnes [27] believes that change is an inherent feature of the organization. In view of the unpredictable nature of the changes, the need for CM arises ad hoc, the very practice tends to be reactive and continuous, changes are often triggered by organizational crises. However, Balogun and Hope Hailey [28] cite data that about 70% of all change programs do not end with success. This is due to the fact that the theory of change management is not yet fully developed, the various models often contradict each other and are poorly supported by empirical results [25].

Various theoretical models of organizational change are proposed in [15, 29, 30] and in many other works. In particular, all the listed authors consider the drivers of changes, types of changes and suggest various models of CM. Graetz and Smith [31] compared 10 very broad interpretations of organizational changes (which they called "philosophies"), including those based on psychological, rational, institutional, resource, systemic and other approaches. Their main conclusion is that a successful organization should be based on a modular structure and support the strategy of ambidexterity. By the definition of Pil and Cohen [32], the modular system consists of diversified elements that independently perform various functions. The strategy of ambidexterity means creating along with the organizational hierarchy a horizontally integrated network that supports the decentralized implementation of strategic decisions [33]. Langley et al. [34] summarized the results of research on organizational changes based on the process approach. They showed that the source of change is often the contradictions and frictions between different levels of the hierarchy.

Particular interest from the point of view of management is the process of change. According to [35], in any process of change, three significant stages are distinguished:

- recognition of the need for a change (diagnosis);
- preparation for change (creating readiness);
- implementation of change (change adoption and institutionalization).

The term '*change readiness*' (CR) is proposed by Armenakis et al. [36] as the opposite of the concept of '*resistance*'. Readiness is formed on the basis of communications, wide awareness and due to the active involvement of employees. This allows the organization to assess the probability of the successful change implementation, consolidate and focus efforts, assess the sufficiency of resources and the potential feasibility of goal.

According to Dalton and Gottlieb [37], CR combines the properties of state and process. A state of readiness means that there is a general conviction that the proposed change is necessary and feasible. Readiness as a process includes activities such as recognizing a situation in which a change is necessary, estimating the costs and benefits of implementing a change, scheduling a change.

Many researchers [16, 38, 39] note that CR is manifested at two levels: individual (motivation, competence, etc.) and organizational (culture, climate, availability of resources, etc.). It follows that the CR is closely related to knowledge both at the individual and organizational levels. Thus, it can be argued that knowledge management and change management are complementary practices, so only their joint implementation will have the maximum effect on the activities of the organization.

3 The Model of the Impact of KM and CM on the Effectiveness of the Organization. Research Hypotheses

In most cases, the effectiveness of the organization (EO) is measured through financial indicators, but this approach is only valid when analyzing the activities of commercial firms. Various organizations participated in our study, not only firms but also suppliers of public services (medicine, education), subsidiaries of state and municipal government, etc. In addition, when we view knowledge management as the main and integral part of management, a new way to determine and assess prospects, the question of value added as a result of KM becomes irrelevant [9]. Similar considerations can be applied to change management. Therefore, many researchers [14, 40, 41] use quantitative metrics to measure organizational performance based on subjective assessments of parameters such as:

- the ability to develop new products and services;
- ability to predict the results of their actions and assess risks;
- opportunities to process new information.

To construct measurement that depends only on internal features of organization, we will follow the statement of Argyris [42], who argues that most people distinguish between efficiency and effectiveness. Efficiency comprises achieving existing objectives with acceptable use of resources. Argyris [42] identified three significant aspects of effectiveness relevant to organizations of any type:

- goal achievement,
- optimal use of resources, and
- adaptation (i.e., change in objectives) to the external environment.

Therefore, effectiveness means efficiency plus adaptability. The effective organization is both efficient and able to modify its goals as circumstances change. This definition is consistent with the concept of dynamic capabilities, which determine the ability of the organization to detect and seize opportunities and appropriately transform and reconfigure itself. So, to measure effectiveness, we need to take into consideration all factors: achieving objectives, resource utilization, maintaining the internal system and adaptability [14].

As noted above, changes are an inherent feature of any organization, as it is forced to respond to the permanent challenges dictated by the external and internal environment [16, 25–27]. From this, it follows that change readiness is the key factor that determines the effectiveness of the organization. Thus, the first hypothesis of the study can be formulated as:

H1: *The change readiness positively affects the effectiveness of the organization.*

The second factor that makes the organization effective in modern conditions is the enterprise knowledge management [12, 13, 43, 44]. This allows us to formulate the second hypothesis of the study:

H2: *Knowledge management positively affect the effectiveness of the organization.*

The factors listed above (effectiveness of the organization, change readiness, knowledge management) are not sufficiently well defined and cannot be measured directly. The system under consideration belongs to the class of so-called "soft" systems, which do not have a completely defined structure, a fixed composition of elements, and prescribed laws of behavior. In this case, there may be several simultaneous and incomplete representations about the characteristics of soft systems, which is a consequence of the presence of a social component in them [45].

Therefore, we used the technique of factors measurement through observable indicators. To do this, an analysis of the literature was carried out and questions were developed that made it possible to quantitatively assess the factors studied. As a result, a questionnaire was received, which included 4 questions for evaluating each factor - a total of 12 questions. Each question was formulated in a positive affirmative form (for example, "we pay special attention to the work with personnel in the changes"), the interviewee had to choose the answer from the range defined by the 5-grade Likert scale (from 1 – "completely disagree" to 5 – "completely agree"). Factors and questions for their measurement are presented in Table 1.

In addition, the questionnaire included questions about the characteristics of the organization, which, according to preliminary estimates, could significantly affect the factors studied, namely: the type of activity (business, state and municipal management, public services - education, medicine, etc.), size (number of employees), who is the main owner (state or private investors), as well as the date of establishment of the organization. The organizations studied were divided into two groups. The first group included organizations created during the times of the Soviet Union (until 1991), they inherited in many respects hierarchical structures oriented to command-administrative methods of management, and a high degree of bureaucratization. The second group included organizations created after 1991, presumably they use more modern forms of management.

Table 1. Research questionnaire

Factor	Variable	Question	References
CR (change readiness)	*CR1*	We pay special attention to work with personnel in the changes	[16, 35, 36, 38]
	CR2	We always try to find and solve the problem that is behind incidents in different areas	
	CR3	We can always determine the boundaries of the proposed change	
	CR4	We create an effective communication environment for analysing and planning changes	
KM (knowledge management)	*KM1*	We participate in various studies to understand how much we need new knowledge	[46–49]
	KM2	Sharing knowledge is officially encouraged in our organization and we have time for this	
	KM3	We carefully study any promising idea, despite its source	
	KM4	We realize that knowledge is a resource on the basis of which our organization creates a value for the consumer	
E (effectiveness of organization)	*E1*	We always strive to make the best use of available resources	[40, 42, 50, 51]
	E2	We are constantly reducing any types of losses: useless work, downtime, excess stocks, etc.	
	E3	We always respond in a timely manner to any events in the external environment	
	E4	We continuously update products, services and production processes	

4 Research Organization

The study was conducted in two stages. The first one was conducted in October–November 2015, the second in February 2017. References to the questionnaire, implemented in Google Forms, were distributed through professional communities (financial directors, HR directors, IT directors), and in the Facebook social network and on professional off-line conferences. In total, at the first stage, 92 responses were received from various organizations, of which 83 were found to be valid. At the second stage, 28 questionnaires were received, of which 12 were filled correctly. Thus, 95 organizations participated in the study. Their distribution is shown in Table 2.

Table 2. Distributions of organizations

	Number of organizations	Share in the sample	F-test value	F-test critical value
Activity				
Business	67	0.71	1.090	3.095
State and municipal management	17	0.18		
Public services	11	0.12		
Size of organization				
Less than 100 employees	21	0.22	1.966	2.705
100–500 employees	30	0.32		
500–1000 employees	15	0.16		
More than 1000 employees	29	0.31		
Owner				
State	36	0.38	4.729	3.943
Private investors	59	0.62		
Creation date				
Before 1991	38	0.40	0.039	3.943
After 1991	57	0.60		

After the data collection was completed, the dataset was analyzed to estimate the errors that may be caused, firstly, by the difference in the method of data collection, and, secondly, by the potential bias of respondents (the questionnaire is filled only by people of a certain character). For this, a two-sample *t*-test was performed for the two data groups collected in 2015 and in 2017. Similar studies were conducted for valid and rejected questionnaires. The results showed that there was no statistically significant difference between these groups of data, and therefore there are no errors related to data collection and bias of respondents.

Little and Rubin [52] noted that statistical analysis often suggests that errors in measuring the variables in the sample are independent of their values. To test this assumption, MCAR statistics were computed [52], the results showed that the errors are random and do not significantly affect the values of the variables.

An important aspect of quantitative research in the field of "soft" systems is the estimation of the overall bias of the method used [53]. The source of such error may be unaccounted factors that determine the variation of the investigated variables and, consequently, the correlation between them. So, factor analysis without rotation was performed, as a result, 6 factors explaining 58.2% of variation were found, with the first factor explains only 19.4% of the variation. From this, we can conclude that there is no single factor determining the bias of the results obtained. In addition, the maximum correlation between the variables in the dataset is 0.678, which does not exceed the critical value of 0.9. Thus, the results of these tests indicate that the overall bias of the method is not a problem in this study.

To assess the degree of influence of the selected characteristics (the type of activity, size, age, type of ownership) on the effectiveness of the organization, a single-factor analysis of variance (ANOVA) was carried out for each of them. As the dependent variable, the average efficiency $\overline{E}_j = \sum_{i=1}^{4} E_{ij}$ was taken, where E_{ij} is the j-th respondent's answer to the i-th question regarding the effectiveness of the organization. The calculated and critical values of Fisher's F-test are given in Table 2. It follows from the data given that there are two groups in the data set under study, the average efficiencies of which are statistically significantly different. The separating variable is the type of the organization's owner, the effect of all other characteristics is not significant. Thus, the analysis of the model should be carried out separately for each type of owner of the organization.

5 Research Results and Discussion

Although two distinct groups are found in the dataset, a simple quantitative analysis of the joint influence of the level of knowledge management and change readiness on the organization's performance across the entire sample can be made. Based on the completed questionnaires, an average assessment of the knowledge management $\overline{K}_j = \sum_{i=1}^{4} KM_{ij}$, change readiness $\overline{C}_j = \sum_{i=1}^{4} CR_{ij}$ and the efficiency $\overline{E}_j$ were calculated for each organization, where the variables with indices ij denote the answer of the j-th respondent to the i-th question.

Let us estimate the degree of influence of the variables $\overline{K}$ and $\overline{C}$ on $\overline{E}$. To do this, we construct the regression equation

$$\overline{E} = a + b_o OWNER + b_c \overline{C} + b_K \overline{K} \quad (1)$$

where $OWNER$ is a dummy variable, depending on the type of organization owner: $OWNER = 1$ for state-owned organizations and $OWNER = -1$ for private. The results of the calculations are presented in Table 3, from which it follows that all the coefficients are statistically significant ($t_{critical} = 1.986$ at a significance level of 0.95), the coefficient of determination of the obtained model $R^2 = 0.55$.

Table 3. Coefficients of Eq. (1)

Coefficient	Value	t statistics	p value
a	1.145	5.399	0.0
b_o	−0.188	−2.918	0.004
b_c	0.391	4.583	0.0
b_K	0.291	3.639	0.0

Of particular interest in the results obtained is the fact that the value of the coefficient b_o is negative. Given that the variable *OWNER* has a positive value for state-owned organizations and negative for private organizations, this means that the *efficiency of state-owned organizations is lower than that of private ones when other circumstances being equal*.

Let us find the regression equation

$$\overline{E} = a + b_c\overline{C} + b_K\overline{K} \tag{2}$$

separately for state-owned and private organizations (Table 4). It follows from the results for private organizations that the impact of knowledge management on efficiency is higher than the impact of change readiness. The regression coefficient for the variable $\overline{K}$ is statistically insignificant for state-owned organizations (the value of t statistics is less than t critical), perhaps this indicates that knowledge management is not a factor affecting efficiency for them.

Table 4. Coefficients of Eq. (2)

Coefficient	Private organizations			State-owned organizations		
	Value	t statistics*	p value	Value	t statistics**	p value
a	1.281	5.605	0.0	1.230	2.391	0.023
b_c	0.308	2.782	0.007	0.429	2.879	0.007
b_K	0.391	3.795	0.0	0.154	1.078	0.289

* т $t_{critical} = 2.003$
** $t_{critical} = 2.035$

The analysis of the obtained results allows us to draw important conclusions about the role of knowledge management in Russian organizations.

First, it should be noted that the importance of the role of knowledge management in ensuring effectiveness has been confirmed for private organizations.

Secondly, the most important result of the study is the fact that for state-owned organizations knowledge management is not a factor affecting effectiveness. Obviously, this cannot be explained only by the high bureaucratization of large state-owned organizations (state corporations), an unjustifiably large hierarchy of decision-making. A significant number of state-owned organizations that took part in the survey have a relatively small number of employees (1000 or less), so the problem lies in the general approach to management. The results of modeling suggest that such organizations are suppressed individual initiative, decisions are made only by management or require its approval. This kind of management, oriented to command-administrative methods, is more typical for Soviet-era organizations, but analysis shows that the time of setting up an organization is not a significant factor. This means that in state-owned organizations this way of management is reproduced at the present time.

6 Conclusion

In general, the hypothesis that the increase in effectiveness through the introduction of knowledge management can only be achieved by ensuring adequate change readiness can be considered confirmed. As follows from Table 3, state-owned organizations provide less effectiveness than private ones in the same conditions. This is due to the fact that knowledge management for them is not an effectiveness factor, which is a consequence of suppression of initiatives at the individual level.

This result is especially important in the context of the continuing nationalization of Russian companies, the share of state-owned companies in the economy today is close to 80%. From the presented results, it can be concluded that a high level of state participation in economic activity is the reason for the low efficiency of the Russian economy as a whole.

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A Case Study on Challenges and Obstacles in Transforming to a Data-Driven Business Model in a Financial Organisation

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Abstract. The former British Prime Minister Benjamin Disraeli once quoted 'change is inevitable, change is constant'. This is very much the current scenario for any businesses in today's world. The environment in which the businesses operate are changing rapidly. The influences of changes in PEST (Political, Economical, Social, Technology) are having an immediate impact on today's businesses. The businesses that do not understand or willing to react for these changes will fail miserably. We have witnessed these failures in many businesses as in case of Carillion plc, a British multinational facilities management and construction services company, Lehman Brothers, HMV, Clintons, Jessops, Woolworths etc. The underlying failures of all these firms are due to their inability to understand and adapt to the changes and not willing to change their traditional business models. Especially the financial industry is more vulnerable in today's world due to the interconnected macro-economy and in order to stay competitive they will have to adapt to a more robust dynamic business models rather than the traditional static models. As part of this case study we are trying to understand if employing a very dynamic data-driven business model will actually help the financial firms to stay ahead of their competition and also the potential challenges and obstacles the companies will face whilst undergoing this transformation. This case study was primarily conducted specifically for an asset management firm based in London, UK.

Keywords: Data-driven business model · Big data · Business transformation
Cloud technologies

1 Introduction

According to the investment association annual survey report, the total asset under management by UK asset management firms is approximately around £6.9 trillion as of year ending 2016; this is equivalent of 373% GDP of UK economy. (Verick 2010) Since the global economy crisis for 2008 and also the recent Brexit referendum, the pace of changes has been enormous across the industry, influenced by various market forces such as constant increase in customer demand, technological advancements, Increased pressure for profits from stake holders, political uncertainty, impacts of

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global macro-economy. As a result of all the above listed factors the firms are facing enormous pressure on their operating margins. This means to stay competitive the firms should constantly innovate and provide utmost value for their customers or the customers will move their investments elsewhere. This presents a challenging environment for the asset mangers and the management to make incredibly bold decisions to lead the business in the right direction. The traditional static business models can only support the firm to some extend during these difficult and changing period so the firms has to accept and adapt to more dynamic business model which will allow the firm to constantly diffuse strategic business models to tackle the changing environment. While, its quiet obvious to advocate for constant business transformation but the struggle for the firms are two-folds. Firstly, to identify the business model that will provide the capability to adapt dynamically based on the market influencing factors. Secondly, having identified the model the next challenge will be on how to diffuse this new model with in the firm without much disruption due to the dynamic nature of the business model. The employee's will be willing to participate in the business transformation programs for the benefit of the company's growth but if that is going to be a never ending transformation waves then how will it affect them and their performance? Without doubt plenty of questions and challenges will arise when we undertake business transformation programs. However, the businesses should find the solution to tackle these challenges and keep moving at a steady pace for that it needs a solid dynamic business model, which should be focussed on two main attributes. Speed and agility are the two important core attributes the dynamic business model should focus on. This case study will be based on Data-driven business model to understand if this model will provide the much needed dynamic business transformation capabilities for the assert management firms. Also, this case study will be focussed on presenting the challenges and obstacles in implementing the Data-driven business model in a UK based asset management firm based at London.

2 Overview on Traditional Business Models

(Gelderen et al. 2011) Asset management firms invests large sum of money in varied asset classes on behalf of its clients. The clients are basically retail clients i.e., individuals and institutional clients, likes pension funds, insurance companies, investment and retails banks etc. The firms creates diverse funds and invests the money in order to reduce the risk exposure and earn good returns. The income for the asset management firms comes from charging the clients a percentage fee for managing their money. It is therefore essential to have a large pool for money for investment in order to sustain in this business. These kind of long term investment requirements needs a lot of trust from the clients. Asset management firms plays a vital role in an economy. These firms invests heavily in the fixed income asset class, which is debts relating to corporates, government etc. This is a major steady source of funding for the corporates and stabilises the economy.

According to the information accessed from the companies website. Aberdeen asset management firm, another elite asset manager claims their vision and purpose is to help people harness the potential in the global investment market to realise their goal and also they would like to position themselves as a trusted partner for investments. Their core principles to deliver the value are quality, ambition, teamwork, integrity and challenge. The legal and general, the leading asset manager in UK claims their reason for long term financial sustainability is due to the products and services reflecting the customer at heart and shows both economic and social value for the future.

According to the information accessed from the companies website. The Group Chief Executive Officer of the Schroders Peter Harrison heading one of the biggest global asset management firm head quartered in London says,

> 'We've never forgotten that our business is all about our clients'. He says this is the core reason for their sustainable business. Where understanding the client needs and also anticipating their future needs and servicing them to increase their investment means staying relevant and up-to date in the market.

Below, is the business model of the Schroders (Fig. 1).

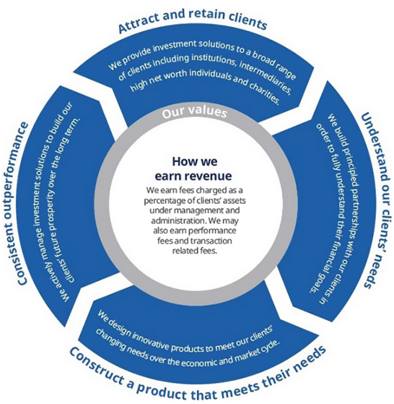

Fig. 1. Schroders business model

The business model of Schroders could be summed up as understanding the clients requirements, constructing a product based on the requirements, outperforming and continuously delivering high value, retaining and acquiring new customers. The key attributes that we could infer from the above business models are know your customers, product innovations, delivering value, earning trust. These attributes will in turn provide the revenue for the business in the form of AUM (Asset under management). This value chain is an iterative model and it will be constantly changing.

Below is the business structure of the Schroders, the main business unit of Schroders are Asset Management and Wealth Management. The asset management unit supported by the investment, product, distribution. Although traditionally there was no separate product unit but recently the company has created the product unit to specifically focus on product innovation to stay ahead of the competition. Further the business is supported by infrastructure and group for the operations and strategic directions. This is the Schroders model that is proven to be successful for them to operate in this tight market (Fig. 2).

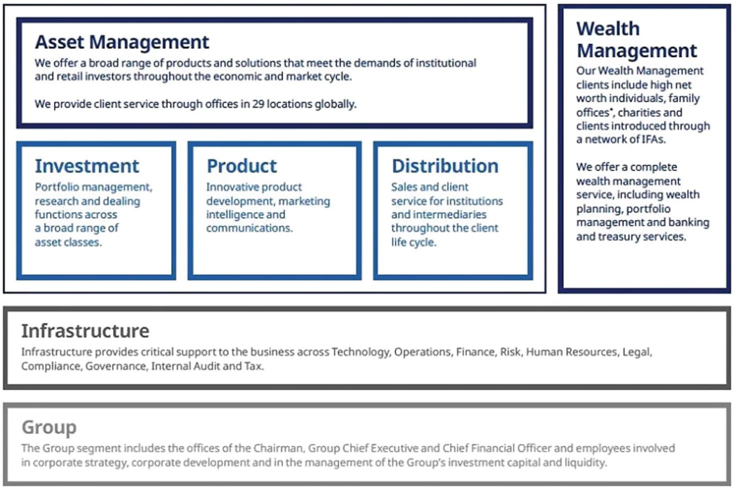

Fig. 2. Schroders business structure

Overall, most of the asset management firms follows a very similar model to service their valuable clients. But, the biggest question often asked is are these existing models sufficient and dynamic enough to deal with constant changes and serve the best needs of the customers? To find the answer for the above question we need to learn more from the asset management market study report published by FCA (Asset management market study) in June 2017 According to this industry watch dog report it claims the UK's 6.9 trillion pound industry is a market failure. I would like to highlight especially the five biggest findings from this report.

2.1 Asset Management Firms Earn Outsize Profits

The FCA, based on the data from 16 firms understand that the UK asset management firms are currently enjoying about average profit margin of 36% over the past six years. The larger firms revenue increases steeply with the increase in their AUM (Asset Under Management), this encourages the asset managers to focus on accumulating more wealth than working on improving the performance of the investments. The FCA also compared asset management's profitability with that of other industries and found it second only to real estate, with a 16% average profit margin.

2.2 Conflict of Interest from Investment Consultants

The report heavily blames the UK investment consulting firms gift culture and their growing influence in the industry. They could influence the asset managers ratings and advise the institutional investors based on their preference. In the lights of these findings the FCA has highly recommended for further tighter regulations for the investment consultancy firms. The report also warns of a high reliability of the pension funds on these consultants as they have a limited ability to assess the quality of work provided by the investment consultants.

2.3 Active Managers Don't Negotiate on Execution Prices or Outperform

Most of the firms were unable to give a clear clarity reports on their execution prices. In some instances where compliance staff were not empowered by senior management to provide effective challenge to the front office on the quality of execution either they were not given access to the data or they have no knowledge of how to use these data effectively to produce the required reports. Although there has been limited price competition among active managers, asset management charges have not changed significantly over time, the FCA says: "Clustering of prices appears to be a feature of the asset management industry."

2.4 No Clarity on Dealing Commissions

The FCA reports a lack of transparency on segregated mandate costs, particularly for transaction fees, annual management charges, defined contribution products, hedge funds, private equity, and fiduciary management. Only the headline charges are disclosed and it is evident it is difficult for asset owners to understand the fee structure charged. Also the FCA noted that the dealing commission charged from the clients are used for their internal research budget rather than purely for the cost of execution.

2.5 Institutional Investors Are not Receiving Lower Fees

The institutional investors are not receiving their reduced fees, which they can be obtained if the asset managers focus on optimising their execution models etc. In some instances even if the process are optimised the benefits of reduced cost is not distributed to the institutional investors. On fee negotiations, the report says, investors have to be persistent: "When trying to negotiate on prices, asset managers will initially refuse to negotiate, but will do so when pushed."

Although the firms claiming that they are putting the clients first and their business models are focussed on delivering value for their clients. It is very evident from the FCA report that this industry is facing various challenges to deal with the on going changes. Also, from the report we could infer the following key questions for their failure.

Q1 – If the business units are working in silos then how is it possible for them to work together to deliver value for the clients? This question is inferred from the report stating that the compliance staffs are not having adequate information to perform their role effectively.

Q2 – Why the dealing commission information is not clear? Is it due to the lack of information sharing between the business units?

Q3 – Why the active asset managers if they are not providing much value then still charging the premium to manage the funds?

Q4 – Why the required record keeping reports are not maintained adequately? Are the required data is not shared when required?

Q5 – In the current scenario, how can a business generate any reports in order to react to any market influencing events?

It is clear from the FCA report that the asset management firms are still running on a static business models and they are not ready yet with a dynamic business model to react to any market influencing events adequately on time. The above five questions could be summed up into the lack of centralised data to obtain the desired results. This is an opportunity for researching a suitability of data-driven business model to answer the above questions.

3 Data-Driven Business Model

Analysing the issues faced by the asset management firms it is becoming clear that they are not organising their data from desperate system in a centralised way to generating any valuable information that could help the business on time. Also, the business requires more and more data analysing to provide utmost value for their clients. Is it the call for transforming the business in to Data-driven model? Lets first understand how the Data-driven business model work.

As data-driven strategies taking lead, they will become an increasingly important point of competitive differentiation. According to (McAfee and Brynjolfsson 2012) companies that inject big data and analytics into their operations show productivity rates and profitability that are 5% to 6% higher than those of their peers.

Since the big data technologies are advancing and the companies are getting much comfortable with this technology the Data-driven business models have caught fire as they keep finding ways to analyse the obtained data to gain a competitive edge. Traditionally the businesses not use data to support their business decisions fully but mostly executives still make decisions based on guy instincts and narrow observations.

That's not to say companies haven't found data useful until now. Senior executives usually talk to the customers to obtain their feedback and try and make decisions based on them rather than considering the broader section of their customer base. Data certainly has been an important aid in the decision-making process, but executives have usually placed a higher priority on instincts and unscientific information. As one technology strategist said, "Data informs, but belief rules." A new report from EY and Forbes Insight, Data & Advanced Analytics "High stakes, High rewards", based on a survey of over 1,500 executives from around the world, highlights the current situation and the provides various good suggestions to progress further with this new approach. According to Amir Orad, CEO of Sisense, a business intelligence software provider, true data-driven companies understand that data should be omnipresent and accessible. According to him a data driven company is where every individual has access to the data they need to analyse and make their effective decisions, even if they are working with big or disparate data sources. To become a data-driven company, it is not enough to start a formal data governance program, becoming data-driven requires a disciplined shift in the mindset of all employees towards maintaining the integrity and quality of their data argues Chris Jennings, vice president of technology services at Collaborative Consulting. Analyst firms and consultants urge companies to rely heavily on that data to drive their decision process and let observations and intuition take a back seat. Moving to data-driven business models, they've said, results in a quantifiable competitive edge.

According to the research conducted by (McAfee and Brynjolfsson 2012) the Data-driven businesses has proven to increase the productivity around 5–6% higher compare to the companies not utilizing the data-driven approach. It is also very interesting to note that 71% of banking firms directly agree the use of big data providing them a competitive advantage. The research further collected primary data from 40 companies ranging from start-ups to well established firms via their annual reports, website information and case studies and tested their proposed six questions of a data enabled business. The six fundamental questions forms their framework for constructing their proposed data-driven innovation blue print.

The six questions are

1. What do we want to achieve by using big data?
2. What is our desired offering?
3. What data do we require and how are we going to acquire it?
4. In what ways are we going to process and apply this data?
5. How are we going to monetize it?
6. What are the barriers to us accomplishing our goal?

Below is the proposed data-driven innovation framework by Brownlow et al. (2015).

Inspired by proposed data-driven innovation, as part of this case study we validated this innovation model in a well established asset management company based in UK, London. Our aim is to validate the proposed data-driven innovation model for the suitability of the firm and if the model has been adapted then will it help the firm to answer and tackle the five questions that we have raised above after the FCA report findings (Fig. 3).

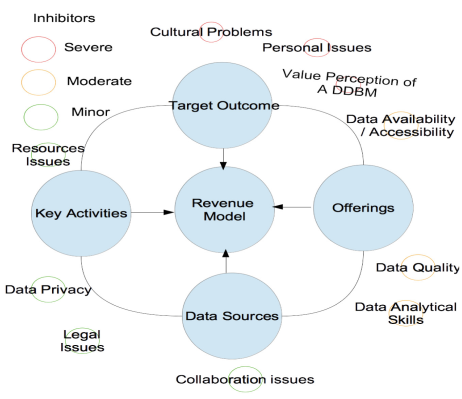

Fig. 3. The proposed DDBM-Innovation Blueprint

4 Research Methodology

The study used quantitative method in the form of online web based questionnaire for identifying the facts about core components of the data-driven model and also used qualitative interview method to collect the data on inhibitors. The questionnaire was divided into two sections. Section A contains the demographic information of the respondents. Section B contains the six questions inspired by the data-driven innovation model proposed by Brownlow et al. (2015). To identify the fit for the data-driven business model and also its to understand the challenges and obstacles in implementing the data-driven business model in a specific UK based global asset management firm, this survey was sent to 18 participants with in the organisation in various business unit. A response rate of 61% (11 responses) was received from various business unit. Due to the limited time the scope of this data collection is limited.

5 Results

Below I have presented the results of an online survey from 11 respondents. The results are presented in the same order of the questions asked in the questionnaire.

5.1 What Do We Want to Achieve by Using Big Data?

About 45% respondents were thinking about big data as a tool for driving innovations and it means access to the whole world of data for unlimited imagination. 27% respondents replied as an opportunity for transparency within the organisation to open up the silos and hence they believe they could further performa their role efficiently. Only 18% thinking of it as a competitive advantage until the company understands this the big data and diffuses the relevant programmes. Further 9% thinks it could be helpful for compliance reporting and recordings (Fig. 4).

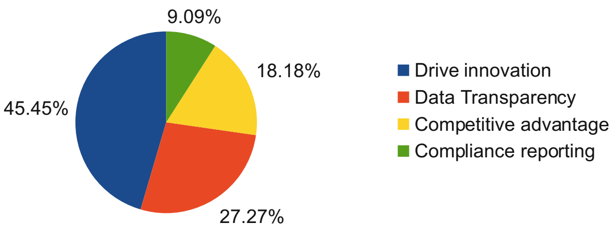

Fig. 4. Desired achievement by using big data.

5.2 What Is Our Desired Offering?

Almost 45% of respondents thinks it has an opportunity to serve the customers in a better way and further could offer them better value for their investments in terms of improved ROI (return of investment). An interesting 27% of respondents envisage as an opportunity to provide tailored product for customers, this is a very innovative approach in fund managers space as mostly the funds are created first based on the market research and then sell it to customers. Remaining 27% respondents believes internal performance improvements and it will provide a huge value for the business (Fig. 5).

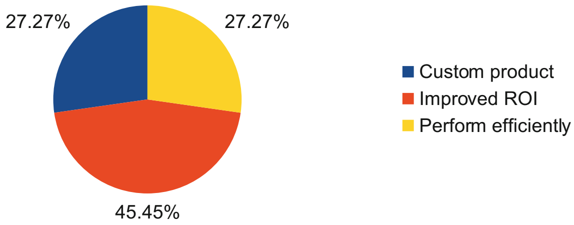

Fig. 5. Desired offering using big data.

5.3 What Data Do We Require and How Are We Going to Acquire It?

Almost 45% of respondents wants to start with the existing fund data to understand more insight of our current business trading activities. 27% of respondents were keen in loading the external market risks data and further 27% were interested in crowd-sourced data (Fig. 6).

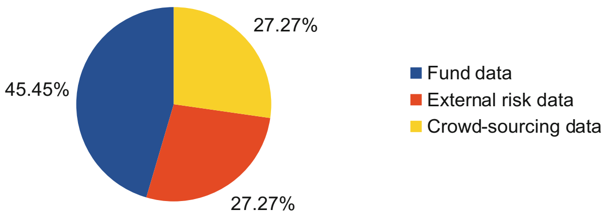

Fig. 6. Data acquiring strategy.

5.4 In What Ways Are We Going to Process and Apply This Data?

Most of the respondents were believing the collective data will be of a better use for predictive analytics. About 27% respondents believes the data could be used for general analytics purposes and further 18% think of visualisation and reporting usages (Fig. 7).

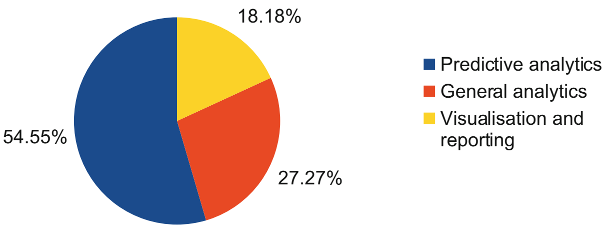

Fig. 7. Data processing strategy.

5.5 How Are We Going to Monetize It?

The majority of about 72% respondents thinks the capabilities should be advertised well enough to the customers to gain their trust and build our brand and thus it could be converted into investments. Further 27% respondents thinks about open sourcing the platform for monetizing it (Fig. 8).

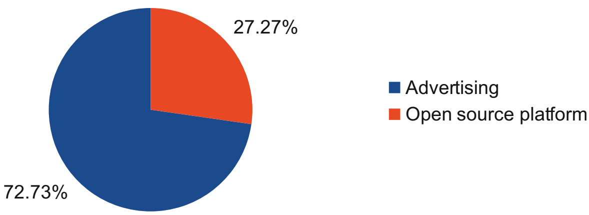

Fig. 8. Data monetizing strategy.

5.6 What Are the Barriers to Us Accomplishing Our Goal?

To obtain this data, the 11 survey respondents were interviewed briefly to talk about the potential barriers. This is an open question to understand the broader aspect of the problem at hand. There was various answers obtained when asked about the barriers and below I've presented few key barriers listed by the participants.

Data integrity - Most of them pointed to data integrity issues and they find its important to address this adequately to value the acquired data.

Perceived value of benefits vs time - The participants although valuing the data-driven approach but questions raised in terms of design and implementation time vs value in return. Most of them believed that there should be a strong push for this kind of initiative from the senior management in order to obtain the required fundings.

Technological challenges - The available skills in the team and the understanding the usage of required technologies are all considered as a potential barriers.

Cultural issues - Most of them believed to achieve the success there should be a strong cultural change and this should be managed appropriately.

Business structure - The current static business structure could potentially hinder to drive this initiative to obtain real benefits. There is a clear indication for the need of change in business structure.

Internal Politics - Few of them pointed out the company politics in various business units could make it difficult to centralise the data.

Data accessibility - Obtaining access to the required data could be challenging but everyone agreed this should be achievable through proper approach.

Analytical skills - The analytical skills required in the team to churn the centralised data could be challenging.

General Data Protection Regulation - There were few pointers on the impact of GDPR affecting the data driven business model.

6 Proposed Solution

Upon identifying the core components of the data-driven model required for the firm then I've presented the below data-driven model along with the inhibitors to validate the model in practise. I've agreed with the management to start this validation of new business model by providing solution for a very important problem that the business is facing currently. The business was happy and provided a challenge by asking the following question.

Could we find out our current group risk exposures by country?

To provide a background on the context, at the moment the firm needs about 2 months or so to answer this question as they have to coordinate among various companies across the world and get the required approvals from the different business units. Also, some business unit needs further explanations and of course they will hinder providing the required data. At times the provided might not be correct so they have to go back and fourth and get the correct data and then analyse the data for few more days based on the teams schedule and priority. By the time we get an answer the answer becomes stale as we have moved few months now and the answer is not of much value to the business. These kind of questions are very time sensitive in the fast market moving situations and the senior management needs the answer at the earliest as possible to make their sound key decisions and without having this capability they are of course going to make a decision based on the information and gut feeling, which could potential prove disastrous for any company. In order to find an answer for the business question, we did setup a small team to work on this mission. The main aim of answering this question is to identify suitability of the adaptability of domain-driven model and also to find out the real inhibitors and categorize their severity as part of our study.

7 Identifying the Challenges and Obstacles

The team started off with identifying the required datasources to solve the problem. It requires all the group fund position data, position related instruments data and market risk benchmark on these instruments. Collaborating and obtaining the fund position data from various companies in different countries was challenging as they handle and maintain the data in a different formats etc. We had to influence them to send us the daily end of day positions at a agreed time schedule. We did face the difficultly in obtaining the data as providing these data is not of utmost value for the individual funds running in different countries, when everyone is implementing their own business transformation programmes etc. Data availability/accessibility was challenging but its is achievable provided we strongly push for it and reach through an organised channel. Also, the data integrity, data analytical skills and internal politics was equally challenging forces but it was still moderate enough to deal. There were technological know-how issues but with the amount available resources we found it easy enough to tackle this problem. Also, there was some minor concerns raised by the data management team about the GDPR requirements for the data-driven projects. Through out the project life cycle the major issues according to the team is the business structure, it was very difficult to convince the business units about the benefits of centralising the data and also their willingness to understand the value of DDBM in a short term. They are not against the DDBM but they are not willing to accept the time it would take to achieve the value or benefits out of the DDBM. Also, the cultural problems is a major impeding factor to progress.

Thus, we have identified with our practical experience the following inhibitors impeding our progress and classified them accordingly (Fig. 9).

Minor inhibitors – Technological issues, GDPR
Moderate inhibitors – Internal politics, Data analytical skills, Data integrity, Data availability/accessibility
Major inhibitors – Cultural problems, Business structure, Value of perception of a DDBM.

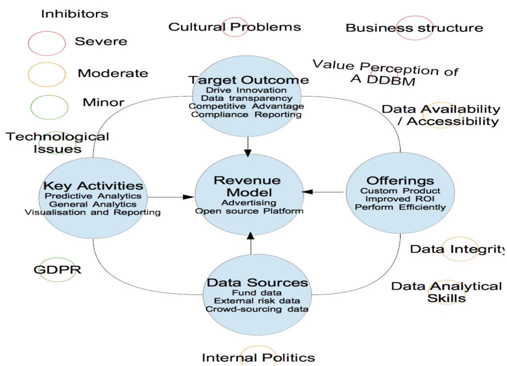

Fig. 9. The proposed DDBM-Innovation Blueprint

8 Recommendations

Using data to drive business decisions requires a change in strategy, culture and operations. It will be a time consuming exercise to transform an organisation into a data-driven business model but yet it is a valuable process for the business in the long run. Also we have learned that the power of fear is quite tremendous in evolving oneself and to ask questions today that we weren't asking about our roles before. And it's that mind-set change and more of a dynamic mind-set and much more learning oriented, as opposed to a fixed mind-set. It needs a strong culture change in the organisation and it should be initiated by the senior management. The data-driven business model should be driven with a clear business questions as it will be a daunting task to obtain value in the large cluster of data without knowing what you are looking after. It is essential to start with centralised the data first to do that you need the backings of key stakeholders. Communicating often the benefits and constantly pushing forward for adding the data sources is one way of achieving the success. Also, this initiative should start from the very senior management in an organisation. Analytical skills are essential in order to derive the desired results out of the accumulated data. The more accessible and visually presented data is better for the senior managers to easily obtain the insights from the data to help them make better informed decisions. Choosing a right set of tools is also equally important to achieve the data-driven business model. Although there are plenty of cloud product offerings available in the market and it's important to choose the right pricing model for your organisation. If the resources cost is not managed properly then you could end up paying a fortune for these services. There will be various inhibitors impeding the implementation progress but by identifying the inhibitors up front and develop a strategy to mitigate them at the earliest is essential during the transformation stage.

9 Conclusions

When diving deeper into organisation's operational function we will often surface the fact that many senior executives still make their key decisions based on their experience and narrow observations, which in today's modern economy could be a risky decisions making. If implemented data-driven model successful with in an organisation then it could eliminate that guessworks and provide a clear clarity for the businesses to make a sound decisions backed by key facts. It is evident from the case study that the cultural issues and communicating clearly the benefits of the data-driven business model to the key stakeholders and involving as much as people in an organisation as part of the transformation process is essential. Due to the time and scope limitation this study was only aimed at one proposed data-driven model.

Also, as part of the current study we were only able to identity the inhibitors developed in the progression phase since the originally aimed work was not completed and it's on going. We need further research to propose the methods to mitigate the inhibitors for adapting the new data-driven model. Although most of the asset management companies are proud to offer best product solutions for their clients. However, the FCA paints a completely different picture of the industry. The gaps and shortcomings in this industry is alarming and any crash to this industry will have a severe blow to the whole of a country's economy in a long run. With the increasing number of companies trying to adapt to the data-driven model to innovate their product offerings. It is very important for companies who are not using big data to think about it seriously else they will be at some point become irrelevant in the market. The companies success rates mostly depends on the strong leadership qualities and hence the driving force for dynamic data-driven model should start from the top level of management to make it more successful.

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An Agent-Based Virtual Organization for Risk Control in Large Enterprises

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Abstract. At present, business decision making is a crucial task in every enterprise as it allows to minimize risks and maximize benefits. For effective decision making, large corporations and enterprises need tools that will help them detect inefficient activities in their internal processes. This article presents a virtual organization of agents designed to detect risky situations and provide recommendations to the internal auditors of large corporations. Each agent within the virtual organization facilitates the interconnection of enterprises with the central decision node of the corporation. The core of the agent-based virtual organization consists of two agents: one that is specialized in detecting risky situations in all aspects of business enterprise and an advisor agent which communicates with the evaluator agents of the different departments of a business and provides decision support services. This paper presents a real-case scenario which includes small and medium enterprises, the results demonstrate the feasibility of the proposed architecture.

Keywords: Agent-based virtual organizations · Internal audit · Case

1 Introduction

Systems used in the organization of enterprises are becoming increasingly complex. In addition, several regulatory standards have been introduced which can make it more difficult for enterprises to make decisions. As a result, it is necessary to propose decision support systems which will complement existing business models and will help enterprises improve their functioning. Such tools and methods can further reduce risks by providing recommendations based on previous experiences. The periodic realization of internal audits is necessary. However, due to their dynamism, the evaluation and prediction of financial systems is, in general, a complicated task. It is necessary to construct models that facilitate the analysis of changing environments.

The wide range of processes involved in the running a business can be classified into different functional areas [1]. Each one of these areas is denominated a “Function”. A Function is a group of coordinated and related activities which are necessary to reach the objectives of the firm and are carried out in a systematic and reiterated way [2]. Functions are divided into activities, which are closely related to clearly defined

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objectives. Commonly performed functions in a firm are: Purchases, Treasury, Sales, Information Technology, Immobilized, Legal Normative Execution and Personal Politics. In turn, each one of these functions is broken down into a series of activities. For example, the function Information Technology is divided into the following: Computer Plan Development, Study of Systems, Installation of Systems, Treatment of the Information Flows and Security Management. Each activity is composed of a number of tasks, for example: register, authorise, approve, harmonise, separate obligations, operate, etc. Control procedures are conducted to ensure that the established objectives are achieved. This article proposes an innovative approach which uses agent-based virtual organizations to propose a model for risk management in business corporations.

In problems like the one presented in this document, standard monitoring and prediction techniques cannot be applied due to the complexity of the problem, the existence of preliminary knowledge, the great dynamism of the system, etc. Thus, it is necessary to use models that combine the advantages of several problem solving mechanisms, capable of addressing the numerous elements of a general problem and also of solving singular problems. In this regard, an adaptive system has been developed. Its flexibility allows it to behave in different ways and to evolve, depending on the state of the environment in which it operates. Virtual organizations of agents are the most prevalent solution to constructing Artificial Intelligence distributed systems [3]. Agents are computational entities that are characterized by their autonomy, reactivity, pro-activity, social abilities, reasoning, learning and mobility [4–8]. These characteristics make agent-based virtual organizations very suitable for constructing intelligent environments. An agent can act as an interface between the user and the rest of the elements of an intelligent environment [6, 9–12]. Moreover, intelligent agents can incorporate advanced artificial intelligence models to predict risky situations. In this study we propose a distributed approach where the components of a large enterprise are modelled as agent-based virtual organizations which collaborate to create models that can evolve over time and adapt to the changing conditions of the environment. Thus, they make it possible to detect situations that imply a risk for the enterprises and providing suggestions and recommendations that can help to avoid undesirable situations. The core of the agent-based virtual organization are the evaluator and advisor agents, they incorporate new techniques for analysing enterprise data, extract the relevant information, and detect possible failures or inefficiencies in the operation processes.

The article is structured as follows: the next section briefly introduces the problem that motivates this research. Section 3 presents the designed agent-based virtual organization. Sections 4 and 5 outline the results obtained after testing the system and the conclusions drawn from this study.

2 Risk Management in Enterprises

"Risk Management" is a broad term for a business discipline that is focused on protecting the assets and profits of an organization. - This is done by reducing the possibility of unfortunate events occurring. In case an unfortunate event does occur, its impact can be mitigated, and measures are taken to recover from the losses rapidly. Risk management encompasses a series of steps that include risk identification, the measurement and evaluation of exposures, exposure reduction or elimination, risk reporting, and risk transfer and/or financing for losses that may occur. All organizations manage risks in multiple ways, depending on the exposure they must address [13]. Changes in the economic environment are increasingly pressuring companies to address risks at the highest levels of the organization. Companies that incorporate a strategic approach to risk management use specialized tools and have more structured and frequent reporting on risk management. As such, they are in a better position to ensure that risk management provides relevant and applicable information that meets the needs of the organization and the executive team. But no matter what an organization's approach is, the tools used must be backed up by solid, actionable reporting. To get their voice heard, risk managers should not only conduct their own analysis, but they should also work on forging strong relationships with internal auditors and other departments that will provide them with additional risk reports [14].

Enterprise Risk Management (ERM) is defined as "a process, effected by an entity's board of directors, management and other personnel, applied in strategy-setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives." [15]. The management of risks and uncertainties is central to the survival and performance of organizations. Enterprise risk management (ERM) is an emerging approach to managing risks across different business functions in an organisation and it represents a shift from paradigms that focus on managing specific risks [16, 17]. This paper provides a web intelligent model to ERM, which will subsequently lead to better organisational performance.

3 Agent-Based Virtual Organization for Risk Management

Over the last decades, agent and multi-agent systems have become important tools in a range of fields [18, 19]. Agent-based virtual organizations are distributed organizations where the components (agents) collaborate to achieve a series of goals [20, 21]. Agents are autonomous entities that are characterized by their capabilities: autonomy, proactivity, reactivity, social skills, organization, etc. These capabilities make agents ideal, problem solving tools in business intelligence and risk management scenarios. In these scenarios the agents can play different roles and establish an organizational model which emulates human behaviours and management processes. In this regard, it is possible to obtain different agent types, specialized in concrete tasks and behaviours, that can collaborate to increase the productivity of the business and manage risks effectively. Agents can act as an interface between human users and systems, trying to provide advanced facilities and personalize the access to the system, but also can act as autonomous entities that are proactive and can make decisions independently. This paper leverages virtual organizations of agents to provide advanced capacities for risk management in large enterprises. The system provides a web system interface to facilitate remote interaction with the human users involved in the risk management process. The core of each agent-based virtual organization is a special type of agent, called CBR-BDI agent [22–24]. This agent type integrates a case-based reasoning mechanism (CBR) in its internal structure to take advantage of the reasoning abilities of the CBR paradigm [25–32]. CBR-BDI agents are characterized by their learning capacities and their ability to adapt to dynamic environments. These agent types are used to evaluate the business' status and to generate recommendations that can help the business avoid risky situations. CBR-BDI agents collaborate with other deliberative agents [33] in the system to find optimum models for risk management.

The agents in the system allow the users to access the system through distributed applications, which run on different types of devices and interfaces (e.g. computers, cell phones, etc.). Figure 1 shows the basic schema of the proposed architecture, where all requests and responses are handled by the agents in the platform. The system is modelled as a modular multi-agent architecture, where deliberative BDI agents can cooperate, propose solutions to very dynamic environments, and face real problems, even when they have a limited description of the problem and few resources available. There are various kinds of agents in the architecture, each one with specific roles, capabilities and characteristics:

– Business Agent. This agent was assigned to each of the departments in an enterprise. These agents collect new data and allow consultations. The enterprise can interact with the system by means of this agent, by introducing its information and receiving predictions.
– Evaluator Agent. It is responsible for evaluating and predicting situations that may entail risks. This agent goes through the four CBR stages that allow it to estimate the state of an activity. In the retrieval stage, the multi-agent system identifies situations from the past which are similar to the current situation and retrieves them from the case base. The information contained in these cases is adapted and reused in the current situation, in this way an initial estimate of the state of the activity is generated. Old situations serve as a basis for detecting inefficient processes within the activity and allow to correct them by choosing the best options. In this way, an enterprise can establish the extent to which an activity is risky, define clear objectives and mitigate unfortunate events. its function, and the company itself, to develop in a more positive way. The retain phase allows the system to learn from past cases and as a result it evolves together with the company by basing its corrective actions on the calculation of previous errors.
– Advisor agent. The objective of this agent is to provide recommendations to help the internal auditor decide which actions they should take and in this way, improve the company's internal and external processes.
– Expert Agent. This agent helps the auditors and enterprise control experts that collaborate in the project to provide information and feedback to the multi-agent system. These experts generate prototypical cases from their experience and they receive assistance in developing the Store agent case-base.
– Storage Agent. This agent's memory has been fed with cases constructed with information provided by the enterprise (through its agent) and with prototypical cases identified by 34 enterprises control experts, using personal agents who have collaborated and supervised the developed model.

– The Evaluator and Advisor agents are CBR-BDI agents with advanced reasoning abilities that provided great adaptation and learning capacities.
– The Evaluator and Advisor agent use the same type of case and share the same memory of cases. The data for the cases were obtained by Expert agents from the surveys conducted with enterprise experts in the different functional areas of various enterprises. This type of survey attempts to reflect the experience of the experts in the different fields. For each activity, the survey presents two possible situations: the first one tries to reflect the situation of an activity with an incorrect activity state, and the second one tries to reflect the situation of an activity with a satisfactory activity state. Both situations will be evaluated by a human expert using a percentage. Each activity is composed of tasks, and each task has an importance rate, and values of realization for both incorrect and satisfactory activity state. The data acquired by means of surveys were used to build the prototype cases for the initial Storage agent case base.

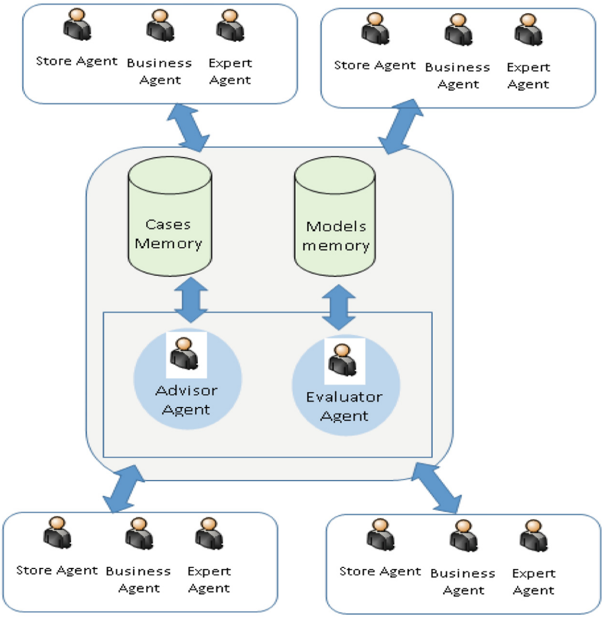

Fig. 1. Virtual organization of agent.

The internal structure of the CBR-BDI Evaluator and Advisor agents is similar to the architectures proposed in previous works [22–24]. In the present work, we use a Maximum Likelihood Hebbian Learning (MLHL) based model [34] to automate the process of case indexing and retrieval in the evaluator agent. The reuse stage incorporates an innovative mixture of experts that makes use of multilayer perceptron, support vector regression and radial basis function neural network [35, 36]. The revise and retain stages implement a decision support system for experts. Moreover, the knowledge obtained during the prediction process is of great importance for subsequent predictions. On the other hand, the advisor agent is specialized in providing recommendations that help avoid risky situations and improve the overall functioning of the company. The retrieve phase recovers similar cases and their corresponding solutions. The reuse phase incorporates a novel approach based on decision trees and probabilistic gain functions to assess efficient and inefficient tasks. The revise and retain stages also implement a decision support system for experts. The use of Maximum Likelihood Hebbian Learning Based Method derives from the work of several authors [37–40], etc.. in the field of pattern recognition as an extension of Principal Component Analysis (PCA) [41, 42]. The network operation is:

$$\text{Feedforward} : y_i = \sum_{j=1}^{N} W_{ij} x_j, \forall_i \tag{1}$$

$$\text{Feedback} : e_j = x_j - \sum_{i=1}^{M} W_{ij} y_i \tag{2}$$

$$\text{Weights change} : \Delta W_{ij} = \eta . y_i . sign\left(e_j\right) |e_j|^{p-1} \tag{3}$$

Applying Eqs. 1 to 3 to the Case-base, the MLHL algorithm groups the cases in clusters automatically. The proposed indexing mechanism classifies the cases/instances automatically, clustering together those of similar structure. This technique attempts to find interesting low dimensional projections of the data so that humans can investigate the structure of the data without any tools. One of the greatest advantages of this technique is that it is an unsupervised method, so we do not need to have any information about the data beforehand. When a new case is presented to the CBR system, its type is classified by applying Eqs. 1 to 3 to it. This mechanism may be used as a universal retrieval and indexing mechanism for any similar problem to the one presented in this work.

4 Experimental Results and Case Study

A case study aimed at providing innovative web business intelligence tools for the management of large Corporations was carried out in the region of Castile and León, Spain. The experiment consisted in constructing the initial prototype from case memory and then in predicting unfortunate events for the enterprises taken into considerations and providing recommendations. The case study presented in this work was oriented to detect possible risky situations in large corporations, considering the market crisis. A multi-agent system was implemented and 26 branches/subsidiary companies that belong to 2 large corporations, participated in the experiment and were assigned a personal business agent. The enterprises were situated in different sectors of the Spanish market. The economic context is the same for all the Companies. The system was tested for 24 months, from January 2015 to January 2017, tuned and improved given that knowledge was acquired from a total of 758 cases. The evolution of the enterprise was monitored by analysing its internal activities and predictions were made based on the previous experiences and on the situation of the market (the possible crisis that affect the market). The experts complete a survey to provide information about the enterprise.

To validate the overall functioning of the system it was necessary to individually assess the performance of the Evaluator and Advisor agents. These virtual agents provide predictions on the performance of the activities and detect the processes that can be improved within each activity, achieving an overall improvement. In the following paragraphs we will focus on the evaluation of the CBR-BDI agents and their influence on the multi-agent system. To validate the performance of the Evaluator agent, an estimation of the efficiency of the predictions provided by this agent was carried out. To evaluate the significance of the different techniques integrated within the Evaluator agent, a cross validation was established, following the Dietterich's 5 × 2- Cross-Validation Paired t-Test algorithm [43]. Value 5 in the algorithm represents the number of replications of the training process and value 2 is the number of sets in which the global set is divided. Thus, for each of the techniques, the global dataset S was divided into two groups S1 and S2 as follows: $S = S_1 \cup S_2$ and $S_1 \cap S_2 = \varphi$. Then, the learning and estimation processes were performed. They were repeated 7 times and had the following steps: the system was trained using S1 and then it was used to classify S1 and S2. In the second step, the system was trained using S2 and then it was used to classify S1 and S2. To assess the performance of the Advisor agents, it was necessary to take into account that the aim of this agent which is to detect inefficient tasks by means of gain functions, as explained in the previous section. To assess the functioning of the Advisor agent the tasks which obtained higher values for the gain function were selected. The selected tasks were used to estimate the different scenarios for different execution values for the task. The estimation was performed using the values provided by the Evaluator agent, obtaining a concrete value for the task.

The obtained results demonstrate that the organization based system contributed to the positive development of all enterprises. This development was reflected in the reduction of inefficient processes. The indicator used to determine the positive evolution of the companies was the state of each of the activities analysed. After analysing the company's activities, it was necessary to prove that the state of the activity (valued between 1 and 100) had increased beyond the state obtained in the previous four-month period. The system considered small changes in the tasks performed by the corporations, and all the experts that participated in the experiments considered four months as a significant time to evaluate the evolution of a company related to these changes. Figure 2 shows a global positive evolution of the different activities of the enterprise and a set of recommendations for each of the activities, consisting of suggestions that try to improve the efficiency of the activities. The proposed virtual organization of agents can be considered as a unique system, since it is useful for dynamic environments and open enough to be used in other enterprise environments, the subsidiary companies of the corporation shared results via the organization system, benefiting from this cooperation. The experts noted that the behaviour of the system improved as the number of cases in the case base grows.

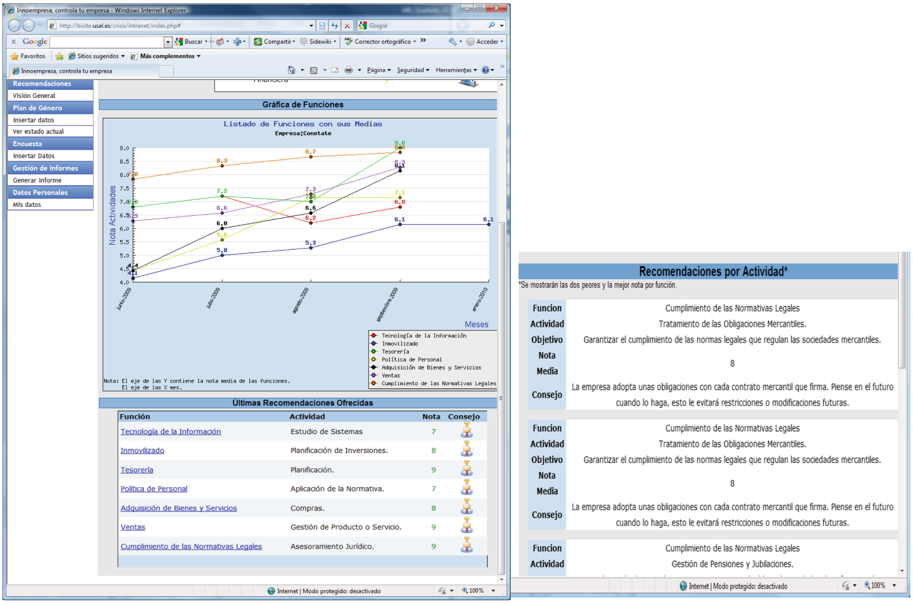

Fig. 2. Information on the global activities of a company provided by the evaluator agent and recommendations provided by the advisor agent.

The system facilitates the identification of company inefficiencies and establishes rational plans aimed at improving these processes. An average of 17 processes where identified by the virtual organization as risky situations and among them an average of 76% were successfully reconfigured with the help of the virtual agents with the four-month window stablished for it.

5 Conclusions

In conclusion, the use of innovative tools in business intelligence can help detect situations that involve potential risks and to get a better understanding of their internal functioning. This article presented a virtual organization based multi-agent system which models the behaviour of companies and provides a decision support tool, which helps prevent unfortunate events from occurring by analysing all the processes that compose each of the activities of a business. The proposed approach presents many advantages over other proposals as it incorporates innovative techniques for predicting risky situations and providing recommendations. Both strategies are based on the integration of intelligent BDI agents within CBR systems and multiple experts provide risk predictions. Moreover, the recommender system incorporates a new strategy based on the use of probabilistic gain functions of decision trees for the identification of inefficient tasks. The developed approach was implemented in several Companies (considering the particular problem/casuistic of each company within a large corporation). The case study demonstrated a high percentage of success as the performance of the participating companies improved. Additional work is still required to improve the adaptation of the CBR-BDI agents when the size of the memory of cases is very high and to learn from the cases with invalid solutions. Besides, it is necessary to increase the sample size by including more Companies in the experiments as well as explore different sets of samples. These are our next challenges.

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Crowdworking as a Knowledge Management Mechanism in the Elicitation of Missional Software Requirement

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Abstract. The search of mission critical software requirements for organization of medium or large sizes should be accompanied by a process that ensures that the scope will fully cover the needs of all areas of the organization. This can be achieved through the establishment of a work methodology that allows technical resources. These technical resources include analysts and stakeholders who will make unified decisions regarding the implementation of software requirements that fully address the total needs of the organization. These decisions also include aspects such as the technical assessment of requirement feasibility, identification of user expectations and analysis of the impact and risk at the time of implementation, which will enable stakeholders to make assertive decisions, oriented towards benefits for the organization.

Keywords: Crowdworking · Requirement elicitation · Gig economy Stakeholder · Freelancing

1 Introduction

Open collaborative work is an alternative to formal work imposed over the last decade, thanks to the rise of "gig economy"[1], an economic model characterized by hiring workers to perform small tasks in terms of time and effort, receiving a single payment for the task, without considering additional payment for social benefits or of any form [1].

The impact of this economic model is so great that according to upwork.com, part and full-time freelancers represent over 35% of the whole workforce in USA, projecting that by 2027, the number of freelancers will surpass that of formal employees [2]. This has led gig economy to have the potential of becoming the work modality of the future. Several work modalities have emerged around this trend, which do not imply a formal relationship. One of the most known is crowdsourcing[2], which has as a

[1] Gig economy. Retrieved from: https://dictionary.cambridge.org/es/diccionario/ingles/gig-economy
[2] Crowdsourcing (Verb.). In Thesaurus-Online dictionary. Retrieved from http://www.dictionary.com/browse/crowdsource

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strategy of retrieving resources of all types so that together they can solve a particular issue, considering their abilities, knowledge and skills.

From crowdsourcing comes crowdworking[3], which corresponds to the category where involved workers receive payment as a result of the execution of a specific task assigned, which is a part of a larger set of tasks oriented to a particular goal, through the integration of a large amount of geographically distributed people to complete complex limited-range, on-demand tasks [3].

Note that, the aim of crowdworking is to focus on the development of tasks that require mental processing and therefore is exclusively based on individual contributions. It leads to informal working conditions generating an outline where the work-labor completes the job, disregarding the benefits and stability of formal work, that is, no access to social security, holidays or sick-days, which would be covered by the very worker [4].

One of the sectors of the industry that has benefited most from the incorporation of crowdworking is software, given that it is one of the field with the highest number of professionals. These professionals offer the type of services as well as different skills, knowledge and experience that can be easily adapted to any type of project. This is why crowdworking is ideal for organizations whose business purpose are not relate to software development [5].

In many cases, medium or large organizations have problems regarding requirement elicitation processes, since it is possible that the needs stemming from the application of the same business process for multiple areas of the organization are not fully met because each area can have its own definition of execution procedure. Additionally, as part of the completion process in each area of the organization, several expectations may rise, which do not necessarily generate value to other areas, so it is necessary to outline them and make a collective decision on how to treat them.

This document is organized as follows: First, expectations of stakeholders regarding elicitation processes are described. Next, the characteristics of an efficient software requirement elicitation process are listed. Subsequently, the definitions for a preliminary diagnosis are included to determine how effective it is to carry out this strategy. Finally, the strategy for the implementation of crowdworking in the requirement elicitation processes for sensitive mission software is explained.

2 Some Key Differences Between Formal Work and Crowdworking

Formal work requires that the worker comply with a set schedule of a series of activities, which must be done to achieve the fulfillment of their goals and objectives. This leads to the worker adapting to specific work conditions, such as the work must be carried out in the facilities indicated by the contracting party, some roles and

[3] Crowdworking (Verb.). In Thesaurus-Online dictionary. Retrieved from http://www.dictionary.com/browse/crowdwork

responsibilities that are also assigned for this purpose. In return, the worker receives a basic salary plus the corresponding social benefits of law.

On the other hand, the crowdworker usually charges a single fee based on the estimated time the assigned task will last. In order to carry out his work, he does not have to travel to his client's facilities (unless he requires it, which almost never happens) and can do his work from anywhere while he has connectivity over the Internet. With respect to formal work, some of its main differences are:

- Crowdworker payment does not include healthcare and other benefits: Within the rate charged for their work, the crowdworker must proportionally include the value of the healthcare costs, since they have to assume them directly. The same goes for formal employment concepts such as paid vacations, a concept that does not exist for the crowdworker.
- Crowdworker's income level depends on their online reputation: On many different crowdworking platforms, one of the criteria for the selection of the crowdworker is the reputation formed and the comments of other customers about the quality of their work. This is different from formal employment where they have a weekly or monthly income.
- The crowdworker's workload: While in a formal job there are a set of work hours, in the case of the crowdworker the hours worked depend on what was agreed with the client, which implies that they can work at different times than the formal work (weekends, holidays, etc.).
- Crowdworker's experience can be greater than that of a formal worker: When interacting with different types of clients and projects, the crowdworkers tend to adapt better to the working needs and requirements much faster than the formal workers.

3 Stakeholders' Expectations in Requirement Elicitation

Requirement elicitation process is one of the most crucial stages in the process of software development as it seeks to capture, in a technical way, how one or several processes in the business are established. This is to know whether they need to be managed partially or completely by a software, through techniques that enable the extraction of relevant information from stakeholders. This process is key to translate user requirements from natural and business language to technical language, which can be absorbed by all participants involved in the process of software development.

As stated by Christel [6], there are three types of problems, which may arise during the process of requirement elicitation. The first problem is problems due to unavailability of scarce or extensive information. The second is understanding the problems, usually among requirement analysts, stakeholders and the development team. Finally, volatility problems, as there are requirements that may be modified on request from stakeholders after being initially approved [6]. The impact of the requirement elicitation process in software development is so great, that about 56% of identifiable flaws in the testing stage of software development are originated by incomplete, ambiguous or unhelpful definitions with respect to the information provided by the stakeholders [7].

Even when having a team of professionals who properly follow all stages in the software development process, it is possible that once the product is delivered to stakeholders, it is partially used or abandoned in a short period. According to a study conducted by The Standish Group, regarding the use of company software by stakeholders, it was identified that 45% of its options and functions were never used [8]. One of the reasons why this happens is because, for stakeholders, there are functions that are essential in the software, which are used for their regular activities. However, there are several other functions available in the application that emerged from the expectations that stakeholders had on the software.

In this process, the requirement analyst receives all the needs from the group of stakeholders, catalogues them by priority or impact in the application. Without differentiating in the requirement writing process, which functions identified correspond to real needs from stakeholders and which correspond to functions that add value to the software, but possibly these do not generate a meaningful contribution to the organization or may be the result of executing a function or set of functions several times [9].

Another aspect that influences the efficiency of the requirements elicitation process is that sometimes stakeholders selected to obtain information have a limited knowledge of the business process. Thereby hindering a complete extraction of business needs that will be described in the requirements, which can cause an experienced requirement analyst to use techniques such as observation to include functions whose scope may be limited with respect to what is expected by the stakeholders [6]. Likewise, it is possible that during the process of requirement elicitation, stakeholders will intentionally omit parts of the business process that would automate with future software, since they consider it would jeopardize their job or meaningfully affect the work form that stakeholders master without the need for a software. This therefore implies that stakeholders, in many occasions are not open to change in organizational culture, which allows them to assimilate the benefits of a software in the business process [9].

It is due to all of the above that we propose a strategy for requirement elicitation in medium and large organizations. Through which the organization is able to identify proper transversal requirements, thus reducing the possibility of being unable to apply them uniformly to all areas or units of the business. Also, at the same time establishing the different expectations on functions to validate and determine impact within the organization.

4 Efficiency of Software Requirement Elicitation Techniques

Discussing techniques for eliciting software requirements, there is a common tendency regarding the relevance that the requirement analyst acquires in the process. Their experience leads to the development of greater ability to define the needs received from stakeholders, through the different techniques of eliciting software requirements available.

As stated by Al-Zawahreh, there are four techniques that begin with traditional techniques, such as obtaining information from experts and stakeholders using interviews. They are collaborative techniques where both requirement analysts and stakeholders provide feedback on the generation of requirements through tools such as workshops, focus groups or brainstorming. Using cognitive techniques from the extraction of information found in company documents and observation techniques that can be used to infer the best way to automatize processes from observing daily work resources [10].

These techniques are usually implemented according to the characteristics of each project, namely, project complexity, requirement size or available budget. Likewise, the application of these techniques, according to Al-Zawahreh, is subjected to the situational characteristics of the project, such as experience of the requirement analyst, concept unification, conflict mitigation and language standardization among stakeholders, and requirement elicitation techniques approved by the organization, among others [10].

Much of the success of the process of eliciting software requirements lies on how close to reality (business needs) the requirements in the software can be represented. This is based on how reliable the sources providing requirement information are and how accurately can these needs and expectations be translated. Burnay states that, in order to achieve a high level of efficiency in the requirement elicitation process, it is necessary to identify how reliable stakeholders and engineers (requirement analysts, developers, architects, etc.) are. In order to achieve this, he identifies that factors such as experience, friendliness, empowerment, commitment, loyalty, receptivity, reciprocity, structure, culture, history and positive reputation lead to better results in the quality of software requirements [11].

5 Diagnosis Preliminary to the Implementation of the Strategy

For the implementation of the strategy, a diagnosis is required to identify whether the strategy can be properly applied to establish whether it is viable to continue or not. The following aspect must be considered for assessment:

- Complexity of requirements to be elicited: Usually, in organizations, the establishment of requirements that are transversal or that directly affect the purpose of the business, implies great complexity. In some cases, the different areas of the business ask for requirements for individual particularities, which create the necessity of analyzing if the cost/benefit ratio is positive for the whole organization
- Impact of the requirements to be elicited: If the requirement does not cover all business areas of the organization, it is preferable not to apply this type of elicitation strategy and rather return to some of the traditional techniques of elicitation. However, it can be applied if the present diagnosis identifies that all core processes for the business would be affected by the development of the present requirement.
- Mature, defined, socialized business processes: In order to perform efficient elicitation, it is necessary to include business processes from each of the areas or units that will be affected by the development of the requirement to be elicited. If business processes are not documented, it will be necessary, as a supplementary activity, to perform the description of current business processes (AS-IS), as well as business processes after requirement implementation (TO-BE).

- Knowledge and domain of staff involved in the business process: As these are missionary business processes within the organization, it is necessary to evaluate the personnel available. This is done with respect to seniority in the organization and business area where they work, current role, other roles which s/he has performed in the business area and involvement in other areas of the business, among others. This will enable the identification of potential contributions of the staff regarding complexities linked to standardizing business processes.

6 Strategy for the Elicitation of Missionary Sensitive Software Requirements for Medium and Large Organizations

When a requirement elicitation process is carried out, there are several techniques available for greater effectiveness and assimilation of needs to be implemented in the software.

The process of software development under crowdworking methodologies seeks that multitude of software developers contribute effectively, generating, distributing and coordinating tasks related to software life cycle. This process covers three stages (decomposition, coordination and quality), which significantly contribute to software development through crowds [12].

For the decomposition stage, it is necessary to identify all tasks required for the project and to determine how they can be minimally decomposed without affecting the completion of each activity. Likewise, it is necessary to establish the dependences in charge of the activities decomposed, in order to parallelize activity completion by crowd developers [12].

One of the most used mechanisms for decomposition is through artifacts, connecting the scope of each activity to a deliverable product, which represents the end of a specific development task. It is important to note that the size of the artifact must be related to the size of the task performed, and that the time invested in artifact documentation must be included when effort associated to the activity is defined [12]. However, one of the proposal closest to the requirement elicitation process by crowd workers is CrowdREquire, which would be a technological platform for linking requirements analysts through a scheme in which analysts' assignments can be controlled [13].

The reason why only medium and large organizations are considered for the application of this strategy is the large amount of resources required for implementation, as well as the complexity of requirements to be elicited. This strategy has four main stages which will be describe below:

6.1 Resource Selection

Given the importance of the implementation of this strategy regarding the procedure for future software, it is paramount to include resources that comply with specific characteristics so that their contribution is meaningful. These characteristics are:

Selection of Requirement Analysts. For this type of requirements, it is considered ideal that the analysts have wide experience in gathering information of preference from medium and large organizations. Currently, there is a great diversity of platforms for crowdworking, which handle resources specifically meant for software development projects in all stages, including requirement analysts. However, Burnay has provided a classification including additional factors that influence the selection of requirement analysts, which are [11]:

- Experience: If possible, it is advisable to select resources that have played a role in elicitation of requirement in previous projects in the organization. Successful experiences are not the only source of learning, which is why it is valuable including analysts who have participated in unsuccessful or complex projects.
- Reliability: Analyst reliability can be obtained from several sources; on one hand, through the score they have received in hiring platforms by other customers, which generates a reputation they must maintain in each of the projects they participate in, since future jobs depend on it. If the organization has undertaken projects of this sort, it is recommendable that it maintains contact with these analysts, to avoid crowdworking platforms in the hiring process.
- Commitment: Given that resources under crowdworking distribution are usually managed virtually and without formal affiliation, commitment by workers to solve client's requests in their terms is not always found. This is why, even if it generates an extra expense for additional "dedication" to the project, it is necessary to establish an agreement in which would-be analysts commit to pre-established results and goals.
- Availability: A freelance resource works, on average, for 4–5 clients a month [2], which in the case of a requirement analyst would imply the possible appearance of deficiencies in the acquisition of the information attained from clients, causing flawed requirements or loss of information. In this case, it is necessary to ensure that the resource can have a greater dedication to the project during the process of information acquisition from stakeholders, reducing the impact from other projects.

Selection of Stakeholders Involved in Requirement Elicitation. In order to select stakeholders who will be a part of the elicitation process, Burnay recommends bearing in mind the following factors [11]:

- Experience: More than considering seniority in the process of eliciting, it is recommendable that stakeholders involved know, in depth, the actual characteristics and needs of the process, so their contribution is valuable. Regardless of being in a managerial role, it is more important that the resource has the knowledge necessary to answer to the requirements from the analyst, taking into account all necessary aspects to be included in the software.
- Empowerment: Stakeholders selected must be leaders in their business processes, so they can make assertive decisions regarding possibilities that may arise during the process of requirement elicitation.
- Consistency: Decisions and determinations taken by a stakeholder who will be a part of the requirement elicitation process must be constant over time, to avoid redoing in the life cycle of software development.

- Receptivity: If, as a part of the elicitation process, new ideas surge as to how the business processes should operate to be more efficient, stakeholders must be receptive to any improvement in the current process.
- Recognition: stakeholders must be acknowledged by other members of the organization as the ideals to transmit their knowledge and expertise during the process of requirement elicitation.

Selection of Additional Resources for Requirement Elicitation. Essentially, for the process of requirement elicitation, there are additional roles required to support technical decision-making. Among the proposed resources to be involve are:

- Enterprise and/or integration Architect: Given the impact the requirement implementation will have in the software, it is recommended that the elicitation process include enterprise architects, in case the business process is affected and requires modification or redoing. If the development of new software requires an interconnection with applications pre-existing within the organization, integration architects are recommended.
- Software Architect/Technical Leader: In order to ensure viability of the implementation of the requirement, which has as a sole scope of the software to be implemented, it is recommended to incorporate a software architect and/or technical leader to validate the non-functional requirements of the system to be developed.

6.2 Initial Requirement Elicitation

Once the resources have been selected, they shall be distributed in two groups (preferably with the same number of members) formed by requirement analysts and stakeholders selected at random as follows:

- The first group will be in charge of the definition of initial requirements. In this phase, traditional elicitation techniques are used, such as interview, survey and observation, from which an initial documental version of the process should emerge.
- From the first version of the elicitation document, the second group has the function of validating and finding differences in the documentation, which will be formally notified to the first group through a document. These deficiencies are catalogued in the following types:
  - Completeness: The documentation containing all the information requested in the formats defined for that purpose.
  - Grammatical: Issues of writing and typing in the document.
  - Interpretation: Requirements or parts of requirements whose interpretation may contain ambiguities, flaws or missing information that may cause misunderstandings in the development process.
- The first group must correct all grammatical and syntactic deficiencies identified by the second group. However, deficiencies in interpretation that the first group considers to have been wrongfully identified must be discussed jointly in a focus group, which enables the establishment of points to be considered by each party and make a joint decision regarding each particular case. This meeting shall be referred to as

"elicitation war room", since all the decisions corresponding to requirements shall be resolved in this meeting, which cannot be concluded until every item in the agenda is resolved and the requirement documentation is approved.

6.3 Technical Feasibility Assessment on Business Needs and Expectation Identification

After the approval of requirement documentation by elicitation teams, the process of identification of business needs continues as follows:

- A team with technical experience made up of the managerial architect (if applicable), integration architect (if applicable), software architect and technical leader (if applicable) will validate, at a technical level, the feasibility of implementing requirements approved in the first stage.
- Because of this process, the technical feasibility of the implementation of business needs identified at the enterprise, integration and software levels will be evaluated, as the case may be.
- Identified expectations are documented as a part of the assessment process.
- If, as a result of validation, the team identifies that implementation of one or more requirements is not technically feasible, elicitation groups will be summoned to a "technical war room" to jointly discuss technical findings identified and making a decision about the continuity or not of said requirement, or what the parameters of its update should be. These jointly approved decisions must be updated in the requirement documentation.

6.4 Assessment on the Implementation of Expectations Identified by Stakeholders and the Technical Team

One of the most relevant aspects in the previous stage is expectation identification. If, as part of the process, expectations from the user are identified, the following steps should be followed:

- The technical team described in the previous stage must generate a report on the expectations identified in the technical assessment. This report must contain the possible implication of implementing functional and non-functional expectations in terms of cost, technicity, impact and risk, among others they consider to have implications in future software implementation.
- Summoning selected stakeholders once more and generating two random groups, which are preferably different from the ones in the elicitation process. The report is then handed to the teams so they can analyze and discuss internally and make a decision regarding the implementation or not of identified expectations.
- Once the report described in the previous stage has been completed, a new "technical war room" must be held, to discuss the implications addressed in the report.

7 Conclusions

Large organizations demand, more and more often, the incorporation of IT solutions that adapt to their needs. Given the variety of elicitation techniques that align the business needs and the expectations of the stakeholders, it is necessary to adopt a strategy that incorporates them and allows from the technical and business point of view to determine the feasibility of their implementation.

In many cases, stakeholders mistake, during the process of elicitation, what they actually need from the software with respect to what they expect from it, which in many cases leads to building software with a variety of functions which are never used, generating additional time and cost to the software development process. All of this occurs because the elicitation process does not use the appropriate techniques for requirements that are complex or transversal to the organization.

Because of this, it is necessary to establish a strategy that guides all actors in the process of requirement elicitation (stakeholders, requirement analysts, architects, among others) through a structured process that seeks to ensure technical, economical and operational viability of the requirements to be implemented.

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How to Manage Business in Collaborative Environment – A Case Study of Multinational Companies

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Abstract. The changes in contemporary management are oriented towards long-term sustainable solutions. By creating synergic effects between distinct cooperating organizational forms is a solution. In order to create a necessary condition for the synergy establishment it is important to harmonize all the processes within the strategy management, as well as the management decision making. One of the important findings of this study is the key role of company's human capital and particularities of its behavior deriving from top managers' behavior and spreading across the whole company. Subsequently, by creating internal synergy, company is able to collaborate successfully with outer environment.

Keywords: Collaboration · Strategic management · Synergy effect
Multi-party cooperation · Organization and management
Competitive advantage

1 Introduction

The initial analysis of the issues points out that the synergy effect derives from the synergy within the shared activities (interactions) which brings a certain added value, higher performance or incidental benefits, at a higher rate than by individual activities. In the business environment, various cooperative organizational forms are operating and able to ensure synergy by creating unique synergy effects. It is important to draw attention to strategic management: to organize groups of enterprises in a way that would enable the management to create deliberately synergy effects, increase the performance, profitability and competitive capacity of these groups. The success of such efforts would bring the synergy effects creation for all that are involved.

The problem lies in the inefficient application of the strategic management elements within the collaborating groups. As a result, the synergy effect is not created, i.e. bilateral collaboration within the arising synergy effects is not efficient. The findings of our research have been published in article. Its major outcome has been the definition of cooperation management as effective and efficient management of relationships in

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cooperation between separate and relatively independent organizations or individuals, with the goal of improving their competitiveness (Soviar et al. 2014).

Our goal is to provide case studies from multinational companies which analyze their main cooperation management processes based on synergy effects creation. Based on this analysis we set some recommendations about effective cooperation strategy management (synergy and knowledge based).

We see that the synergy effects in multinational companies' collaborative environment have significant relation with knowledge creation, its communication, as well as with knowledge management (as a complex approach). This collaboration/cooperation management is a comprehensive process. We see management principles of planning and reaching of synergies by effective collaboration as an integral part of knowledge management theory and praxis.

For this paper, we choose two major research methods: (a) content analysis of significant references and (b) case studies. We focused on references with strong content connection to the topic and based on the we have created the following case studies. Framework for analysis of case study is based on the following sequence: (1) Firstly, we have made a targeted selection of businesses that are competitive, financially stable and generating profits; (2) We have searched for and collected available data on selected businesses and their cooperative relationships. This was mainly strategic management data. (3) We evaluated the current strategic management of selected cases, and in the discussions, we generalized the appropriate elements of the strategic management of the cooperating transnational companies' cooperation environment in order to generate synergic effects.

2 Overview of Synergy

How to achieve high efficiency of the management of organizations? There are many factors influencing it. One of them is the synergy itself. Synergy has started to be investigated by researchers only recently. According to Haken (1978), synergy originates in physics and it is identified as a theory of new cooperative structures creation in non-equilibrium systems. Ivanička (1997) suggests that the synergy is a proof, that time, change, evolution and history are essential in inorganic, organic and social world. This leads us to the current understanding of synergy, the selection of the right tools for collaborative management, as well as to the knowledge management and the ability to know and to predict not only the changes in organization and strategy, the trends, global problems, digitisation, but also the requirements of evolution. Lasker et al. (2001) make connections between various authors' results and specify the features of the partnership that have impact on its ability to achieve high degree of synergy. They consider the synergy resources as building blocks. These are primarily financial and internal resources, e.g. funds, premises, equipment, material, skills and experience, information, networking with people and organisations, the power of belief, validity and credibility. They also characterize partners who use their own resources to obtain external funding and internal support, i.e. seeking and finding partners who can provide the necessary resources. Searching for how to achieve the synergy is not based on the number or diversity, but on the form of collaboration between partners and the definition and achievement of their corporate objectives.

Synergy is a connection and engagement in collaboration within the environment that is changing, evolving and responding as well. This connection is formed by the combination of the qualities of two or more mutually interacting elements.

Synergy effect is a value, both expected and unexpected result, a condition arising within a particular environment. It is not only a value, but an input and output substance of many actions and changes in the evolution.

According to various authors examining synergies (Corning 1995; Goold and Campbell 1998; Kaplan and Norton 2006; Vodáček and Vodáčková 2009, etc.), there is an important base established: synergy does not always occur as a positive and unified form, but it can be expressed in various divisions and results which, unlike the practice, may not be beneficial. The result of the collaboration of subsystems may be different from the sum of the results which can be reached by individual subsystems. The disparity in input into the collaboration is obvious in the business process involving subjective processes of measurement, evaluation and problem-solving. This process results in a conflict of interest and misconceptions (Damodaran 2005). According to Roll (1986), arrogance and vanity of management proves a major stumbling block to many collaborations, in which the businesses still estimates the result and the time.

If the organization needs to achieve synergy through their business and support units, the systems harmonization plays a crucial role. Enterprise knowledge cooperation network is established as an integration of knowledge nodes and cooperation connection links among those nodes. The nodes represent knowledge used in enterprise business process (Liu et al. 2014).

The accurate assessment of the advantages of organization's systems harmonization is enabled by the system of measurement and management based on the strategy maps and BSC systems. (Kaplan and Norton 2006) Ivanička (1997) also points out the business' harmonization in which new structures are not derived only from previous systems structures, but primarily from the interactions between the systems and the environment. From this point of view, synergy derives from the functioning of the individual businesses within their environment and it only harmonizes their influence on the synergy effects creation. Systematic thinking of strategic management in the dynamic environment requires appropriate combination of control elements. From the point of view of the current research, these elements represent potential model elements of strategic management. Identified elements have strong impact on the expansion of partnerships within collaborative organizational forms. It is also necessary to point out the strategy. The enterprise must have prepared strategic alternatives, possibilities, ways and features of management which it is able to control and apply in the business management. This is confirmed by Idenburg (1993) who emphasizes that strategy consists of certain points and rules selected and applied by a manager, some of which may prove to be useful while others not. Mintzberg (1999) supports the view in which strategy is considered as a pattern for decision making in the enterprise and it determines and reveals the vision and the objectives, both main and supporting. Strategic decisions efficiency influences the enterprise in various ways and affects input and output balance. In practice, strategic management of collaborative organizational forms is supposed to be built on these bases: (a) Building solid collaborative relationships based on trust; (b) Support knowledge management within transfer of knowledge and skills (Howlett et al. 2013); (c) Partners should be selected on the basis of expertise and cultural adaptability – appropriateness (Elmuti and Kathawala 2001); (d) Essential error is set in misunderstandings and problem situations – seeking out solutions (Ariño and Doz 1999).

3 Case Study – External Analysis of Key Aspects Based on Synergy Influencing Business

The selected companies are: DuPont, Ingersoll-Rand and IBM. They all have been active on the market for a long time and, despite the difficulties encountered, they have been one of the best companies in their respective fields. These enterprises represent interconnected collaborative groups of units. From the financial indicators published by nasdaq.com between 2010 and 2017 it is possible to determine the positive net income and increasing number of employees. Selected companies generated profit every year despite the decline in sales. However, if we look at the EPS growth, we can see an increase in EPS for investors, which has a positive influence on building new investment ties and relationships. These businesses are also characterized by their high value on the stock market and strong market capitalisation.

DuPont have been operating on the market for more than 200 years, since 1802. They operate in more than 90 countries and represent a broad portfolio of innovative products, materials and services. Partnerships they have established over this period with other subjects on the market, e.g. customers, governments, NGOs, represent their major asset. DuPont present them as an enterprise that responds to global challenges, whether it is the population growth and food availability, the reduction of dependence on fossil fuels or the environment protection. Their definite core values are: safety and health, environmental stewardship, respect for people and highest ethical behaviour (DuPont Code of Conduct).

Ingersoll Rand has been operating on the market since 1871. Their portfolio presents innovative products and services provided to customers around the world, meeting need for clean and comfortable air, safe and fresh food, energy efficiency, and sustainable business practices. In all their business practices, they are steadfast in their commitment to integrity. They seek to create a positive impact on societies throughout the world. The company puts emphasis on the values such as integrity, respect, teamwork, innovation and courage.

IBM was set up in 1911 as the Computing-Tabulating-Recording (CTR) Company. The company deals with the information technology and their connection to people's needs, e.g. production and sales of computer software and hardware and related services. Its current focus is on cloud-based solutions and the artificial intelligence. They operate all around the world, in more than 170 countries. The company is based on values such as dedication to every client´s success, innovation that matters – for the company and the world, trust and personal responsibility in all relationships.

Data we used for our research of the selected companies is from currently available secondary data including annual reports from 2016, journals, actual statistical data and statements of the employees. Recently, the companies faced internal changes.

In the dynamics of the current globalised environment, the enterprises try to find different ways to increase their chances for success. The research on synergy effects in the business environment brings one of the future strategies in those difficult conditions. Strategic management successfully applied in a collaborative environment can create the synergy effects. The decision on the selection of research subjects was based on their common characteristics: (1) Multiple relationships and interactions with stakeholders; (2) Multigenerational activity in the context of changing market conditions; (3) Positive economic results and growth in financial indicators.

These also represented main problem areas in the selected companies. There is often a problem with sharing the information setting up of a mutually beneficial communication between collaborating companies or departments. On the other hand, the companies′ culture must adapt to changes by harmonizing with the culture of collaborating companies, as well as by adopting flexible working hours and by linking the personal and corporate goals and values with motivation and remuneration at the level of career growth. These are the reasons why it is important to connect findings of several theoretical and practical analyses of the collaborative environment and to contribute to a more precise identification of the strategic management of companies.

DuPont, Inc.

DuPont harmonized the internal processes to achieve their financial targets for sales growth and cost reduction through the adjustment of the internal environment, i.e. employees and managers. The strategic business areas emphasized primary aims of the organization: perfect running of the enterprise, supplies and services, management of the portfolio of products and applications, customer care management and new business plans. All departments - strategic business units (Kaplan, Norton: Alignment 2006) based their strategy on the previous five topics which created opportunities to achieve synergy effects between the business units, although only a few of them were expected to focus on all the five areas. A problem occurred in the way how each unit could contribute to these areas at the division level, and what should the cooperation and integration between the units look like to create synergy between them.

The solution is to be directed to the management and controlling of these units. We can consider the management of this big organisation based on its employees' testimony. The database Indeed contains 701 reviews of the organisation, 139 of them being about the management. When analysing these statements, the work environment varies across divisions and depends mainly on the management (management practices, responsibility division, workload, remuneration conditions), the working environment consisting in the staff and management, and the time of operating on the market (foundation of the unit or department, management and staff hiring). Overall, the management assessment is positive however there are some downsides according to the reviewers: weak management divisions (lack of experience, focus on stakeholders more than on employees), the unwillingness to accept new ideas, the lack of respect, a higher workload (Indeed 2017).

DuPont's internal environment indicates the need of synergy, especially in the process of safety culture and operational discipline, for which it has created a training schedule with the engagement that every employee will perform every role always in the right way. (Lutchman 2013) The awareness of collaboration of external and internal environment of individual units is the collaboration between DuPont and Dow Chemical which brought saving in cost of more than 3 bil. $. Synergy represents the exceeding of the stated objective of 1 bil. $ (Bromels 2016).

DuPont's initial strategic initiative has led to the implementation of multiphase reform plan based on the collaboration and reliable supply chains. Due to this change, in the first place DuPont created a global worldwide manufacturing contract, named Center of Competency (CoC), which should have implemented and controlled the changes in all business units. It has currently many such manufacturing contracts, e.g. Finished Product Purchase for Resale, Tolling, and Custom Raw Materials. These contracts include several internal stakeholders, mainly leading positions and business leaders. Secondly, it began to apply business risk evaluation (process management, safety, supply responsibility, quality, investment, etc.), and their identification has helped to improve individual activities and purchases. Thirdly, it was necessary to define standards for the establishment of new connections and the control of the existing ones. These standards helped to carry out more thorough critical evaluation of every supplier (partner) and to encourage creation of new agreements. Fourthly, DuPont established the verification of standards achievement by DuPont Internal Audit team which visited the company's branches in every region to carry out audits. Their aim was to help the collaborating partner branches to understand the established standards and give them coaching and to enhance their knowledge and skills. Finally, the Coca implemented Capacity Building program which focused on the Development of tools, processes and systems that would help the DuPont's employees to successfully manage relationships. By these steps DuPont has achieved the creation of a system for establishing, managing and maintaining partner relationships, the reduction of business risk and the establishment of uniform standards for world-wide teams (Arraiza-Monteux 2013; Poe 2017).

Ingersoll-Rand

How to create a new integration between the units? The promotion of integration was supposed to enable the company to employ the sales channels usefully, to promote the products more effectively, to employ the customer base, as well as the people's knowledge and experience more effectively. It consists in synergy in the form of the process of strategy implementation and processes harmonization within an organizational unit in accord with the entire company. System harmonization of activities takes place based on internal communication on efficiency between the employees, managers and strategic operational units. Ingersoll-Rand clearly established its identity and focused its strategic operational units on common themes – integration, culture and success. It set essential procedural topics: operational excellence (environment, technologies, and safety), customer's knowledge with the view of sales growth (marketing programs, market targeting), products innovation. An important step in the unification was the need to change the organizational structure. The company had introduced a new structure and divided the independent product groups into four global sectors.

These sectors should have ensured greater focus on the market, the sales channel sharing and the provision of cross-selling. The operating units are supposed to strive for creating a new value for customers, by solving their problems. The company had not only managed to create synergy and save costs, but also achieved 96% of supplies reliability (Stephens 2017).

Ingersoll-Rand focused on the impact of the strategy in the human resources area in the following areas: focus on leadership, teamwork-oriented culture and increased economic efficiency enabled by better management (Kaplan and Norton 2006).

The Human resources department creates the value which largely contributes to the results of the company. The whole company acquisition, as well as its value, is produced by means of its managers and employees. Ingersoll's Employee Value Proposition (AVP) creates greater value than just salary and benefits for an employee. There are five specific categories included: earn, save, live, grow and thrive, which relate to advanced education and training of staff for their current or future position (Bolland et al. 2017). Ingersoll Rand Employee Resource Groups – provide employees with opportunities to cooperate on new products, customer satisfaction, market needs, and support of employees' engagement, knowledge sharing and appreciation of diversity (Lamach 2017). High-performance culture development is supported by the unification of proceeding and the development of key competences of the employees and managers. These competences enable making distinction between an average and a competitive performance (Carter 2013).

The effort of harmonization of the employees' thinking with the company is demonstrated in internal energy audits which has brought energy costs savings. This audit is carried out by the staff volunteers with the necessary experience, who are part of an Expanded Energy Audit team (U.S. Department of Energy 2010). The strategic objective is to make material management one of the key competences of every employee, to standardize the best procedures for individual departments and to achieve improvement in the key performance indicators, e.g. supplies, stocks turnover (Stephens 2017). Synergy is created by teamwork within the organizational structure and the business management. The employees should create value together.

Managers are responsible foe number of activities, from the cost optimisation, goals achievement and plans implementation, through maintaining relationships with stakeholders, to staff management and evaluation (Career Builder 2017). The company has created the six leadership competencies which are evaluated according to the success in the development of the seven competences of the employees. Therefore, it in necessary not only to manage the staff but also to be in contact with them, to coach them and to develop their potential (Carter 2013). Responsibility is not placed only on the managers' activities, but it is also considered as a collective responsibility for the whole company performance and leadership towards success. Together they create strategic initiatives, communicate, take care of the talents and diversity, as mentors they help to train future mentors (Kaplan and Norton 2006).

The results of the synergy aiming mainly at the organizational structure and human resources of the company are: the significant increase in profit, the higher cumulative value of the company, the operating margin growth and the revenue stabilisation.

IBM

The success of IBM has been based on the company's clear vision, the acquisition of the skills needed for business and the profit-driven economic model (Bower 2012). IBM's basic strategy is to offer complete solutions tailored to customer needs. Management has defined the values in leadership and of creation of the collaborative organizational culture which is global. In this set of strategy and values, there were three principles established to maintain it when making decisions across the organization (George 2012). IBM's survival and competitiveness are based on several essential activities: quick adaptability to change, understanding of customer requirements in advance, satisfying them sooner than the competitors, large investment into the satisfaction of employees who oversee customer satisfaction and return, preservation of core values of company (Koehn 2011).

Integration of the strategic themes within a decentralized system of strategic operating units in various geographical areas was IBM's problem area. It was necessary to find a suitable organizational structure, to adapt to the market, to coordinate various large companies and their product lines. The solution is in the implementation of BSC, which is a mechanism of setting common objectives, and enables collaboration of various organizational units towards completing a specific mission (Kaplan and Norton 2006). IBM needed leaders, who would be sensitive to changes, would help to change the culture and would be able to connect with the company and its strategy. These top-level leaders form IBM's high-performance culture. They see the customer not only as a traditional buyer, but as a client – as someone they establish long-term relationship with and as a personal investment. Together they create mutual influence to deal with problems (Tickler 2004). The business value of IBM's solutions focuses on three essential areas: visibility (clearer view of business operations), collaboration (support of cross-functional and cross-divisional outcomes), management (business operations are managed regarding the company's strategic objectives) (Ticknor 2016). System harmonization at IBM is actively controlled as a constantly ongoing process.

Companies in the field of strategic management have been able to achieve positive changes in the areas of human resources, culture and organizational structure reform. The same areas represent the strengths of the management of the business and its affiliates. The interesting thing is to see how the weaknesses in the past have been transformed into the strongest areas. As we can see, these big companies with more than 45,000 employees are able to apply the management based on success not only for profit, but also for the satisfaction of their employees and customers.

4 Recommendations for Strategic Management

Multinational companies with a lot of links with stakeholders (suppliers, customers, investors, and others) create a diverse global environment. The starting point of our research is based on the situation in which the companies control their strategic operating units with the aim of generating profit. The focus on strategic management of business units is crucial for the sustainability of collaboration and competitiveness at global level. It is necessary to determine the strategic steps for the successful management of the collaboration emerging between several business units and to know the elements influencing this collaborative environment. In the last few years, we have investigated several Slovak companies, in which the qualitative and quantitative research (interviews and surveys) has been carried out in the field of collaborative management. This extensive research has pointed out to us many important outputs and directions to follow for the business management in the global environment. The main bases are two statements:

1. The objective of collaboration is the business development, the increase in its competitiveness and attractiveness in the market.
2. The efficient collaboration requires the establishment and maintenance of strategic management processes.

Awareness of the companies involved in our research has a positive direction, i.e. good collaborative potential for establishing and maintaining new relationships. Connections have been made between the results by observing their performance in the functions of management and from the information published by other observers or actors in the field. This method of observation is based on a comprehensive induction from secondary sources of information. For the purposes of strategic management within the collaboration of multinational companies with the objective of synergy effects creation, following areas have been identified:

(1) **A clear vision and the values of the company**, in which the strategy and the key competences create its growth potential, are confirmed especially by DuPont and IBM. Kaplan and Norton have also emphasized the strategic areas and objectives of the company, which aim to apply the tools for processes improvement; management of portfolio of products and applications; making difference for customers and customers management. DuPont has opted for formal rules in the form of contractual relationship, which has enabled it to support changes in the management of production and of supplier-customer relations. The establishment of the collaborative organisational structure that supports the integration of individuals (teamwork), as well as the individual operational units (departments). Such integration within the organisational structure contributes to the growth of processes effectiveness, e.g. production, sales, expansion of the customer base and the sharing of people's knowledge and experience. For Ingersoll-Rand and IBM there were two main factors: (1) Organisational structure supporting the harmonisation of diverse environment; (2) Appointment of leaders – managers able to support the harmonization of the culture towards the common strategic objectives.

(2) **The development of the unified corporate culture.** The features of the culture in the investigated environments were: unification of behaviour, strengthening of the key competences of the employees and managers, orientation to team work and an emphasis on staff management. Kaplan and Norton emphasised the importance of the knowledge and experience of both the employees and the executives for

enhancing the performance and increasing the value. In the environment created by Ingersoll-Rand and IBM, there are leaders who create a long-term relationship with their partners and consider it not only as business but as a personal investment. These leaders can implement the adopted strategy with respect to the company's values.

(3) **Human capital management.** The enterprise, as well as the managers are supposed to create a work environment based on: (a) Staff education and training for fulfilment of their current and future tasks; (b) Sharing of the responsibility for the assignments; (c) Providing the motivation; (d) Use appropriate management practices. This environment is particularly important for the companies Ingersoll-Rand and IBM, as it provides them with a competitive advantage. It is important to create a relationship management system – to manage successfully the interactions with partners, who the staff are in contact with. It is necessary not only to manage the staff, but to be in contact with them, to provide them with coaching and to develop their potential. Also determining the principles of decision-making in the whole organisation facilitates open communication and reduces the risk of misunderstanding in the management of reform. According to Kaplan and Norton, the company's value is created by means of the strategic management.

(4) **Setting standards for establishment and management of new relations.** This element is clearly identified in each of the three selected companies: DuPont, Ingersoll-Rand and IBM. The standards are focused on the improvement in collaboration between the actors involved and on making fair new contracts, etc. Managers are usually in charge of business contacts, whereas the staff oversees the relationships with customers and producers. However, the standards need to be set to provide the staff with the guidance in establishing and maintaining new business relationships. A profound knowledge of customers (marketing programs, communication and targeting) is crucial for the establishment and maintaining of new relations, not only to meet the expectations but also to maintain the relationship in the future. According to Kaplan and Norton, a Relationship manager, responsible for system harmonization of a relationship, i.e. relationship management, contributes to an efficient process of business system harmonization.

(5) **Controlling of processes and outcomes of all actors involved.** In a company, it is necessary to evaluate the business risks in purchase, safety, quality, investments and other areas. Another way is to carry out audits, i.e. to investigate standards achievement, in a company. Audits made in DuPont and Ingersoll-Rand enabled the staff to keep control over the processes in the companies, which contributed to an increase in the degree of interdependence with the company. They have implemented internal communication about strategic performance that has led to stronger linkages between operational units and the organisation. Kaplan and Norton pointed at the ability to recognize these deviations and their causes and to adopt some corrective measures. This process has been linked to the process of learning of the controlling tools by the individual employees and the company.

5 Conclusion

Business management has currently undergone multiple changes. Many companies struggle to make profit and to survive at the market. Strategic management in the collaborative business environment is an environment suitable for investigation of the issue. Comparison of the performance, internal management processes and decisions with their outcomes and the impact on the individual collaborative interactions is very complex process. To achieve the synergy by means of strategic or knowledge management it is necessary to address the problem areas of the strategic management of collaborating businesses and their units. The comparison of the findings led us to the following recommendations:

– At the beginning of the cooperative relationship, it is necessary to clearly define goals and vision.
– The course of cooperation should encourage the emergence of a collaborative organizational structure. It is also necessary to build a unified culture of cooperative relationship, in the sense of common rules and communication.
– Human capital is designed to achieve results that are linked to common learning, agile management, and the application of appropriate management techniques.
– Updating management within the framework of cooperative relations relates to the continuous improvement of cooperation with business environment actors.
– Every cooperative relationship needs to be continuously checked.

It has been confirmed that the specific areas of strategic management of the selected companies have later become their strengths and have enabled them to achieve synergy effects, e.g. the operating margin growth, the increase in profit, the higher cumulative value of the company, the costs savings, the adaptability to changes, the customer satisfaction and return and new relationships. Although the human capital is acting as a significant element of strategic management, further research of its impact on the business results is required.

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Drug-Related Crimes and Control in Indonesia and Taiwan: Cooperation Regarding Narcotics Smuggling Prevention and Countermeasures from the Point of View of International Law

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Abstract. Narcotic-related crime is one of the classic crimes that, even at present, are difficult to tackle. Almost all countries in the world are affected by the problem of narcotics, and the seriousness of this problem is judged in terms of the number of users and the amount of smuggled narcotics. This paper discusses the steps taken by the Indonesian government under the leadership of President Joko Widodo in preventing and tackling narcotic crimes and an effective model of cooperation between Indonesia and Taiwan in preventing and overcoming narcotic crimes. This research uses the normative research type and the qualitative research method. The results show that under the leadership of President Joko Widodo, the war against narcotics is being intensively implemented. All law enforcers have maximized the implementation of the Law of the Republic of Indonesia Number 35 Year 2009, which prescribes severe penalties for narcotics dealers, ranging from execution of drug dealers to shooting of drug traffickers who resist arrest. Indonesia and Taiwan have done their best to combat narcotics through national policies and the impressive efforts of their law enforcement agencies. Based on this, the authors recommend that the Taiwanese and Indonesian governments must ensure consistency in fighting narcotic crimes. The ongoing smuggling of narcotics, which is a problem that affects both countries, does not mean that the efforts made during this time have failed. However, an effective strategy is needed to prevent narcotic crimes in both countries.

Keywords: Model · Prevention and countermeasures · Narcotics
Indonesia · Taiwan

1 Introduction

The current era of globalization provides considerable opportunities for anyone, including governments, to undertake various forms of cooperation in any field. The cooperation could be between agencies of two states (bilateral), three states (trilateral), or many states (multilateral). The rapid development of science and technology leads to more efficient information flow, which makes drug circulation easier. Hence, states

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should be prepared to adapt to these changes in order confront the problem of drug trafficking. Taiwan and Indonesia are also affected by these issues.

Currently, narcotics smuggling has become a national issue in every state. The large quantity of narcotics in circulation in a state, including those that are produced domestically (national scale) as well as those smuggled from outside the country (transnational scale), raises concern for the state. Citizens become vulnerable and may become trapped by narcotics addiction, especially young people, who make up the next generation.

At the time of its development, around 2000 BC, narcotics were used for ritual ceremonies and for treatment purpose. The first narcotic that was used was opium, commonly referred to as madat. Opium trade is growing rapidly in Egypt, Greece and some regions of the Middle East, Asia and South Africa. As a result of colonialism, the opium trade grew tremendously, especially in the colonies of the time, including Indonesia, which was under the rule of the Dutch colonial administration. Also, the use of opium by ethnic Chinese/Tionghoa became massive (the Presidential Decree of the Republic of Indonesia Number 12 Year 2014 on the Substitution of the Chinese Terms to be Tionghoa or Tiongkok, on March 14, 2014) [1].

The population of Indonesia is very large, exceeding 200 million, and this makes Indonesia a target of illicit drug trafficking. Initially, Indonesia was only a destination of drug trafficking, because of its strategic location. But gradually, the illegal drug dealers began to make Indonesia an easy place to distribute their drugs. As time went on, Indonesia began to transform from a place of drug distribution to a place of drug production, as evidenced by the discovery of several drug laboratories in Indonesia. This issue is certainly a very serious problem that could eventually lead to a breach of national security and order [2].

In terms of age, narcotics are used not only by teenagers but also by middle-aged and old people; even children are not spared from the use of narcotics. The use of narcotics has spread not only in big cities but has also penetrated small towns and sub-districts, even villages [3].

Indonesia is one of the most addicted states to narcotics. Almost all professions are affected by narcotics addiction, including judges [4], prosecutors [5], teachers [6], artists [7], members of the People's Legislative Assembly [8], regents (head of a regency) [9], students and Professors [10]. Recently, (September 15, 2017) 13 police officers became addicted to narcotics and one became a narcotics dealer [11]. Based on the report of the Minister of State Apparatus Empowerment and Bureaucratic Reform of the Republic of Indonesia [12], 15 percent of Civil Servants were involved in narcotics abuse cases in 2016. This is astonishing, because Indonesia is a state that is famous for its religious and cultural beliefs, but its inhabitants are addicted to narcotics.

The use of narcotics for purposes other than treatment or science development is increasing rapidly, because of the enormous profits gained by illegally trading narcotics into various countries [13]. Narcotics should be used for the benefit of mankind, especially for treatment and health services. On the medical side, narcotics are widely used in the process of inducing anesthesia before a patient is operated, since narcotics containe substances that can affect the feelings, thoughts, and awareness of patients [14].

The Deputy of Eradication of the National Narcotics Agency of the Republic of Indonesia asserted that there were three routes of entry from Taiwan to Indonesia; this is related to the raiding of 284.3-kg of shabu from a warehouse in Pluit, Penjaringan, North Jakarta, on Wednesday, July 26, 2017. During the raid, two suspects who are Indonesia citizens, with 'S' and 'AD' initials, were arrested, while a suspect who was a Taiwanese citizen, with 'KHH' initials, was shot dead by officers of the National Narcotics Agency of the Republic of Indonesia [15]. Also, it was found that 66 new drugs have entered Indonesia, one of them coming from the Taiwanese network [16]. Based on these facts, this paper discusses the steps taken by the government of Indonesia under the leadership of President Joko Widodo in preventing and overcoming narcotic crimes as well as effective models of cooperation between Indonesia and Taiwan in preventing and overcoming narcotic crimes. This research is done because narcotics is a new method to destroy the generation of the nation. The number of phenomenon of narcotics smuggling from Taiwan to Indonesia, a strong reason why we choose the two countries as research sites. This research is in line with one of the research topics in KMO namely Case Studies and best practices.

2 Literature Review

2.1 Research Accomplished

Muhamad [17] in his research reveals that the large and lucrative drug market in Indonesia causes international syndicates to make efforts to smuggle drugs into Indonesia. However, Aditya [18] states that the level of drug crimes in Indonesia continues to increase from year to year; the types of drugs continue to vary, and the modus operandi is changing. Indonesia has become the target country of international drug syndicates.

Research by Puspitosari [2] indicates that the advances in communication and transportation technologies make drug circulation easier. Transactions can be made through packaged internet media, so sellers and buyers can avoid the risk of meeting face-to-face, which can be easily detected by the police. In addition, smuggled drugs are packed in various ways to fool security officers. The major reason why Indonesia experiences the crisis of drug distribution is the fact that 60–70% of narcotics circulating in Indonesia come from abroad; only 30–40% of narcotics originate locally, mainly marijuana. This means that Indonesia has indeed lost control, which makes it easier for foreign countries to export such drugs.

Anggraini [19] explains that the misapplication of narcotics and dangerous drugs is a phenomenon that has long existed and is experienced by all countries in the world. This misapplication is basically involved in transnational crimes, given the chain of activities, such as misuse of narcotics and dangerous drugs as well as trading and production activities. Transnational crime requires proper planning and organization. Southeast Asia is one of the areas that have high levels of misapplication of narcotics and dangerous drugs in the world, and the region is the second largest producer of opium in the world. Misapplication of narcotics and dangerous drugs in Southeast Asia raises potential threats that impact on the security of a country, given that this phenomenon is a transnational crime.

2.2 The Theory of Crime Prevention and Countermeasures

In general, the theory comes from laws, books/scientific papers, and research reports [20]. Lopa [21] explained that efforts in tackling crime can be implemented in some integrated steps, including repressive and preventive measures. Crime prevention efforts can be implemented using criminal policy theory. The theory of criminal policy is divided into two aspects: (1) Penal Policies: Crime prevention by penal policies lays more emphasis on repression (oppression/eradication/crackdown) after the crime has occurred [22]. This policy pays attention and leads to the achievement of the goals of social policy in the form of social welfare and social defence [23]. This is related to the view of Jeremy Bentham, who argues that the purpose of punishment is to prevent the occurrence of similar crimes, since it has a deterrent effect on the perpetrators and other individuals [24]. (2) Non-penal policies: crime prevention with non-penal policies focus more on prevention (deterrence/control) before the crime occurs [22].

The prevention of empirical crime can be achieved by three main efforts: (1) Pre-emptive efforts: they are the initial efforts made by the police to prevent the occurrence of crime. (2) Preventive efforts: they are the follow-up to pre-emptive efforts and are still in the level of prevention before the crime. It is emphasized that preventive effort eliminates the opportunity for a crime. (3) Repressive efforts: they are attempts made after a crime has occurred, involving cracking down on the perpetrators in accordance with their actions and making them realize that their actions are unlawful and harmful to the public; the heavy sanctions deter perpetrators and others from repeating the crimes [25].

2.3 What Is Responsible for the Worsening Drug Problem: Bad Strategy or Draconian Laws?

According to World Health Organization (WHO), drug is any substance which if introduced into a living organism will change one or more functions of the organism. Substances such as opioids (morphine, heroin), cocaine, marijuana, sedatives/hypnotics and alcohol have such effects, especially causing changes in the functions of thinking, feeling and behavior of the person who uses them. Drug abuse is the use of these substances, in small or large doses, for recreational purpose rather than medical purpose; drug abuse can cause dependence (drug dependence) [26]. This knowledge is commonly used by almost all countries in their domestic narcotic laws.

According to Budi Waseso (Head of the National Narcotics Agency of the Republic of Indonesia), the number of drug users in Indonesia by November 2015 had reached 5.9 million people, and about 3 tons of shabu had been seized. It is shocking that every day 30–40 people die from drugs [27]. In Taiwan, Taiwanese media periodically release articles about the growing population of drug users and the Taiwanese government's actions, as many of its Asian neighbors have harsh laws regarding drug use and trafficking. According to the National Police Agency, nearly half of the total prison population (46.3%) were serving sentences related to drugs in 2014 [28]. This is very confusing, because there is a progressive strategy for the war against narcotics in the country, but narcotic crimes are increasing both in terms of the number of cases and users.

3 Research Methods

In this study, the authors used the normative research type [29] and the qualitative research method, which (in general) generates words rather than numbers as data for analysis [30] and seeks answers to a question [31]. The approach used is observation and interpretation [32], which makes these phenomena observable [33], equipped with in-depth interviews [34] of the relevant parties to this study. This paper provides information on the latest trend in research [35].

4 Results and Discussion

4.1 Narcotics Prevention and Countermeasures Under the Leadership of President Joko Widodo

The problem posed by the abuse of narcotics is getting worse. Narcotics abuse has become a national and even an international issue, because the impact has been widespread throughout many countries. Nationally, narcotics trafficking has spread into every layer of society, from the upper class to the lower class of the society [36]. So, a strong law is needed to combat it, because human interest is involved [37]. According to Tadjbakhsh and Chenoy [38], there are several threats to human security, namely uncontrolled population growth, disparities in economic opportunities, the pressure of population migration, environmental degradation, illicit drug trafficking and international terrorism.

The drug trafficking situation in Indonesia is a sort of contradiction. Indonesian drug laws are among the strictest in Southeast Asia, yet the use of illegal drugs is relatively high in some parts of the country. Indonesia's war on drugs is somewhat compromised by the country's size and island geography. The Indonesian Anti-Narcotics Agency (BNN) does not have enough resources to monitor the country's endless miles of coastline, through which marijuana, ecstasy, meth, and heroin manage to slip through with regularity. This should not be taken as a green light to indulge, though. The Indonesian authorities are ready to make an example of foreigners who use illegal drugs in their jurisdiction. The law permits some accused drug users to be sentenced to rehabilitation instead of prison time. Article 128 of Indonesian Law No. 35 Year 2009 allows underage users (those under 17 years of age) to be sentenced to rehabilitation instead. A 2010 ruling (offsite) issued by the Indonesian Supreme Court lays down the rules by which rehabilitation may be chosen instead of prison, including a maximum amount of drugs in each group that need to have been found on the user at the time of the arrest. Should a death sentence be imposed, prisoners are allowed to appeal to the district High Court, then the Supreme Court. Otherwise, a death row prisoner may appeal to the President of Indonesia for clemency [39]. The

United Nations Office on Drugs and Crime (UNODC) focuses on assisting Member States to implement evidence-based policies and programs [40].

Penalties for Drug Use in Indonesia: Under Indonesian Law No. 35 Year 2009, the controlled substances list is divided into three different groups. Chapter XV of the 2009 law lays down the penalties for each group, while the Appendix lists all the drugs that fall into each group. Possession and trafficking of all the drugs listed in the Appendix are illegal, unless undertaken by people or companies approved by the government. The drugs are divided into 3 groups as follows [39]:

Group 1: Drugs that are viewed by the Indonesian government as therapeutically useless with a high potential for causing addiction belong to this group. Group 1 drugs merit the weightiest sentences, life imprisonment for possession and the death penalty for convicted drug traffickers. Possession is punishable by 4 to 12 years imprisonment and fines of IDR 800 million to 8 billion. If the drugs exceed 1 kg for raw drugs, like marijuana, or 5 grams for processed drugs, like heroin and cocaine, a maximum punishment of life imprisonment may be imposed. Trafficking is punishable by 5 to 15 years imprisonment and fines of IDR one billion to ten billion. If the quantity of drugs exceeds 1 kg for raw drugs or 5 grams for processed drugs, the death penalty may be imposed. Drugs in Group 1 include but are not limited to the following: heroin, cocaine, marijuana, hashish, mescaline, MDMA (ecstasy), psilocybin, LSD, amphetamine, methamphetamine, opium and its derivatives.

Group 2: Drugs that are seen by the law as useful for therapeutic purposes but dangerous due to their high addictive potential belong to this group. Possession is punishable by 3 to 10 years imprisonment and a fine of IDR 600 million to 5 billion. If the quantity of drugs exceeds 5 grams, 5 to 15 years imprisonment may result. Trafficking is punishable by 4 to 12 years imprisonment and fines of IDR 800 million to eight billion. If the quantity of drugs exceeds 5 grams, the death penalty may be imposed. A partial list of drugs in Group 2 is as follows: morphine, methadone, oxycodone, pethidine and hydromorphone.

Group 3: Drugs that are seen as therapeutically useful and moderately addictive, but not to the same degree as the drugs in Group 1 or 2, belong to this group. Possession is punishable by 2 to 7 years imprisonment and a fine of IDR 400 million to 3 billion. If the quantity of drugs exceeds 5 grams, 3 to 10 years imprisonment may result. Trafficking is punishable by 3 to 10 years imprisonment and fines of IDR 600 million to five billion. If the quantity of drugs exceeds 5 grams, imprisonment of 5 to 15 years may be imposed. Drugs in Group 3 include but are not limited to the following: codeine, dihydrocodeine and buprenorphine. The penalties listed here are not absolute; Indonesian judges may take mitigating circumstances into account and impose a lighter sentence as a result.

Data released by the National Anti-Narcotics Agency in 2014 showed that cannabis was the most widely used drug in Indonesia, particularly among workers and students. In 2015, a report from an independent and quasi-judicial expert body, the International Narcotics Control Board, indicated that about 29 tonnes of cannabis were seized across Indonesia, more than three times the 8.7 tonnes of the drugs seized in China that year. Indonesia has taken a tough stance on cannabis use. A 2016 report by an international research and advocacy group, the Transnational Institute, found that between 2009 and

2012, about 37,000 Indonesians were sentenced to jail terms for using the drug. In 2011 alone, the report found that of the estimated 3.7 million to 4.7 million drug users in Indonesia, 2.8 million were pot smokers [41].

Severe Punishments for Drug Crimes: Indonesia's President Joko Widodo (aka Jokowi) is again urging an increase in efforts to fight illegal drugs in the country. Jokowi instructed the police to shoot foreign drug dealers who "resist arrest". He added that the country is in a "narcotics emergency position". Jokowi made his comments at a political event in late July. Days before the speech, police shot and killed a Taiwanese man for resisting arrest. Police say he and several others were trying to smuggle 1,000 kilograms of crystal methamphetamine into Indonesia. Recently, Jakarta Police Chief General Adham Azis said he would "not think twice" about dismissing police officers who were not fighting drug trafficking enough [42]. Problems must be overcome [43] in accordance with applicable legal principles [44].

As the Indonesian government intensifies its crackdown on illegal drugs, there are currently 11 Taiwanese that have been sentenced to death for drug offenses, a new record according to Indonesian official sources cited in a CNA report. In its effort to clamp down on the illegal drug trade, foreign nationals have also been targeted, with 11 Taiwanese sentenced to death for drug trafficking, three of whom are already on death row, including Chen Chia-wei, Wang An-kang, and Lo Chih-cheng, stated the report. The eight other Taiwanese citizens who have been sentenced to death by Indonesian district and high courts are surnamed Lin, Chen, Chuang, Li, Shih, Wu, Hung, and Yeh. Although the eight have not completed the judicial process, Indonesia's track record on death penalty cases indicates that their chances of appealing their sentences are slim. Since 2016, four Taiwanese drug suspects have been executed for their crimes in Indonesia. There are currently over 30 Taiwanese nationals imprisoned in Indonesia for drug trafficking. As part of the country's war on drugs, Indonesian President Joko Widodo is intensifying the severity of punishments, and he has even told his police officers to "gun down" drug traffickers if necessary, especially foreigners, said John Chen, head of the Taipei Economic and Trade Office in Indonesia. Chen was quoted by CNA as warning Taiwanese citizens "not for one moment to consider smuggling drugs to Indonesia" [45].

In addition, the Ministry of Law and Human Rights recently announced a plan to place all people currently jailed for drug offenses into four prisons. The prisons, which are in West Java, North Sumatra, Central Java and Central Kalimantan, would get increased security. In August 2017, Indonesian officials seized the largest amount of crystal methamphetamine in the history of the country. The head of Indonesia's narcotics agency, General Budi Waseso, called for a war on drugs similar to the one in the Philippines. The market that existed in the Philippines is moving to Indonesia; the impact of President Duterte's actions is an exodus of drug traffickers to Indonesia. Drug trafficking can carry a death sentence in Indonesia, which considers the offense as serious as murder or terrorism. People found guilty of low-level drug crimes are estimated to make up 70% of Indonesia's prison population. Southeast Asian countries have resisted reducing the punishments for drug users or traffickers. Besides Indonesia and the Philippines, other countries in the area, including Singapore, want to continue with harsh punishments for drug crimes. Last year, however, Thailand considered changing the criminalization of methamphetamine, because prisons were becoming overcrowded, but there are no similar considerations in Indonesia. In 2015, Jokowi led an anti-drug campaign that resulted in the execution of 14 people for drug offenses [42].

4.2 Cooperation for Indonesia and Taiwan

Taiwan's national policy in the fight against narcotics has made Pre-emptive, Preventive, and Repressive efforts through the following policies: drug monitoring: deny entry and strengthen inspections; drug prevention: zero tolerance for drugs in schools; drug sweeps: no place for drug dealers to hide; drug rehabilitation treatment: provide comprehensive, empirical and continuous treatment services. More specifically, the Taiwanese Government's efforts are meant to achieve the following: an increase in criminal sentences and fines for manufacturing, transporting and trafficking in illegal drugs; an increase in punishments by half for the sale of illegal drugs to minors or pregnant women and for the manufacture, transport and sale of hybrid drugs; the introduction of an expanded confiscation system to cut off money flows generated by drug trafficking; the amendment of current laws to bring emerging illegal drugs and similar substances and precursors under legal supervision all at once; the closing of loopholes that allow these harmful substances that are not yet under legal supervision to be circulated; the amendment of regulations regarding rewards and punishments in anti-drug efforts; giving equal weight to the number of suspects investigated and the amount of drugs confiscated to incentivize drug enforcement efforts and trace upstream drug sources; the establishment of a reporting and tracing mechanism for military cases involving drugs; the promotion of legislation that holds venues of special businesses responsible for drug control to foster a safe and clean entertainment environment free of drug parties and gatherings [46]. Similar actions have also been taken by Indonesia in its national policy through BNN institutions.

In addition to the strategies for preventing drug abuse in Taiwan, the three major United Nations international drug control conventions set a supportive and complementary system to effectively control the production (manufacture), trafficking and abuse of drugs. In response to the spirit of the United Nations drug control treaties, Taiwan has instituted a framework of classification, administration and license issuance. There is also circulation control for managing the diversion of controlled drugs from pharmaceutical plants and medical institutions as well as the use of controlled drugs among pharmaceutical and medical professionals under the Controlled Drugs Act. Most of the controlled drug registration and prescription licenses issued by the Taiwan Food and Drug Administration (TFDA) by the end of 2011 were for clinics (7186) and physicians (39,329) [47].

Since there is a large overlap between controlled drugs and illicit drugs, drugs can be considered either controlled or illicit based on proper or improper usage. In Taiwan, there are three strategies to prevent drug abuse: supply reduction, demand reduction and harm reduction. For supply reduction, TFDA classifies and manages legal drugs in order to prevent abuse, and eliminate fraudulent manufacturing and illicit smuggling. The goals of demand reduction are to prevent first-time drug use, reduce illegal drug abuse, prevent overprescription and misprescription of controlled drugs, and promote drug rehabilitation. The harm of drug abuse needs to be reduced for the purposes of reducing the criminal rate, the transmission of contagious disease, and the impacts on family and the community [48].

Strategies for preventing drug abuse in Indonesia: (1) Primary Prevention: This is targeted at people who are not into drugs and community components that can potentially prevent drug abuse. The activities undertaken in this prevention effort include counselling about the dangers of drugs, information dissemination through various media about the dangers of drugs, and education to provide knowledge about drugs and the dangers of abusing it. (2) Secondary Prevention: This is targeted at people who are trying to abuse drugs and community components that can potentially help to stop the abuse of drugs. The activities undertaken in this prevention effort are, among others, early detection of children who abuse drugs, counselling, social counselling through home visits, and individual development education, including communication skills, skills of rejecting pressure from others, and skills of making good decisions [49].

Cooperation between countries is needed to overcome every national problem [50], by using lobbying and bargaining facilities [51]. Based on the pre-emptive, preventive and repressive efforts that have been undertaken by the national policies of each country (Indonesia and Taiwan), the cooperation to prevent and overcome smuggling of narcotics in both countries is achieved by adopting UN Convention as follows:

- Exchange of Drug Criminal Information and Intelligence;
- Create an Extradition Agreement;
- Mutual Legal Assistance in Drug Criminal Matters;
- Transfer of Drug Criminal Proceedings;
- Transfer of Sentenced Persons;
- Joint Investigation of narcotic crimes; and
- Joint Operation against narcotic crimes.

Nevertheless, it is difficult for such cooperation to take place because until now Indonesia has not opened diplomatic relations with Taiwan, because it is restricted by the One China Policy.

5 Conclusions and Recommendations

5.1 Conclusions

Based on the results and discussion, the authors make two important conclusions as follows: First, under the leadership of President Joko Widodo, the war against narcotics is being intensively implemented. All law enforcers have maximized the implementation of the Law of the Republic of Indonesia Number 35 Year 2009, which prescribes severe punishment for drug dealers, ranging from death sentence to shooting of perpetrators who resist arrested. The latest examples include 11 Taiwanese that have been sentenced to death for drug offenses and 4 Taiwanese that have been executed for their crimes in Indonesia. There are currently over 30 Taiwanese nationals imprisoned in Indonesia for drug trafficking. Second, Indonesia and Taiwan have done their best to combat narcotics through national policies and the impressive efforts of their law enforcement agencies. Nevertheless, smuggling of narcotics still continues to occur; therefore, international cooperation is necessary, especially between Indonesia and Taiwan, in preventing and overcoming narcotic trafficking. The cooperation is in the form of exchange of drug criminal information and intelligence, creation of an extradition agreement, mutual legal assistance in drug criminal matters, transfer of drug criminal proceedings, transfer of sentenced persons, joint investigation of narcotic crimes, and joint operation against narcotic crimes.

5.2 Recommendations

Based on these conclusions, the authors make the two following recommendations: First, the Taiwanese and Indonesian governments must ensure consistency in combating narcotics without relenting. Although smuggling of narcotics is still ongoing in both countries, it does not mean that efforts have failed so far. Second, effective strategies are needed to prevent and control narcotic crimes, which have been a problem for Indonesia and Taiwan.

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Politics, Abusive Supervision and Perceived Organizational Support: The Influence of Work-Family Conflict and Procedural Justice

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Abstract. Underpinned by conservation of resources theory, this study examined why and how abusive supervision and perceptions of organizational politics is related to work-family conflict and perceived organizational support in a sample of employed parents in Hong Kong (N = 206). The results revealed that consistent with our predictions, work-family conflict mediated the relationship between the antecedents (abusive supervision and perceptions of organizational politics) and perceived organizational support while procedural justice moderated the relationship between work-family conflict and perceived organizational support.

Keywords: Organizational politics · Abusive supervision · Procedure justice Work-family conflict · Perceived organizational support

1 Introduction

Research on perceived organizational support (POS) at work has focused predominantly on the favorable treatment (e.g. fairness, supervisor support, and organizational rewards and job conditions) received from the organizations as the source of POS (Rhoades and Eisenberger 2002). Based on the social exchange theory, it is expected that when an individual treats well another, the reciprocity norm obliges the return of favorable treatment (Gouldner 1960). Settoon et al. (1996: 219) noted that in the context of an employment relationship,"research findings suggest that positive beneficial actions directed at employees by the organization and/ or its representatives contribute to the establishment of high-quality exchange relationships that create obligations for employees to reciprocate in positive, beneficial ways." From this argument, it is believed that when an organization treats employees well, the POS among employees should increase, which in turn make them to return favorable outcomes to the organization (e.g. affective commitment, performance, and lessen withdrawal behavior) (Armeli et al. 1998; Eisenberger et al. 1986; Nye and Witt 1993; Wayne et al. 1997). In recent studies on POS, more studies have found the mediating role of POS in the relationship between favorable treatments and beneficial outcomes to

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employees and the organization (Hochwarter et al. 2003; Rhoades and Eisenberger 2002). For example, Wayne et al. (1997) found that POS mediates the relationship between human resource practices and affective commitment, OCBs, and the intent to quit. Therefore, it is generally believed that favorable or unfavorable treatments are related to POS. However, what is currently lacking in the literature is the theoretically relevant mediators of the relationship between favorable or unfavorable treatments and POS. As per our knowledge, there is no research to date have yet examined in this issue. Therefore, the goal of this study is to examine the mediating potential of work-family conflict on the relationship between unfavorable treatments (abusive supervision and perceptions of organizational politics) and POS, and the moderating potential of procedural justice on the relationship between work-family conflict and POS.

Abusive supervision describes 'subordinates' perceptions of the extent to which their supervisors engage in sustained displayed of hostile, verbal and non-verbal behaviors excluding physical contact' (Tepper 2000: 178). Examples of such behaviors include intimidating by use of threats of job loss, aggressive eye contact, public ridicule, rudeness and silent treatment (Keashly 1998; Tepper 2000). On the other hand, perceptions of organizational politics refer to behaviors that are perceived to be informal and designed to promote or protest the self-interests of an individual (Cropanzano et al. 1995; Ferris and Judge 1991). Ferris and his colleague pointed out that organization politics "involves an individual's attribution of self-serving intent, and is defined as an individual's subjective evaluation about the extent to which the work environment is characterized by coworkers and supervisors who demonstrate such self-serving behavior" (Ferris et al. 2000: 90). Examples of such self-serving behavior include taking advantage over others, and sacrificing the organizational goals and objectives to achieve one's own agenda (Ferris et al. 2002; Hochwarter et al. 2003).

Although a handful research has shown that unfavorable treatments (e.g. politics perceptions, role stressors and negative affectivity) are negatively related to POS (Rhoades and Eisenberger 2002), these research has mainly focused on the social exchange theory to explain the direct relationship between unfavorable treatments and POS. No research has yet to adopt another perspective (e.g. a resource perspective) to examine the indirect relationship between unfavorable treatments and POS in which there could be a potential mediator to link up the relationship. Underpinned by conservation of resources (COR) theory, this study conceptualized abusive supervision and perceptions of organizational politics as a stressor or a resource loss in the work environment. According to Spector and Jex's (1998) definition of interpersonal conflict, abused employees could feel more work-family conflict when their supervisors are rude to them.

Tepper (2000) also reported that abused employees will experience more work-family conflict. On the other hand, employees perceiving a high political work environment could feel a lack of control on work as they have to protect self-interests of the actor (e.g. their supervisors) at work. Chesney et al. (1981) noted that a lack of autonomy over work could contribute to greater work-family conflict. Based on this conceptual argument, in this study, we examined (i) the mediating influence of work-family conflict on the relationship between unfavorable treatments (i.e. abusive supervision and perceptions of organizational politics) and POS, and (ii) the moderating influence of procedural justice on the relationship between work-family conflict and POS in a sample of employed parents in Hong Kong.

2 Literature Review

Conservation of resources (COR) theory initially represents an integrated resource theory for understanding the stress process. However, some scholars have extended COR theory applying to other organizational behavior research. For example, Grandey and Cropanzano (1999) applied COR theory to examine work-family conflict, and Hobfoll et al. (1990) developed social support resource theory based on COR theory. Theoretically, COR theory defines stress as a reaction to the environment in which there is (a) the threat of a net loss of resources, (b) the net loss of resources or (c) a lack of resource gain following the investment of resources (Hobfoll 1989: 516). Central to COR theory therefore, is the notion that individuals seek to 'retain, protect, and build resources and that what is threatening to them is the potential or actual loss of these valued resources' (Hobfoll 1989: 516). COR theory hence suggests that an individual has intended to preserve and protect the resources which they value. This makes the acquisition and facilitation of resources a fundamental motivational construct in COR theory. Hobfoll (1989: 516) defined resources 'as those objects, personal characteristics, conditions or energies that are valued by the individual or that serve as a means for attainment of these objects'. Examples of resources include self-esteem, knowledge, social support, time, participation in decision making, job control and socio-economic status. In this study, we would like to extend the implications of COR theory to work-family conflict and POS. Based on COR theory, we argue that when an individual does not have enough resources (e.g. supervisor's support and job control) to be used to handle their job or family demands, they would perceive that the organization has not given them enough support over their work. Therefore, if one is unable to retain, protect, and build resources at work, one would experience more work-family conflict which in turn could create a negative feeling towards POS from the organization. On the contrary, if one experiences adequate resources to meet demands at work or at home, one should feel less work-family conflict and his or her positive feelings towards POS from the organization will increase.

Underpinned by COR theory, we conceptualized abusive supervision and perceptions of organizational politics as a resource loss (or a stressor) which creates an incongruence between organizational demands and an individual's resources or ability to meet these demands leading to POS. To account for the abusive supervision-POS linkage, we posit that abusive supervision and its implied lack of supervisory support threatens the ability of individuals with significant family responsibilities to combine their work and family responsibilities leading to work-family conflict. To account for the perceptions of organizational politics-POS linkage, we posit that perceptions of organizational politics and its implied lack of control over work disallows individuals to handle their work and family demands systematically leading to work-family conflict. We further posit that the depletion of one's resources in the struggle to fulfill work and family demands partially accounts for the abusive supervision-POS linkage as well as the perceptions of organizational politics-POS linkage. COR theory suggests that to offset resource loss or gain resources, individuals call on resources available to them from the environment. We posit that procedural justice constitutes an important resource in the work environment that an individual may call upon to mitigate the influence of work-family conflict on POS.

2.1 Abusive Supervision, Perceptions of Organizational Politics, and POS

Abusive supervision constitutes an interpersonal or social stressor because it is perceptual in nature, precipitates uncertainty, and threatens the abused subordinate's resources (e.g. lack of social support) at work (cf Ferris et al. 1996). POS is defined as employees' global beliefs to the extent which the organization value their contributions and cares about their well-being (Eisenberger et al. 1986). Levinson (1965) pointed out that employees always perceive that any actions or treatments they have received from agents of the organization are the intentions of the organization, not the intentions of the agents themselves. In an organization, supervisors are usually considered as the agents of the organization (Rhoades and Eisenberger 2002), and therefore employees always view the treatments by their supervisors as an indication of organizational support (Eisenberger et al. 1986; Levinson 1965). According to COR theory, as a form of interpersonal stressor, abusive supervision undermines the abused subordinate's sense of control and social support which constitute a loss of resource. The loss of resource at work constitutes perceptions among the abused subordinates that the organization does not value their contributions nor take care of their well-being, which in turn makes them feel a decrease in POS. In support of our contention, Tepper (2000) reported that the abused subordinates will have perceptions of unfairness which could make them feel that the organization is not on their side. In the end, they could feel a lack of support from the organization (i.e. POS). As a form of mistreatment at work, Bies and Tripp (1998) conceptualized abusive supervision as a source of injustice, and therefore abusive supervision may suggest a lack of interactional justice (failure of organizational representatives to treat subordinates with respect, propriety and sensitivity to their needs) which could lead to POS. Evidence has shown that fairness and supervisor support are related to POS (Rhoades and Eisenberger 2002). The preceding discussion suggests the following hypothesis:

Hypothesis 1a. Abusive supervision will be negatively related to POS.

Perceptions of organizational politics are one's perceptions towards the political nature of one's work environment to influence one's way to work. Politics is a subjective evaluation because it is the cognitive evaluation of perceptions of events that influence people's reaction and the outcome of these reactions (Lewin 1936). These perceptions can extend to influence how they feel about the organization including the boss, supervisors, co-workers, and so on (i.e. POS). According to COR theory, perceptions of organization politics undermine the sense of one's control at work and the likelihood of one being fairly treated which both constitute a loss of resource, as one has to promote or protest the self-interests of the actor (e.g. supervisor). The loss of resource at work constitutes perceptions among individuals that the organization does not give enough support to protect their own self-interests leading to decrease in POS. In other words, "the employee will simply see that the organization is not holding up their "end of the bargain" with regarding to providing favorable psychosocial treatment in political environments" (Hochwarter et al. 2003: 441). Kacmar and Carlson (1997) pointed out that an organization with limited resources will usually have high political environments, where politics leads to lower level of support (Hochwarter et al. 2003). The argument for this is that individuals always have to compete with resources in political environments where the resources are perceived to be scarce (Mintzberg 1983). In support of our contention, Hochwarter et al. (2003) reported that politics perceptions are negatively related to POS. As a form of unfair treatment at work, the perceptions of organizational politics could be conceptualized as procedural injustice (the perceived unfairness of decision-making processes) at work which could lead to POS (Rhoades and Eisenberger 2002). The preceding discussion suggests the following hypothesis:

Hypothesis 1b. Perceptions of organizational politics will be negatively related to POS.

2.2 The Mediating Influence of Work-Family Conflict

A salient change in the composition of the workforce in most developed and transitional economies is the growth in the labor force participation of women many of whom are married with children. Given that the coordination of work and family was facilitated by a stay-at-home spouse usually the wife, the phenomenal growth in the labor force participation of mothers has precipitated a steady stream of research on the coordination of work and family. This stream of research has focused predominantly on the difficulties experienced by dual-earner couples in coordinating their work and family roles or work-family conflict (Aryee et al. 1999; Bellavia and Frone 2005; Frone et al. 1992; Greenhaus and Beutell 1985; Voydanoff 2002). Work-family conflict describes a form of inter-role conflict in which the demands of work and family roles are incompatible in some respect so that participation in one role is made more difficult because of participation in the other role (Greenhaus and Beutell 1985). Based on the directionality of the interference, researchers have distinguished between work-family and family-work conflict (Gutek et al. 1991). We focused in this study on the former because our study was situated in the context of work.

Much research on the antecedents of work-family conflict has focused on within-domain time-based (e.g. number of hours worked per week and schedule inflexibility) and strain-based (e.g. role overload and role ambiguity) antecedents (Frone et al. 1992). While these antecedents constitute demands that tax or deplete one's resources negatively affecting participation in the family role, research has also focused on resources within the work domain that facilitate the integration of work and family roles. One such resource is supervisor work family support which describes a supervisor's emotional (e.g. empathy) and instrumental (e.g. work rescheduling) support (Grandey 2001; Thomas and Ganster 1995). According to COR theory abusive supervision and perceptions of organizational politics constitute a resource loss which undermines an individual's ability to integrate work and family roles leading to work-family conflict. In support of our contention, Tepper (2000) reported abusive supervision to be related to work-family conflict, while organizational politics is always reported to be related to conflict in literature (Drory and Romm 1988; Frost 1987;

Mintzberg 1985). Although there is a dearth of research that has directly examined the relationship between organization politics and work-family conflict, political behavior will certainly create conflict in an organization. Drory and Romm (1990) noted that conflict is a must consequence of organizational politics as one's control of self-interests has been threatened by another's self-serving behavior. This could make an individual feel as being unfairly treated by organization. Grandey (2001) argued that organizations with unfair practices will create more work-family conflict among their employees. Evidence has also shown that the perceptions of whether an individual has been treated fairly or not (e.g. procedural injustice) is related to work-family conflict (Judge and Colquitt 2004).

Following COR theory, we expect work-family conflict to be negatively related to POS. COR theory posits that the experience of work-family conflict represents a situation whereby demands exceed an individual's resources to cope with their work and family responsibilities, in a situation that an individual is not fairly treated by organization practices (i.e. abusive supervision and organizational politics). Given that situation, one's perceived organizational support (POS) will be negatively affected as the consequence of work-family conflict where one has difficulties in coordinating work and family roles due to a lack of resources. Therefore, we predicted work-family conflict to mediate the relationship between abusive supervision, perceptions of organizational politics and POS.

Hypothesis 2. Work-family conflict will partially mediate the relationship between abusive supervision, perceptions of organizational politics and POS.

2.3 Moderating Influence of Procedural Justice

Much research has examined dispositional variables as resources individuals can summon to mitigate the negative consequences of unfairness experiences in the workplace (Bolger and Zuckerman 1995; O'Driscoll and Dewe 2001). However, interest in organizational intervention programs suggests a need to focus on contextual factors. One such contextual factor examined in this study is procedural justice. As a dimension of organizational justice, research on procedural justice has shown that the fairness or unfairness environment can affect the attitudes and behaviors of employees (Colquitt and Greenberg 2003; Cropanzano and Greenberg 1997).

Procedural justice describes the fairness of procedures used in the allocation process (Tyler and Lind 1992) or an employee's evaluation of the perceived fairness of rules and procedures used by the organization to distribute outcomes (Thibaut and Walker 1975). In the view of Cropanzano et al. (2002) procedural justice is primarily concerned with the extent to which structural features of decision-making facilitate appropriateness of criteria and the accuracy of information used to arrive at a decisional outcome. Pearce et al. (2000) equated these structural features of procedural justice to the due-process and rule-constrained practices that reflect the meritocratic principles of universalism and impersonal decision-making of Weberian bureaucracy (Weber 1947). COR theory explored what individuals do to offset resource loss or to gain resources. Hobfoll (1989: 517) argued that 'they employ resources that they possess or they call on resources available to them from their environment'. Because procedural justice may give employees control over the work environment, so promoting justice in the workplace could help to reduce employee's pressure caused by work-family conflict. Judge and Colquitt (2004) argued that one way to handle work-family issues is to promote (procedural) justice in the workplace as (procedural) justice can enhance one's ability to reduce uncertainty and lack of control. From a COR theory perspective, the control fostered by procedural justice constitutes a resource that enhances one's ability to combine one's work and family responsibilities more flexibly which could reduce the work-family conflict caused by mistreatments (i.e. abusive supervision or organizational politics) thereby improving one's perceptions of the support from organization (i.e. POS). In contrast, low procedural justice provides no such additional resource for one to manage his or her work and family responsibilities which will consequently lessen his or her POS. Thus, in a low procedural justice work environment, the relationship between work-family conflict and POS will be exaggerated where the organization does not have resources available in the work environment (procedural justice fostered control) which employees could use to handle their work-family issues. The preceding discussion suggests the following hypothesis:

Hypothesis 3. Procedural justice will moderate the relationship between work-family conflict and POS such that high levels of procedural justice will mitigate the negative effects of work-family conflict on POS.

3 Methods

Respondents were employed parents drawn from multiple organizations in Hong Kong. The authors approached human resource managers of participating organizations and explained the objective of the survey, the extent of the organization's involvement in the survey, and assured them of the anonymity of their organizations. On being granted access, an employee of the human resource department who acted as survey coordinator was briefed about the objective of the study and the data collection procedure. This employee then publicized the study and drew up a list of potential respondents. Survey packages were distributed randomly to respondents through the organization's internal mail. A cover letter attached to each questionnaire noted that the objective of the study was to learn about employed parents' experiences of combining work and family demands, assured respondents of the voluntary nature of participation in the survey, and the confidentiality of their responses. Completed questionnaires were returned sealed in envelopes provided by the researchers to a box in the human resource department designated for that purpose.

Of the 402 questionnaires distributed, 240 were returned. However, after listwise deletion of cases with missing data on the relevant variables, the final sample was 206 representing a response rate of 51.2%. Of the 206 respondents, 52.9% were female, reported an average of working 50.5 h (s.d. = 6.95) at work a week, an average of spending 21.9 h (s.d. = 13.48) on domestic work a week, and an average age of youngest child of 8.3 years (s.d. = 6.00). In terms of educational attainment, 47.1% had a postgraduate degree or professional qualification, 28.2% had an undergraduate degree, and 16.5% a polytechnic diploma. Around 54% of respondents were in the 40–49 years age bracket, 35.4% in the 30–39 years age bracket, and 7.3% in the 50 and above age bracket.

3.1 Measures

Abusive supervision. A 10-item version of a scale developed by Tepper (2000) was used to measure abusive supervision. Perceptions of organizational politics. A 6-item shortened version of a scale developed by Kacmar and Ferris (1991) was used to measure organizational politics. Work-family conflict. We used a 6-item scale three of which were developed by Gutek et al. (1991) and the other three by Netemeyer et al. (1996) to measure work-family conflict. Perceived Organizational Support. A 6-item shortened version of a scale developed by Eisenberger et al. (1986) was used to measure perceived organizational support (POS). Procedural justice. We used a 6-item adaptation of Niehoff and Moorman's (1993) scale to measure procedural justice. Demographics. We controlled for the demographics of gender (male coded 1), marital status (married coded 1), age of youngest child, education level, hours worked per week, hours spent on domestic responsibilities per week, and job level.

4 Data Analysis

Table 1 presents the results of the CFA that examined the distinctiveness of the study variables. As shown in the table, the fit indices revealed that our hypothesized 5-factor model fit the data better than each of the alternative models suggesting support for the distinctiveness of our variables.

Table 1. Confirmatory Factor Analysis (CFA) results of measurement model

Model	χ^2 (df)	$\Delta\chi^2$	Δdf	RMSEA	NNFI	CFI
Hypothesized 5-factor model	821.40 (517)	____	____	0.054	0.96	0.97
4-factor model	1004.15 (521)	182.75***	4	0.067	0.95	0.95
3-factor model	1979.13 (524)	1157.73***	7	0.12	0.88	0.89
1-factor model	5354.68 (527)	4533.28***	10	0.211	0.72	0.74

Table 2 presents the results of the regression analysis that examined the mediating influence of work-family conflict on the relationship between abusive supervision, perceptions of organizational politics, and POS, followed by the steps recommended by Baron and Kenny (1986). As shown in the upper part of table (Model 2), both abusive supervision ($B = -.27$, $p < .001$) and perceptions of organizational politics ($B = -.21$, $p < .05$) were negatively related to POS satisfying the first condition for mediation (and providing support to Hypothesis 1a and 1b). As also shown in the table (Model 1), both abusive supervision ($B = .14$, $p < .05$) and perceptions of organizational politics ($B = .38$, $p < .001$) were related to work-family conflict satisfying the second condition for mediation (Baron and Kenny 1986). The regression results in Model 2 indicate that work-family conflict was related to POS ($B = -.16$, $p < .05$) after abusive supervision and perceptions of organizational politics were controlled. However, after considering the mediating influence of work-family conflict, abusive supervision continued to be significantly related to POS at the same magnitude ($B = -.25$, p < .001) whereas perceptions of organizational politics was no longer significantly related to POS (B = −.15, p = n.s.). Following Baron and Kenny (1986), this pattern of results suggest a partial support for Hypothesis 2 in that work-family conflict partially mediated the relationship between abusive supervision and POS but fully mediated the relationship between perceptions of organizational politics and POS. In order to examine whether perceptions of organizational politics has a direct influence on POS or not after taking into an account of the influence of mediator (i.e. work-family conflict), we subsequently used structural equation modeling (LISREL) to compare the fitness of the hypothesized partially mediated model to the suggested model as mentioned above (i.e. work-family conflict fully mediated the relationship between perceptions of organizational politics and POS). As shown in Table 3, the results showed that the suggested model is preferred based on the chi-square test, though there is no difference in the fit indexes between the hypothesized model and the suggested model. We also found that the direct path from perceptions of organizational politics to POS in the hypothesized model is not significant which indicates that the mediating influence of work-family conflict absorbs the direct influence from perceptions of organizational politics to POS. On the other hand, all the loading paths in the suggested model are significant. Besides, based on the rule of parsimony, we should take the suggested model as the more appropriate model.

Table 2. Results of regression analysis for mediation

Variable:	Model 1 Work-family conflict B	Model 2 POS B
Controls: Gender Age Marital status Age of youngest child Education level Hours worked per week Hours spent on domestic responsibilities per week job level	.07 −.02 −.31 −.01 .10 .05*** −.01* .02	.07 −.01 .41 .01 −.18* −.01 −.00 .05
R^2	.27***	.05
Direct effects: Abusive supervision Perceptions of organizational politics	.14* .38***	−.27*** −.21*
ΔR^2	.10***	.11***
Mediating effects: Abusive supervision Perceptions of organizational politics Work-family conflict		−.25*** −.15 −.16*
ΔR^2		.02*
Overall R^2	.37	.17
Overall model F	11.29***	3.71***

*p < .05; **p < .01; ***p < .001

Table 3. Fit of alternative structural models

Model	χ^2 (df)	$\Delta\chi^2$ (df)	RMSEA	NNFI	CFI
Hypothesized partially mediated model	597.22 (344)		0.060	0.96	0.96
The suggested partially mediated model (no direct influence from perceptions of organizational politics to POS)	600.95 (345)	3.73 (1)	0.060	0.96	0.96

The results of moderated regression analysis that examined Hypothesis 3 are presented in Table 4. As shown in that table, the two-way interaction of work-family conflict and procedural justice significantly predicted POS (B = .16, $p < .05$). To interpret the moderated effects, we solved for regression equations at high and low procedural justice. Consistent with Cohen and Cohen (1983), the high and low values were defined by plus and minus one standard deviation from the mean. The effects of work-family conflict on POS become positive when procedural justice is high, and the relationship between work-family conflict and POS has been exacerbated when procedural justice is low. Thus, Hypothesis 3 is supported.

Table 4. Results of moderated regression analysis

Model	Variables	B	s.e.	ΔR^2
1	Control			.14**
	Gender	.03	.12	
	Age	−.12	.11	
	Marital status	.32	.43	
	Age of youngest child	.01	.01	
	Education level	−.15*	.08	
	Hours worked per week	−.00	.01	
	Hours spent on domestic responsibilities per week	−.00	.01	
	Job level	.00	.05	
	Abusive supervision	−.23**	.08	
	Perceptions of organizational politics	−.24*	.10	
2	Main effects			.25***
	Work-family conflict	−.05	.07	
	Procedural justice	.53***	.07	
3	Interaction effect			.02*
	Work-family conflict * procedural justice	.16*	.08	

*$p < .05$; **$p < .01$; ***$p < .001$

5 Discussion

Although abusive supervision and perceptions of organizational politics constitute a resource loss or a stressor, an aspect of the work environment that causes employees to doubt their ability to cope with work demands (Spector 1996), there is paucity of research that has adopted a resource perspective to examine the processes linking mistreatments (e.g. abusive supervision and perceptions of organizational politics) to its demonstrated influence on POS through a mediating influence of work-family conflict. Although few studies have demonstrated the direct influence of an organization's mistreatments to work-family conflict (Drory and Romm 1988; Frost 1987; Mintzberg 1985) or to POS (Rhoades and Eisenberger 2002), none of these studies are able to explain the mediating influence of work-family conflict to the relationship between mistreatments and POS. Underpinned by COR theory, the findings of this study revealed abusive supervision to be both directly and indirectly (through work-family conflict) related to POS, while perceptions of organizational politics is only indirectly (through work-family conflict) related to POS.

Implicit in abusive supervision is the loss of supervisory social support, an essential resource for employed parents in juggling the demands of work and family (Batt and Valcour 2003; Thomas and Ganster 1995). The result of the loss of this form of social support creates difficulties for employed parents in coordinating work and family demands leading to work-family conflict. According to COR theory, the constant juggling of work and family roles further depletes or drains one's resources (e.g. energy and cognitive effort) and provokes doubts about one's ability to adequately perform role responsibilities. Since the cause of work-family conflict is provoked by a lack of support or resources in an organization, the mismatch between the demands and the availability of resources in organization could hence mitigate one's POS towards an organization.

Implicit in perceptions of organizational politics is the loss of control over work, an essential resource to predict work-family conflict (e.g. Grzywacz and Marks 2000). The result of the loss of job autonomy creates difficulties for employed parents in coordinating work and family demands leading to work-family conflict. According to COR theory, as mentioned above, the loss of resources constraints one's ability to adequately perform work and family responsibilities. The employees who suffered from work-family conflict would hence mitigate their perceptions towards the support from organization, because they feel that the organization has not provided enough support or resources for them to handle the demands from the work and family domains.

However, inconsistent with our prediction, work-family conflict fully mediated rather than partially mediated the relationship between perceptions of organizational politics and POS. Unlike abusive supervision, there is no direct influence from perceptions of organizational politics to POS when considering the mediating influence of work-family conflict. The reason for the differences of these two mistreatments onto the effect of POS through work-family conflict (i.e. work-family conflict partially mediated the relationship between abusive supervision and POS, and work-family conflict fully mediated the relationship between perceptions of organizational politics and POS) could be because of the organization practices in Hong Kong or Chinese societies. The cultural premium placed on interpersonal harmony (especially with a supervisor) coupled with the high power distance (belief that subordinates should play the role of taking instructions and orders from their supervisors) in Chinese societies (Hofstede 1980) foster the commonality of practicing political behavior rather than abusive supervision in organizations. In other words, it is less common for the supervisors to be rude to the subordinates but it could be more common for the supervisors to take an advantage over the subordinates at work. Research on Hong Kong studies is consistent with this argument. For example, Hong Kong Chinese prefer a harmonious atmosphere at work (Hui and Tan 1996); Harmony is very important than the recognition of individual contributions among Hong Kong Chinese (Leung and Lind 1986); Hong Kong employees do not have much expectations about the fairness in organizational rewards or procedures (Bond and Hwang 1994; Hui and Tan 1996). Therefore, when the subordinates have been abused in Hong Kong organizations, it can create a direct impact to POS amongst the abused subordinates as abusive supervision is not treated as an appropriate behavior. However, in Hong Kong organizations, the subordinates are more used to accept orders or instructions from their supervisors or even sometimes they are used to being taken advantage of by others who have high political influence in the organizations. This makes them more likely to accept the political behavior within the organizations, and hence it can explain why perceptions of organizational politics do not have a direct influence on POS.

The results also revealed procedural justice as a moderator of the relationship between work-family conflict and POS. High levels of procedural justice improved the negative relationship between work-family conflict and POS while low level of procedural justice exacerbated the relationship between work-family conflict and POS. Because procedural justice fosters control and makes one to have an ability to reduce uncertainty, we conceptualized it as a resource gain to the employees which give them more flexibility to handle work and family demands. Therefore, the employees should experience greater POS in a high procedural justice environment, whereas the employees should experience lower POS in a low procedural justice environment.

The findings of this study make a number of contributions to the literature. First, while the form of mistreatments have been shown to be related to work-family conflict (Drory and Romm 1988) or to POS (Rhoades and Eisenberger 2002) in the literature, this study is probably among the initial ones to use COR theory to conceptualize abusive supervision and perceptions of organizational politics as a resource loss to examine the mediating influence of work-family conflict on the relationship between mistreatments and POS. Second, much research has shown supervisory behavior (work-family support) and job autonomy as a critical resource for employed parents in coordinating work and family roles. Thus, the influence of abusive supervision and perceptions of organizational politics on work-family conflict in this study highlights the mistreatments from an organization's agent (e.g. supervisors) as a form of loss of resources or stressors thereby broadening our understanding of work domain antecedents of work-family conflict. Third, much research on work-family conflict has mainly focused on the individual's wellbeing or organization's outcomes. But the attitude or the perceptions of employees towards organization (e.g. POS) has rarely been examined as the consequence of work-family conflict. This research hence can enhance our understanding of work domain outcomes of work-family conflict, and provide a potential to call for future research to examine the mediating role of POS in the relationship between work-family conflict and individual's wellbeing or organization's outcomes. Fourth, results of the mediation regression and SEM revealed that the work-family conflict fully mediates the perceptions of organizational politics-POS relationship. Our post facto explanation of this finding highlights the importance of cultural or environmental factors in influencing employee's perceptions of how they have been treated, and therefore we believe that to some extent the influence of cultural factors could affect the relationship between treatments (or mistreatments) and POS. Lastly, results of the moderated regression revealed that procedural justice mitigates the deleterious influence of work-family conflict on POS. The significant interactive effect suggests that procedural justice reinforced employee's control over the workplace which allows them to deal with work or family demands leading to improving their POS towards organization. Individuals in a high procedural justice environment have an understanding of the situation, and therefore they are able to make use of additional resources given by the environment to mitigate the negative consequences of POS generated by work-family conflict.

Given the recognition of organizational justice as a signal construct in employee-organization relations, an important practical implication of the results of the moderated regression is the need to focus organizational efforts to promote fairness throughout organizations. Specifically, the decision making process in organizations should be unbiased and consider employee views and input in order to promote fairness or justice. With this practice, organizations should be more responsive to employee's work and family concerns (Judge and Colquitt 2004), leading to higher POS. Moreover, the training of supervisors should sensitize them to their role in promoting a culture of fairness in the workplace which precludes mistreatment of subordinates. A theoretical implication of our findings is that (i) the aversive experience of abusive supervision denotes low levels of interactional justice which as a resource loss (or as a stressor), directly and indirectly (through work-family conflict) leads to POS; (ii) the experience of practicing political behavior denotes low levels of job control which as a resource loss, indirectly through work-family conflict, leads to POS; (iii) procedural justice which gives employee's control over the work environment promotes employee's perceptions of the support from organization (i.e. POS), thereby improving one's POS in the presence of high levels of work-family conflict.

This study has certain limitations which must be acknowledged. First, the cross-sectional design precludes any inference about cause-effect relations. Future research that adopts a longitudinal design will be better placed to ascertain the causal status of the relationships examined in this study. Second, data on the study variables were based on self-reports suggesting the possibility that our results may be attributable to common method bias. This may be particularly true of the mediated model as moderated models are less susceptible to common method bias (Pierce et al. 1993). Although the CFA results point to the distinctiveness of our variables, our results should nevertheless be cautiously interpreted. Lastly, the partial mediation between perceptions of organizational politics and POS (through work-family conflict) is only partially supported. Future research should specifically theorize and test our post facto explanation of the observed relationship (i.e. full mediation).

6 Conclusion

Underpinned by COR theory, our results suggest that as a loss of resource, mistreatments from organization precipitate work-family conflict and POS. Work-family conflict partially mediated the abusive supervision-POS relationship and fully mediated the perceptions of organizational politics-POS relationship. Procedural justice was also found to moderate the relationship between work-family conflict and POS. Given the implications of POS for employee well-being (e.g. job stress) and organizational effectiveness (e.g. performance), organizations should focus on intervention programs to promote fair procedures at the workplace. For example, organizations should train organizational representatives to communicate with subordinates in positive and humane manners.

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Inclination of Insider Threats' Mitigation and Implementation: Concurrence View from Malaysian Employees

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Abstract. The aim of this paper is to discuss on the insider threat risks and challenges which have been the biggest problem to most organisations. The survey has gauged the employees' agreements level of recommended practices derived from the "Common Sense Guide to Mitigating Insider Threats" produced by the Software Engineering Institute, Carnegie Mellon University (SEI-CMU). The available research works by Computer Emergency Response Team at Carnegie-Mellon University (CERT) offered an effective and possible approach towards identifying the insider threats risk and challenges by identifying feasible activity for implementation as part of a review process within organisation. The respondents indicate that majority of the companies in Malaysia who participated in the survey are basically agreeable to it and currently implementing the recommended practices. The results suggested that most companies are aware of the threats and ready for effective countermeasures. Three factors i.e. **motive, method and opportunity** must be recognised, identified and suppressed within the organization boundary. As a conclusion, this research could assist organization to understand the general acceptance of the respondents towards suggested practices and it could be some important facts that finding effective way to implement best practices are the demand for further research.

Keywords: Insider threats · Trusted human framework
People process and technology

1 Introduction

Insider threat is not a new and sensational risk to most public and private organisations. However, most of these organisations prefer not to openly disclose the incident and often handle it in their respective subtle way. Furthermore, organisations reluctant to state their difficulties in dealing with insider threats issues. This is probably due to

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adverse reputation that may occur after revealing the fact that trusted people within the organisation involved in fraudulent activities. That may further provide an adverse impact to the companies' operations and their customers' perception.

There are many definitions related to insider threats. For this study, the definition was taken from the Computer Emergency Response Team at Carnegie-Mellon University (CERT-CMU). It defines insider threat as "a malicious insider who is a current or former employee, contractor, or business partner who has or had authorised access to an organisation's network, system or data, and intentionally exceeded or misused that access in a manner that negatively affected the confidentiality, integrity, or availability of the organisation's information system" [1]. The definition further elaborated by Bishop as "when a trusted entity that is given power to violate one or more rules in a given security policy" [2]. He later defined that the insider threat can be further elaborated when "Violation of security policy using legitimate access" and "Violation of an access control policy by obtaining unauthorized access" [3]. Therefore, "insider" could consist of the former employee, contractor and business partner who we trust to do the work.

There are Information Technology (IT) security products such as Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS), Firewalls, Data Leak Prevention (DLP), End-Point Controls (i.e. anti-virus/anti-malware software), routers, switches and information security standards (i.e. ISO 27001) or best practices (i.e. COBIT) introduced into the market and selectively implemented. However, most of these implementations were intentionally put in place to deter and detect security breaches focusing on the external threats. Although, there are IT security devices introduce in the market to address the insider threats, many organisations are not interested to implement and yet the focus remains to deter and detect external security breaches. Further to that, most internal threat cases come from internal staff whom we perceive as trusted person and employed within the organisation's boundary. The management believes their entrusted workforces perform and able to deliver per their job requirement and truthful in providing outcome of their work. Hence, countermeasures and controls towards external threats remain as the organisational challenges and top priority unlike mitigating the internal threats standpoint. Thus, this study aims to understand the view of selected employees from Malaysian Companies on their level of agreeableness toward suggested controls in mitigating insider threats. The questionnaire (survey) was developed based on CERT-CMU's Technical Report namely "The Common-Sense Guide to Mitigating Insider Threats 4th Edition".

2 A Review of Insider Attack Trends and Responses

Insider attacks and the threats can haunt organisations and government agencies if not properly handled. Although some of the related insider incidents were found to be marginal but it tends to cause more damages to the company. In May 2013, the world community was stunned when Edward Joseph Snowden, the American computer specialist and former Central Intelligence Agency (CIA) and National Security Agency

(NSA)'s employee, disclosed classified details of the United States and British government surveillance programs to the media. The United States Secret Service and CERT Coordination Center, through their findings noted that most insider threat incidents were thought out and were planned in advance. The study indicates that 81% of the incidents were occurred by insiders which they planned their actions in advance while 85% of the incidents, someone other than the insider had full or partial knowledge about the insider's intentions, plans, and/or activities [10]. In that sense, framework to detect and deter the insider threats is paramount. CISCO Global Security Study found that 11% of employees were reported that they or fellow employees accessed unauthorised information and sold it for profit or stole computers while 60% of employees intentionally keeping their corporate devices when leaving a job and using the device for personal use. Some employees even failed to return the company devices when leaving the job [11]. The 2016 Insider Threat Spotlight report also revealed that 72% of organisations feel vulnerable to insider threats and 42% said that they have appropriate controls in place to mitigate the attack [7].

Generally, organisation consists of people, process and technology (PPT) elements. The organisation's accomplishments depend how well PPT assimilates. This is further explained in the Business Model for Information Security (BMIS) with its holistic and dynamic solution for designing, implementing and managing information security [4]. The BMIS consists of elements and dynamics interconnection (DI) illustrated as follows (Fig. 1):

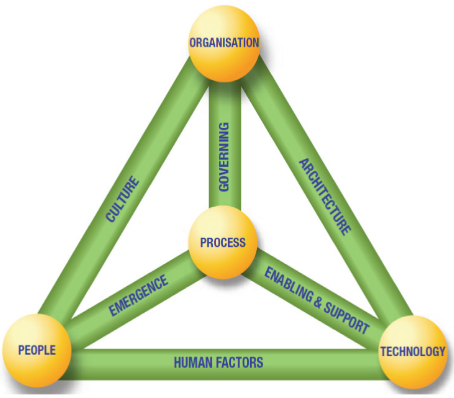


Fig. 1. Source: Adapted from The University of Southern California, Marshall School of Business, Institute for Critical Information Infrastructure Protection, USA

In addition to the PPT elements, organisational element also exists to overarching the culture, governance and architect the PPT. These elements are inter-connected directly or indirectly through the DI namely Culture, Governing, Architecture, Emergence, Enabling & Support and Human Factor.

The elements and DIs are described in Tables 1 and 2 respectively.

Table 1. BMIS elements - people, process, technology and organisation.

BMIS elements	
People	Represents the human resources within organisation (e.g. employees, contractors, vendors and service providers. The primary people are those who are employed or otherwise associated with the organisation. Secondary people are those in the outsourcing environments where multiple vendor relationships or managed-services who indirectly work within or for the organisation
Process	Organised activities that are created to achieve a particular outcome through individual or a series of consistently applied tasks
Technology	The practical application of knowledge, especially in a particular area and capability given by the practical application of knowledge
Organisation	Network of people interacting and using available processes to channel their interaction

Table 2. BMIS Dynamics Interconnections (DI)

BMIS Dynamic Interconnections (DIs)	
Culture	Culture is a pattern of behaviors, beliefs, assumptions, attitudes and ways of doing things
Governing	Set of responsibilities and practices exercised by the board and executive management with the goal of providing strategic direction, ensuring that objectives are achieved, ascertaining that risks are managed appropriately and verifying that the enterprise's resources are used responsibly
Architecture	The fundamental organisation of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution
Emergence	The arising of new opportunities for business, new behaviors, new processes and other security relevant items, as the subsystems between people and processes
Enabling & Support	Demonstrates a balanced process to support the enterprise technology in one direction and show the effect technology has on business processes in the other direction
Human Factor	Human factor can be referred as human-computer interaction (HCI), the man-machine interface and ergonomics. Human Factors DI interacts with the People and Technology elements. This relationship follows from the fact that weaknesses in security can easily occur due to the way in which people use technology and their understanding of the need for and adherence to security concepts. Similarly, Technology as an element can greatly enhance the quality of work and the way in which people accomplish their tasks

Pfleeger described in his Reference Points (RPs) to help understanding the insiders' actions and its risk [13] which the RPs referred as (1) The Organisation, (2) The Individual, (3) The IT system and (4) The Environment. These RPs influence the authors' insider threat risk mitigation which questions were then formulated to understand the insiders' actions.

Based on the respective RPs, questions were developed as follows:

Between the Organisation and Individual(s)

- Does the action violate de jure or de facto policy?
- Is the policy (de jure or de facto) deficient?
- What were the intent and motive of the insider's action?

Between the Organisation and the System

- Are the policies implemented correctly on the system?

Between Individual(s) and the System

- What was the role of the system in the insider's action?

Between the Environment and Individual(s)

- Was the insider's action legal?
- Was the insider's action ethical?

Between the Environment and the Organisation

- Are the policies legal?
- Are the policies ethical?

From the BMIS and Pfleeger's RPs, we could see the important relationship between organisational environments as discussed above as well as dynamic inter-connections and individual's (insider) actions. The overall correlation is important for organisation to understand the resilient links in order to formulate action plans to mitigate the insider threats risk.

3 "Insider" and "Trusted People": Are They the Same?

The elements, DIs and RPs have been discussed earlier, substantiate on how important for organisation to prudently select its potential employees prior to hiring. The selected individual will be the company resource (People) to follow the organise activities (Process) and applied knowledge (Technology) within organisation. It is paramount for organisations to employ trusted people that capable to perform the jobs assigned. The trust relationships are vital so that when employer delegates jobs to an employee, it is expected that an employee able to deliver the jobs as intended. A trust equation to measure trustworthiness can be the basis of organisations to continuously measure the trust. The equation contains 3 variables as the numerator and 1 variable as the denominator. The trustworthiness is viewed based on outcome (variable) of the 4 principles. The human beings must always act to hold these principles consistently and persistently in order to be perceived as trustworthy behavior [5]. The variables for trustworthiness are Credibility, Reliability, Intimacy and Self-Orientation as follows (Table 3):

Table 3. Trustworthiness (Source: Webster online)

Trustworthiness =	$\frac{\text{Credibility} + \text{Reliability} + \text{Intimacy}}{\text{Self - Orientation}}$
Credibility	The quality or power of inspiring belief/capacity for belief
Reliability	The quality or state being reliable/giving the same result on successive trials
Intimacy	The state of being intimate/familiarity
Self-Orientation	Overly concern of own desire

Human also assesses the trustworthiness through vertical trust and horizontal trust. The vertical trust relationship exists between individuals and organisations while the horizontal trust can be concluded from the observations and opinions of others [6]. A constant trust also provides two important outcomes namely speed and cost. When a trust goes down, the speed of doing business or activities goes down and the cost goes up. On the opposite site, when the trust goes up, the speed will go up and the cost goes down [14]. The diagram depicted the trust relationship as follows (Fig. 2):

Fig. 2. Trust relationship

For insider attack incidents to occur, it can be analysed from 3 main contributors or catalysts (also known as factors) to take place. It is when the MOM factors of **Method**, **Opportunity** and **Motive** presence simultaneous. If any of these 3 factors were denied (absence), it could deform the threats. Method is the skills, knowledge, tools and other things that helps perpetrators to succeed the attack. Opportunity would be the time and access to accomplish the attack, and motive would be the reason on why the attack was performed. The National Science Foundation (NSF) concurs that fraud could occur via these factors and suggest identifying the indicators of the components via "Possible Grant Fraud Indicators: NSF-OIG Handbook" publication [8]. The publication highlights the possible motives, opportunities and method for fraud to happen. Once organisation understand and recognise the contributors or catalysts, they could appropriately react to reduce the gap of opportunity by putting countermeasure and denying any possible method that potentially can be used by perpetrators. The organisational biggest challenge would be identifying the perpetrators' intention (motive). However, given at any scenario, the insider attacks or incidents would be most probably not happening as long as the 3 factors are suppressed and not available at the same time. In this particular case, the subject of "insider" and "trusted people" are the same person that capable to become the potential perpetrators (insider attackers).

4 Method

4.1 Conceptual Understanding of Inclination Towards Insider Threat Mitigation Controls

More insider threats research is required to ensure a motivation to detect and deter the threats continuously exist and ahead of what is in the mind of insider fraudsters or perpetrators. There are many completed and on-going research on insider threats where the outcome of the research were the security solutions released to market. However, it was not reasonably accepted as compared to security products for external threats [12]. This was probably due to complexity and exclusivity towards organisation challenges with regard to internal threats. We had conducted basic Scopus online search on 05 January 2016. The "Insider Threat" was used as the input keyword and based on the keyword entered, it produced 670 results from 52 different countries. The results also showed that the related keyword (Insider Threat) study were increasing as shown via the research paper submission year by year between 1977 and 2015. The upward inclination indicates the area of research interests (insider threats) are greatly improved and illustrated as follows (Fig. 3):

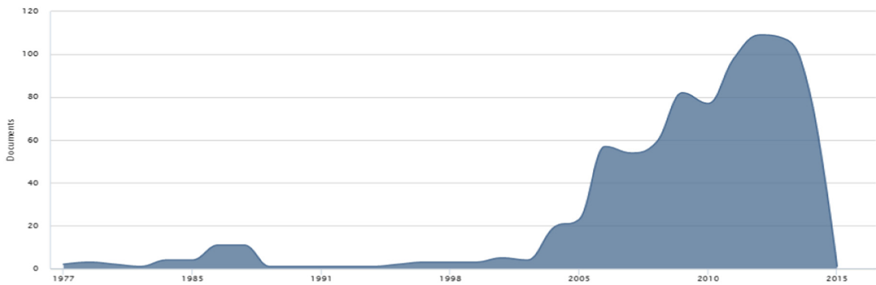


Fig. 3. Increase trend on the "insider threat" keywords (Scopus)

Despite the increased, there is a shortage of the same study from Malaysia as indicated in the following Table 4:

It was noted that highest submission came from the United States (**51.1%**) and followed by United Kingdom (**8.4%**), China (**5.1%**), Canada (**3.1%**), Australia (**3.1%**), South Korea (**2.8%**), India (**2.6%**), Germany (**2.3%**) and Japan (**2%**). The rest of the country recorded at less than **2%** submission. That includes Malaysia which contributed to only **0.5%** from the total submission. Further to that, on 19 January 2014 (21:04) and 25 December 2014 (06:35), the same keyword was entered in the Google Scholar website (http://scholar.google.com.my). The search result produced 108,000 and 126,000 outcomes respectively. Notably, in less than a year, there were **14%** increase in the number of related documents (search result) based on the keyword entered. Detail as follows (Table 5):

Table 4. The country & number of journal submitted (Scopus)

No	Country	#	%	No	Country	#	%
1.	United States	408	51.1	27.	Switzerland	3	0.4
2.	United Kingdom	67	8.4	28.	Poland	3	0.4
3.	China	41	5.1	29.	Russian Federation	3	0.4
4.	Canada	25	3.1	30.	Tunisia	3	0.4
5.	Australia	25	3.1	31.	Norway	3	0.4
6.	South Korea	22	2.8	32.	Egypt	2	0.3
7.	India	21	2.6	33.	Luxembourg	2	0.3
8.	Germany	18	2.3	34.	Portugal	2	0.3
9.	Japan	16	2.0	35.	Singapore	2	0.3
10.	Greece	15	1.9	36.	Belgium	2	0.3
11.	Netherlands	13	1.6	37.	Turkey	2	0.3
12.	Denmark	12	1.5	38.	Saudi Arabia	2	0.3
13.	Pakistan	9	1.1	39.	Oman	1	0.1
14.	Taiwan	7	0.9	40.	Ecuador	1	0.1
15.	South Africa	6	0.8	41.	Peru	1	0.1
16.	Hong Kong	6	0.8	42.	Ireland	1	0.1
17.	Austria	5	0.6	43.	Malta	1	0.1
18.	Spain	5	0.6	44.	Czech Republic	1	0.1
19.	New Zealand	5	0.6	45.	Croatia	1	0.1
20.	France	5	0.6	46.	Colombia	1	0.1
21.	Italy	5	0.6	47.	Bahrain	1	0.1
22.	Sweden	4	0.5	48.	Algeria	1	0.1
23.	Jordan	4	0.5	49.	Azerbaijan	1	0.1
24.	**Malaysia**	4	**0.5**	50.	Mauritius	1	0.1
25.	Israel	4	0.5	51.	U. Arab Emirates	1	0.1
26.	Finland	3	0.4	52.	Hungary	1	0.1

Table 5. Google Scholar searches' results

Result	Search on 19/01/14 (21:04)	Search on 25/12/14 (06:35)	% Difference
	108,000	126,000	+14%
Since 2010	19400	20200	+4%
Since 2013	5,570	17,600	+68%
Since 2014	436	7780	+94%

In this study, the CERT Insider Threat Center is one of the most comprehensive and structured research centers that we found and used as main reference. CERT mission is "to enable effective insider threat programs by performing research, modeling, analysis, and outreach to define socio-technical best practices so that organisations are better able to detect and responds to evolving insider threats" [8].

The related works by CERT Insider Threat Center research consists of the following:

- Case analysis and best practices,
- Modelling and simulation,
- Espionage research,
- Mitigation controls, patterns and pattern languages,
- Identifying and detecting early warning indicators,
- Developing and conducting assessments and workshops,
- Insider threats in software development lifecycle,
- Annual e-Crime Watch Survey, and
- Insider Threat blog.

4.2 Survey Instrument

The Common-Sense Guide to Mitigating Insider Threats 4th edition delivers the most current recommendations when more than 700 related insider threat cases and continued research analysis were referred [9] to develop this survey instrument. The guide defines 19 practices for organisation to adopt and implement in order to prevent and detect insider threats. Each practice indicates challenges, recommendation and a mapping practice to industry information security standards such as ISO 27001. The document focuses 6 groups within organisational structure namely Human Resource (HR), Legal, Physical Security, Data Owners, Information Technology (IT) and Software Engineering. It also contains action plans to articulate practices and formulating the continued research and analysis of various insider threats incidents recorded by researchers at SEI-CMU. For this study, we intend to understand the inclination towards insider threats among Malaysian employees and gauge their level of agreement as per recommended practices. The gained responses would be able to inform us whether the company they are working for is basically implementing the recommended practices. It could also provide indication whether companies in this country are recognising the threats as well as their readiness to fight insider threats. Based on the 19 recommended practices, we developed at least 2 questions of each practices with a total of 55 questions.

5 Result

The survey was targeted for employees who primarily work in listed Malaysian companies. We had blasted an email to at least 200 potential respondents but received only a total of 50 responses (n = 50). Based on follow up calls to at least 5 respondents who did not return the forms, they felt that the subject "insider" is a bit sensitive information for the company to reveal and decline to provide feedback. That was probably one of the reasons that the forms returned/received were at only **25%**. Nevertheless, about **40%** of the respondents have more than 5 years of working experience (*yowe*) in their current organisation and **74%** of them have more than 7 *yowe*. Detail as follows (Figs. 4 and 5):

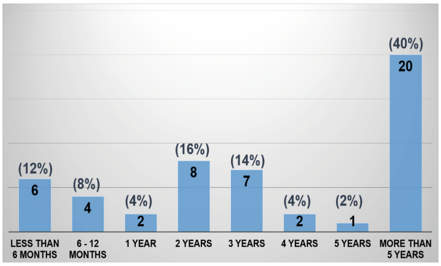


Fig. 4. Respondents' yowe in current organisation

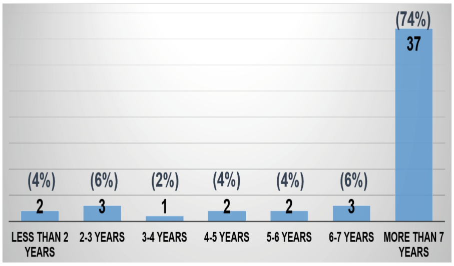
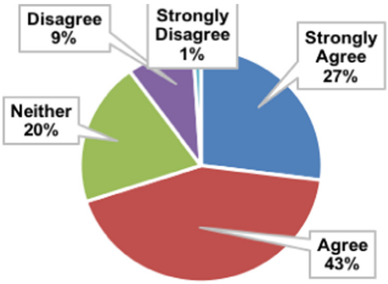
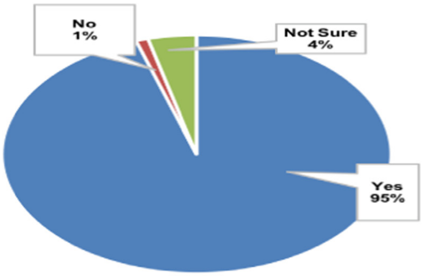


Fig. 5. Respondents' yowe in total

In general, the result shows that **70%** of the respondents said that their company coordinates activities to mitigate insider threats when the overall result of **27%** said that they "**Strongly Agree**" and **43%** "**Agree**". It was only **10%** felt that their company has not done anything yet to mitigate the insider threat risks while **20%** remain unsure ("**Not sure**") about it. The survey also get confirmation via the developed questions on whether the recommended controls (practices) were good countermeasures to be implemented in mitigating insider threat risks (i.e. I agree that the controls (C1–C55) are good countermeasures to be implemented in mitigating insider threat risk?). The result came with **95%** responded as "agree" that the recommended practices were good countermeasure to be implemented for mitigating the insider threat risk.

Detail as follows:



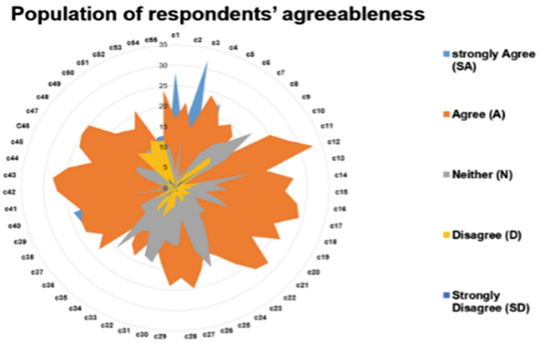


The current CERT Common Sense Guide put additional practice namely "Structure management and tasks to minimise unintentional insider stress and mistakes". However, this study uses the previous version and did not focus on the unintentional insider threats. Organisation can include risk assessment process in the company enterprise-wide for mitigating insider threat. In doing so, companies can demand their vendors, contractors and business partners to sign Non-Disclosure Agreement (NDA) upon them being hiring, employed or contracted. The company should perform background check on employees and business partners particularly to those who will be given access to critical system. Majority of our respondents (i.e. 68%) agree that signing the NDA and performing background check would be able to mitigate the risk.

The visions, missions and objectives of the company must be clearly documented and consistently enforce via its control statements in the policies and procedures. The agreements and its percentage (%) of each practices are as follows:

Practices	% Agreement
I believe that my current company…	
• Briefs the employees, contractors as well as trusted business partner and get their acknowledgement of read and understood the relevant policy and procedures	80%
• Has the latest copy of Policies and Procedures and easily accessible by the employees from the company's Intranet and other centralized repository system	90%
• Encourages new employees and contractors to be trained in security awareness prior to granting them an access to the system	58%
• Conducts periodic security training for all employees	42%
• Conducts a thorough background investigation, which at a minimum include a criminal background and credit check of potential employees	68%
• Encourages the employees to report any suspicious behavior to appropriate personnel	94%
• Enforces policies and procedures consistently to all employees and any exceptions to the policies were discreetly handled	90%
• Limits the user access to the log files to those with a need to know and those relevant to their job's requirement	74%
• Identifies respective asset owners and documenting the type of data in the system	82%
• Prioritises our assets and data to determine the high-value targets (assets)	66%
• Defines certain password requirements and trains their users on creating strong passwords	80%
• Removes users' permissions that are no longer needed	80%
• Encourages the privileged users to have both an administrative account with the minimum necessary privileges	68%
• Implements separation of duties that affect the production system	80%
• Has the process to disable remote access when an employee or contractor separates from the organisation	74%
• Prohibits or limit the use of personally owned devices by the employees	54%
• Has a process to track all accounts (systems' access) assigned to each employee that already resigned, transferred and newly joined	76%
• Encrypts the backup media and manages the encryption keys to ensure backup and recovery are possible	76%
• Establishes policies and procedures that include Human Resource, Legal, Security, management, and Internal Audit to address insider threats	76%
• Monitors the use of printers, copiers, scanners, etc.	52%

We can consider the data gathered was a decent quality since majority of participants who provide us the feedback have reasonable years of working experience (*yowe*) and able to understand the subject discussed (questionnaire). There will be more action plans needed to understand the insider threats and mitigation strategies for Malaysian landscape. Based on the CMU-SEI practice guide to mitigate insider threats, we can clearly conclude that companies in Malaysia are generally practicing the controls. This was clearly indicated by most of the participants when they said that they agree that their respective companies were implementing the suggested activities. Pattern of agreeableness population as follows:



5.1 Conclusion and Future Research

This study provides new insight and understanding on insider threats from Malaysia context. Survey instruments able to discover awareness level company in Malaysia regarding insider threats. Four factors i.e., **motive**, **method** and **opportunity** must be recognised, identified and suppressed within the organisation boundary towards providing effective countermeasure. With that note, finding effective way to implement best practices are demand for further research.

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Information Systems and Information Science

Assessment of Risk Interdependencies on Information System Development Projects

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Abstract. This study aimed to adopt an approach for assessing the mutual influences of risk factors on information system development projects changing from the initialization to control phases. Given that risks evolve dynamically, the variation in the strength and types of risk influences throughout the development process of information system projects should be analyzed so that effective risk management strategies can be devised in a cost-effective way at the right stage. Therefore, our study extended the Decision Making Trial and Evaluation Laboratory technique to assess quantitatively the interdependencies among the risk factors, and analyze the various influences of each risk factor for each project development phase. An empirical case of a information system development project was conducted to demonstrate the applicability of this technique.

Keywords: Information system development project
Decision Making Trial and Evaluation Laboratory (DEMATEL)
Risk influence

1 Introduction

The implementation of ISD projects is a highly complex process, with various risks and uncertainties permeated through the life cycle of project development [1, 2]. Risk management is suggested as a remedy for alleviating the project difficulties, such as budget overrun, schedule delay, or quality deficiencies, and creating a proactive environment of ISD projects [3]. One of the major challenges in project risk management process is the need to assess the significance of potential risks effectively, and determine the priorities so that the subsequent risk control strategies can be guided and implemented in a cost-effective way [4].

Project risk factors are diverse and involved various aspects from technology, organizations, humans, and management. These risk factors are often dependent on each other and mutually related. The interrelationships among risk factors may evoke domino effects from one factor to another, and affect the final project [5]. Project managers often encounter these ill-defined problems with interdependence and

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feedback among risk factors. Any managerial intervention with one risk factor affects all the others, thereby leading to changes in mutual influences among risk factors [6]. This feature complicates project risk management activities. To achieve effective improvements with minimal resources, the resolution strategies are usually associated with better understanding of the structure of causal relations among risk factors [7]. By observing the causal relationships, the key risk factors for improving the overall project performance can be identified and general response strategies can be devised. Thus, the risk interdependence is one of the important aspects that should be thoroughly addressed to enhance the risk assessment procedures.

The DEMATEL technique, which is effective in causal analysis, quantitatively measures the interrelationships among risk factors, distinguishes the cause-and-effect relationships, and determines the strength of mutual influences for risk factors [8]. The causal diagram of DEMATEL provides an overall understanding of interactive relationships among risk factors by providing suggesions to guide the subsequent risk controls, which subsequently, improve the risk management performance [9]. Thus, this study extended the DEMATEL method with multi-phase observations to support the risk assessment procedures. The proposed approach simultaneously considers the interplay among risk factors and incorporates the dynamic nature of risk factors along project development phases, including initiation, planning, execution, and control.

2 ISD Project Risk Assessment

2.1 Risk Factors of ISD Project

The term “project risk”, in accordance with the PMBOK [10] guide, is described as “an uncertain event or condition that, if it occurs, has a positive or negative effect on the project objectives.” Alter and Ginzberg [11] identified eight risk factors, mainly from designers and users in their implementation risk model. Davis [12] claimed that the difficulties in requirement determination lead to poor project performance. Boehm [13] proposed a top ten checklist of software project risk factors. Through thorough literature reviews, Barki et al. [1] developed a generally accepted risk assessment instrument. The instrument consists of 23 risk variables that are categorized into five groups, namely, technological newness, application size, expertise, application complexity, and organizational environment. To address the relative importance of various factors systematically, Schmidt et al. [14] employed a “ranking type” Delphi survey with three panels of experts in Hong Kong, Finland, and the United States. The survey developed a common list of 53 risk factors and produced a rank-order list of top 11 risk factors that deserve the project managers’ attentions during project development. Liu et al. [15] examined and compared the risk factors from the perspectives of Chinese senior executives and project managers based on the work of Schmidt et al. [14]. A comprehensive list of 57 risk factors was identified, and 18 new risk items not identified in prior studies were included [14]. To examine the effects of software development risks on project performance, Wallace et al. [3] further built a theoretical model composed of three constructs (i.e., social subsystems, technical subsystems, and project management) and measured by six underlying risk dimensions (i.e., organization environment, user, requirement, project complexity, team, and planning and control).

2.2 Assessment of Risk Interdependencies

Several approaches [3–5] have been used to model the interrelationships among risk factors. Fan et al. [5] proposed an approach based on DEMATEL to identify the risk factors in information technology (IT) outsourcing projects with considerations of the interrelationships among risk factors. The network structure of complex causal relationships among eight outsourcing risk factors was portrayed with matrices and digraphs in which the numerals of links represent the strength of influences. The functions of risk factors were properly recognized to support the risk control process. Among these causal modeling methods, DEMATEL can model the major elements in the assessment of interdependencies, including the dependencies of how a factor leads to another, strength of the dependencies, and feedback effects from other factors and itself. DEMATEL investigates the interactive and feedback dynamics among risk factors, and provides the most information to interpret the risk interdependencies.

3 DEMATEL Methods with Multi-phase Observations

We used DEMATEL to investigate the interactions among risk factors of ISD projects. Given the dynamic nature of risk factors, DEMATEL is further extended with multiple surveys for different critical phases to analyze the changes in risk influences over time. Based on several studies [6, 16, 17], the procedure of our study to apply DEMATEL method can be modified in seven steps (Fig. 1).

Step 1: Define the list of evaluation criteria and develop a questionnaire

The first step is to define a list of appropriate evaluation criteria or factors, which can be achieved by extensive literature reviews, Delphi technique, expert interviews, or brainstorming. A distinct matrix-type questionnaire is then designed to identify the binary relations between every two factors.

Step 2: Collect data with experts and calculate the initial average matrix

A group of experts is asked to complete the questionnaires. Each expert makes pair comparisons, and indicates the degree of direct influence between criteria/factors. For each expert $h(h = 1, \ldots, H)$, the degree to which criterion/factor i affects the other criterion/factor j at phase p is denoted as $(a_{ij}^{p})_h$. The scales range from 0 to 4, where 0 means no influence and 4 means a very high influence.

Step 3: Normalize the initial direct influence matrix
Step 4: Derive the total influence matrix

For each phase p, the total influence matrix, composed of an infinite series of direct and indirect effects of each element, can be obtained by.

$$\boldsymbol{T}^{p} = (\mathbf{X^p}) + (\mathbf{X^p})^2 + \mathbf{L} + (\mathbf{X^p})^{\mathbf{k}} = (\mathbf{X^p})(\mathbf{I} - (\mathbf{X^p}))^{-1}; \forall p, k \to \infty$$

where $\boldsymbol{T}^p = [t_{ij}^p]_{n\times n}$, for $i, j = 1, 2, \ldots, n; \forall p$; $(\mathbf{I} - \mathbf{X^p})(\mathbf{I} - \mathbf{X^p})^{-\mathbf{1}} = \mathbf{I}.;\forall \mathrm{p}$ and $\mathbf{I}$ is an identity matrix and $0 \le x_{ij}^p < 1$, $0 < \sum_j x_{ij}^p \le 1$ and at least one summation of $\sum_j x_{ij}^p$ or $\sum_i x_{ij}^p$ is equals to 1. Each element t_{ij}^p in matrix $\boldsymbol{T}^p$ provides information on how criterion i affects criterion j both directly and indirectly at phase p.

Step5: Derive four important influence coefficients

From the total influence matrix T^p, the sum of rows (influence given) and sum of columns (influence received) are expressed as vector $\boldsymbol{r}^p$ and vector $\boldsymbol{c}^p$ respectively, using the followings.

$$\boldsymbol{r}^p = (r_j^p)_{n\times 1} = (r_j^p)'_{1\times n} = [\sum_{i=1}^{n} t_{ij}^p]'_{1\times n}; \forall p$$

$$\boldsymbol{c}^p = (\mathrm{c}_i^p)_{n\times 1} = [\sum_{j=1}^{n} t_{ij}^p]_{n\times 1}; \forall p$$

Let r_i^p be the sum of the i^{th} row of the influence matrix. The value of r_i^p represents the total of the direct and indirect influences supplied by criteria/factor i to the others. Suppose c_j^p is the sum of the j^{th} column of influence matrix. The value of c_j^p shows the total of the direct and indirect influences received by criteria/factor j from the others. When $i = j$, the sum $(\mathrm{r_i^p} + \mathrm{c_i^p})$ presents the total of effects both given and received by criteria/factor i, that is, the degree of the central function that criterion/factor i has in the problem at phase p. The difference $(\mathrm{r_i^p} - \mathrm{c_i^p})$ presents the net effect of criterion/factor i contributing to the problem at phase p. The value of $(\mathrm{r_i^p} + \mathrm{c_i^p})$ and $(\mathrm{r_i^p} - \mathrm{c_i^p})$ are named "prominence" and "relation" respectively.

Step 6: Build a Causal Diagram and classify criteria/factors

To illustrate the complex interrelationship in an easy-to-understand structure, a causal diagram is constructed with "prominence" $(r_i^p + c_i^p)$ as the horizontal axis and "relation" $(r_i^p - c_i^p)$ as the vertical axis. The criteria/factors are divided into the cause or the effect group in each phase according to their "relation" value. The interpretations of risk factors and management directions for the four sectors are depicted in Fig. 2.

Step 7: Analyze the changes in factor influences along different phases

In a real situation, some criteria/factors may manifest itself with different characteristics over time. Considering the temporal differences of criteria/factors, the changes in functions of each factor should be analyzed along different phases of time as shown in Fig. 3.

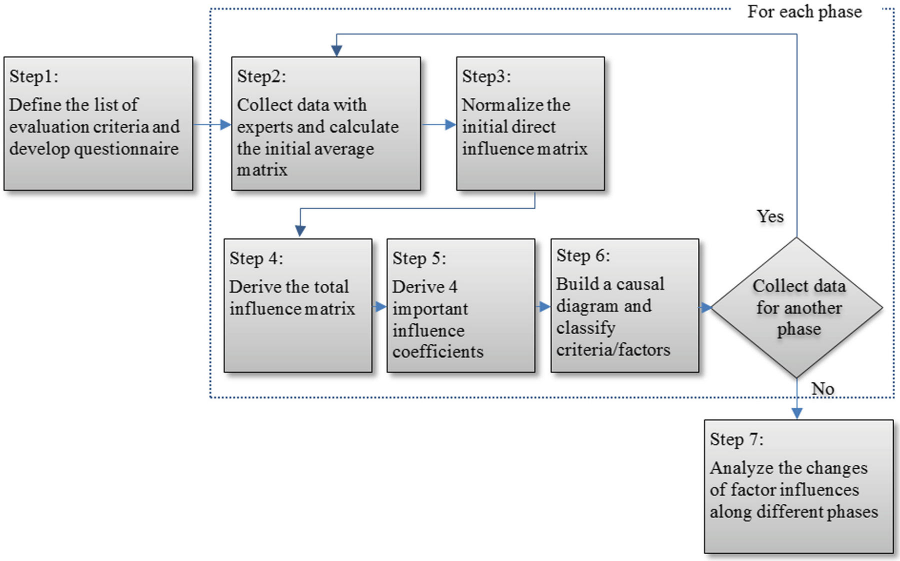


Fig. 1. Procedure of extended DEMATEL method

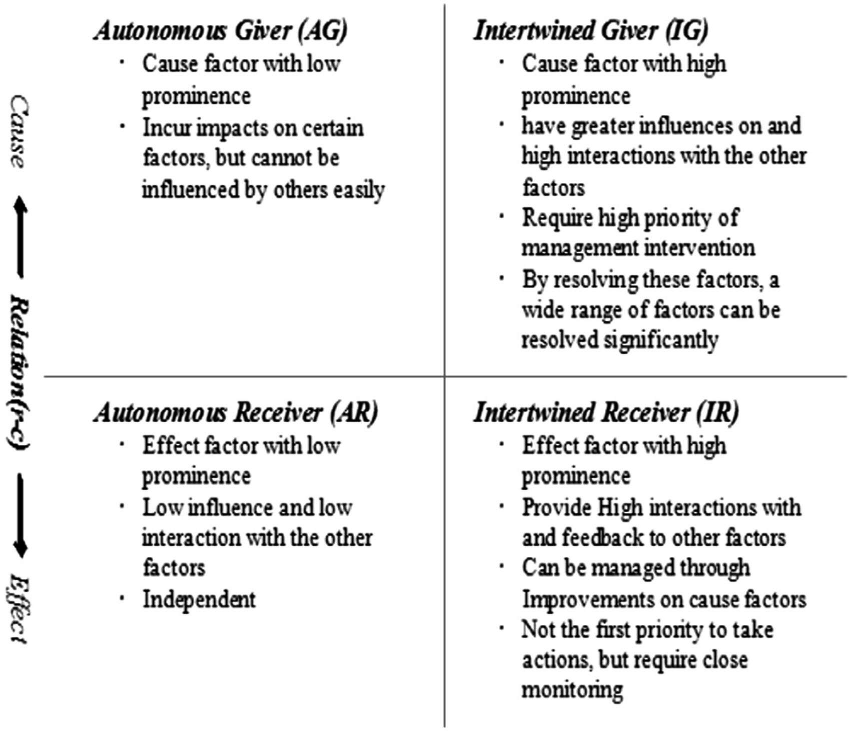


Fig. 2. Four sectors by (interwined, autonomous) vs. (receiver, giver)

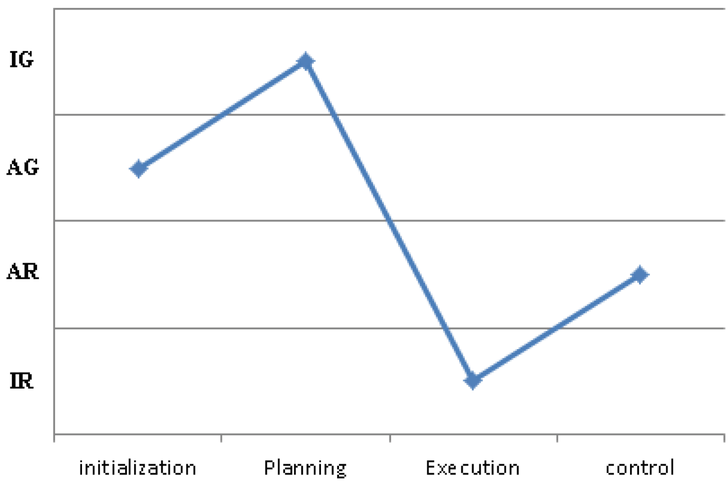


Fig. 3. Variation in criterion/factor along different time phases

4 Empirical Study

The empirical study was conducted in a private university in Taiwan. Faced with the fierce competition of dynamic educational environment, an increasing number of universities appeal to the integrated IS as a solution for saving cost, improving performance, enhancing decision-making quality, and providing better services. A Delphi-based approach was used to identify the major risk factors that would be included in the risk assessment procedure. A panel of five experts, namely, one IT director, two members of an IT steering committee, and two external IT consultants, was chosen for this purpose. The experts possess specialty in project management and profound experiences in UISD projects. Through three iterations of in-depth discussions, they reached a group consensus and extracted 22 relevant risk factors. The hierarchy of risk factors is presented in Table 1.

To investigate the influential risk factors under different project development phases, this study collected data with multiple surveys for each project development phase, namely initialization, planning, execution and control. The knowledge of professionals and experts on project risk management is important for this study. Therefore, respondents consisted of the core team members and academic professors who were familiar and extensively experienced with ISD projects to discuss and fill out the survey. Two of the authors confirmed that each respondent understood how to evaluate the risk interrelationships based on DEMATEL, and provided assistance for any questions during completion of the questionnaires. Respondents completed each questionnaire in 1.5 h to 2 h.

Table 1. Selected risk factors of empirical UISD project

Constructs	Underlying dimensions	Risk factors
Social subsystems	Organizational environment (O)	Top management commitment (O_1)
		Organizational changes (O_2)
		Organizational politics (O_3)
		Environmental changes (O_4)
	User (U)	Users' attitude (U_1)
		Users' conflict (U_2)
		Users' involvement (U_3)
Technical subsystems	Requirement (R)	Requirement stability (R_1)
		Requirement completeness (R_2)
		Requirement validity (R_3)
		Requirement clarity (R_4)
	Project complexity (C)	New technology (C_1)
		Task complexity (C_2)
		Technical complexity (C_3)
Project management	Team (T)	Development expertise (T_1)
		Application know-how (T_2)
		Development experience (T_3)
		Team Stability (T_4)
	Planning and control (P)	Project resource estimation (P_1)
		Progress tracking and Monitoring (P_2)
		Project manager competencies (P_3)
		Communication and coordination (P_4)

4.1 Application of DEMATEL on Analysis of Risk Interdependencies

Following the above procedure, the total influence matrix and four important influence coefficients were obtained for each project development phase. The average of prominence value (i.e., 7.06 for initialization phase) of all risk factors was calculated, and used as a baseline threshold to classify the risk factors into high or low prominence groups. The causal diagram was constructed based on Step 6. For illustrative purposes, Table 2 and Fig. 4 present the total influence matrix and causal diagram for project initialization phase, respectively. All factors were mapped into one of the sectors in terms of the relation (level of influences) and prominence (level of interactions). The causal classifications clearly and intuitively described the functions of risk factors in the initialization phase from the perspectives of risk interdependencies. Sector IG includes factor O1 (top management commitment), T1 (development expertise), T2 (application know-how), T3 (development experience), P1 (project resource estimation), and project manager competencies (P3), which have central functions in the initialization phase and necessitate immediate and appropriate management interventions. Sector IR includes U1 (users' attitude), U2 (users' conflict), U3 (users' involvement), R1 (requirement stability), R2 (requirement completeness), T4 (team stability) and P4 (communication coordination). Sector AG includes O2 (organizational changes), O3 (organization politics), O4 (environmental changes), C1 (new technology) and C2 (task complexity). Sector AR includes R3 (requirement validity), R4 (requirement clarity), C3 (technical complexity) and P2 (progress checking and monitoring).

While the total influence matrix provides information about how one factor affects another, the causal relationships between every two factors can be examined in details. However, it is too complex to reveal the necessary information for decision making if all the causal relationships for each pair of factors are considered. To keep the complexity of risk interdependencies to a manageable level, a threshold value is suggested to filter out some relationships with minor effects [6]. Only the values of causal relationships greater than the threshold are shown in red in Table 2 for further analysis. In our case, we experimented with different threshold values to keep the top 20%, 30% or 50% causal relationships. After discussing with the core team members of the case university, the threshold value for initialization phase is set to 0.19 (rounded to two decimal digits) to retain the top 30% causal relationships. The interrelation of how one factor influences and is influenced by the others is presented. For example, P3 has significant influences on U2 (0.19), U3 (0.21), R1 (0.23), R2 (0.22), R3 (0.21), R4 (0.21), T4 (0.21), P1 (0.21), and P2 (0.20), which means the improvements of P3 can resolve these risk factors. Moreover, P3 has mutual interactions with U1 (0.20 denoted as influencing coefficient; 0.20 denoted as influenced coefficient), T1 (0.20; 0.21), T3 (0.22; 0.22) and P4 (0.23; 0.20) Any management actions on P3 can improve the above four factors, but their feedback effects on P3 and the interactive relationships should be monitored closely. As P3 is influenced by O1 (0.19), enhancements on O1 results in better P3.

5 Discussion

We aggregated the results of questionnaires by the same construct. The causal diagram of the three dimensions in four phases is shown in Fig. 5. Instead of probing the risk factors at an overall project level, more in-depth understanding of risk factors is revealed with multiple observations during the ISD process. Figure 6 shows the various influences of each risk factor along project development phases. Several interesting findings were discovered based on the empirical results.

Table 2. Total influence matrix and influence coefficients of initialization phase

init	O1	O2	O3	O4	U1	U2	U3	R1	R2	R3	R4	C1	C2	C3	T1	T2	T3	T4	P1	P2	P3	P4	r	c	r+c	r-c
O1	0.13	0.18	0.16	0.08	0.24	0.22	0.25	0.24	0.22	0.21	0.21	0.15	0.15	0.14	0.19	0.18	0.21	0.22	0.20	0.18	0.19	0.24	4.16	3.02	7.19	1.14
O2	0.17	0.09	0.14	0.07	0.21	0.19	0.21	0.22	0.20	0.18	0.19	0.11	0.12	0.12	0.16	0.15	0.19	0.18	0.17	0.15	0.17	0.20	3.58	2.52	6.10	1.06
O3	0.16	0.15	0.08	0.07	0.20	0.18	0.20	0.21	0.19	0.18	0.18	0.11	0.11	0.11	0.15	0.14	0.18	0.18	0.17	0.15	0.16	0.19	3.48	2.20	5.68	1.28
O4	0.12	0.09	0.10	0.03	0.14	0.13	0.14	0.17	0.16	0.14	0.14	0.09	0.09	0.09	0.13	0.11	0.14	0.14	0.13	0.11	0.13	0.15	2.69	1.17	3.86	1.51
U1	0.16	0.13	0.12	0.06	0.17	0.21	0.24	0.24	0.23	0.23	0.22	0.15	0.15	0.15	0.20	0.18	0.21	0.22	0.19	0.18	0.20	0.24	4.09	4.18	8.27	-0.09
U2	0.14	0.12	0.10	0.05	0.20	0.15	0.21	0.22	0.21	0.20	0.20	0.13	0.13	0.13	0.17	0.16	0.19	0.20	0.17	0.17	0.18	0.23	3.66	3.88	7.54	-0.22
U3	0.15	0.12	0.10	0.06	0.20	0.19	0.16	0.22	0.22	0.21	0.20	0.13	0.13	0.14	0.18	0.16	0.20	0.20	0.18	0.17	0.18	0.23	3.73	4.32	8.05	-0.59
R1	0.13	0.11	0.10	0.06	0.19	0.17	0.19	0.15	0.16	0.15	0.15	0.12	0.13	0.13	0.16	0.14	0.18	0.18	0.15	0.14	0.15	0.18	3.22	4.46	7.68	-1.24
R2	0.11	0.10	0.09	0.05	0.17	0.16	0.18	0.16	0.13	0.14	0.15	0.12	0.13	0.12	0.15	0.13	0.18	0.18	0.14	0.14	0.15	0.17	3.04	4.24	7.28	-1.20
R3	0.11	0.10	0.09	0.05	0.17	0.16	0.18	0.15	0.15	0.12	0.14	0.11	0.11	0.11	0.14	0.12	0.17	0.17	0.14	0.13	0.14	0.17	2.93	3.94	6.87	-1.01
R4	0.11	0.10	0.09	0.05	0.17	0.16	0.18	0.16	0.15	0.14	0.13	0.11	0.12	0.12	0.15	0.13	0.18	0.18	0.14	0.14	0.15	0.17	3.02	4.00	7.03	-0.98
C1	0.11	0.09	0.08	0.04	0.17	0.15	0.17	0.16	0.15	0.14	0.14	0.09	0.14	0.13	0.16	0.15	0.17	0.16	0.15	0.14	0.16	0.16	3.04	2.83	5.87	0.21
C2	0.12	0.10	0.08	0.04	0.18	0.16	0.18	0.19	0.17	0.16	0.17	0.14	0.10	0.15	0.18	0.16	0.19	0.18	0.16	0.15	0.16	0.17	3.29	2.96	6.25	0.33
C3	0.10	0.08	0.07	0.04	0.15	0.13	0.15	0.16	0.15	0.13	0.14	0.12	0.13	0.09	0.15	0.14	0.16	0.15	0.14	0.13	0.14	0.15	2.79	2.93	5.73	-0.14
T1	0.16	0.13	0.11	0.06	0.22	0.20	0.22	0.23	0.22	0.21	0.21	0.16	0.17	0.17	0.16	0.20	0.23	0.22	0.20	0.20	0.21	0.24	4.11	3.79	7.91	0.32
T2	0.14	0.11	0.10	0.05	0.20	0.19	0.21	0.21	0.20	0.19	0.20	0.15	0.16	0.16	0.21	0.13	0.21	0.20	0.18	0.17	0.19	0.21	3.77	3.42	7.19	0.35
T3	0.16	0.13	0.11	0.06	0.23	0.21	0.23	0.25	0.24	0.22	0.23	0.16	0.17	0.17	0.22	0.20	0.18	0.23	0.21	0.20	0.22	0.25	4.26	4.20	8.46	0.06
T4	0.14	0.11	0.10	0.05	0.20	0.19	0.21	0.22	0.21	0.20	0.20	0.14	0.15	0.15	0.19	0.17	0.21	0.16	0.19	0.18	0.19	0.21	3.76	4.16	7.92	-0.40
P1	0.15	0.13	0.10	0.05	0.19	0.18	0.20	0.22	0.24	0.19	0.19	0.14	0.15	0.15	0.19	0.17	0.20	0.20	0.14	0.18	0.19	0.20	3.76	3.71	7.47	0.05
P2	0.13	0.11	0.09	0.05	0.17	0.16	0.18	0.20	0.18	0.17	0.17	0.12	0.12	0.12	0.16	0.14	0.18	0.18	0.17	0.12	0.17	0.19	3.29	3.53	6.82	-0.24
P3	0.15	0.13	0.10	0.06	0.20	0.19	0.21	0.23	0.22	0.21	0.21	0.15	0.15	0.16	0.20	0.18	0.22	0.21	0.21	0.20	0.15	0.23	3.97	3.77	7.74	0.19
P4	0.16	0.13	0.10	0.05	0.22	0.21	0.23	0.24	0.22	0.21	0.22	0.14	0.15	0.14	0.19	0.17	0.21	0.22	0.19	0.19	0.20	0.18	3.97	4.36	8.33	-0.39

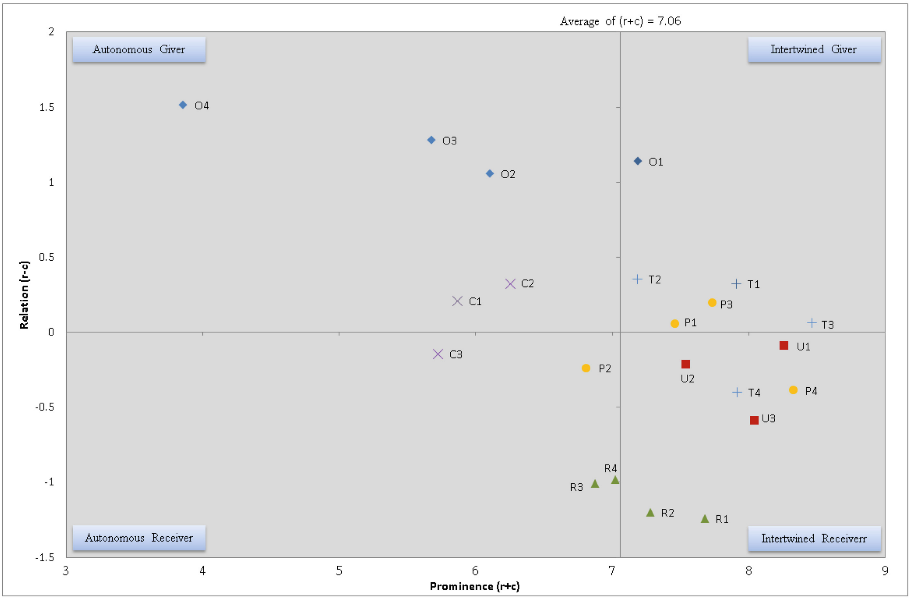
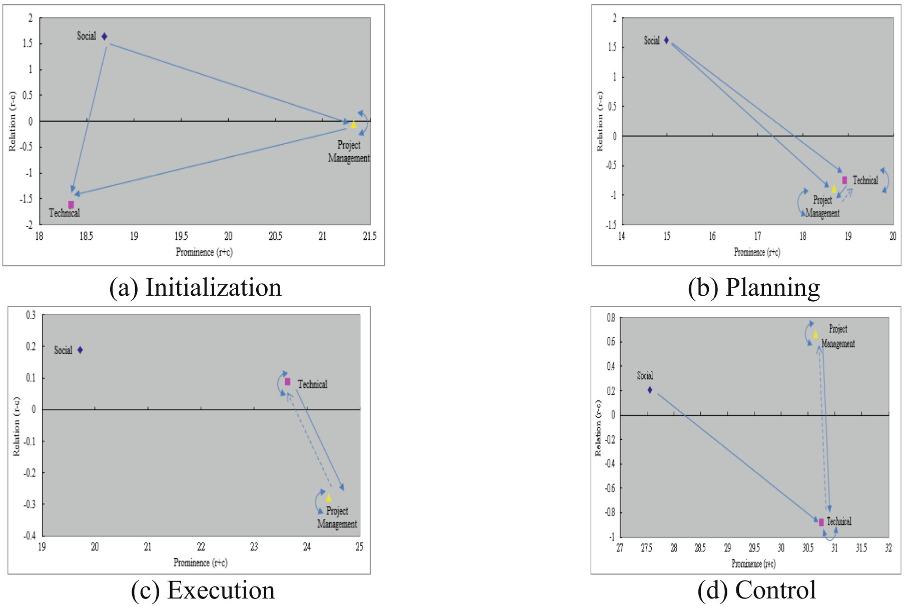


Fig. 4. Causal diagram of project initialization phase



(a) Initialization (b) Planning

(c) Execution (d) Control

Fig. 5. Causal diagram of the thee dimensions of four phases

Fig. 6. Various influences variation of each risk factor along project development phases

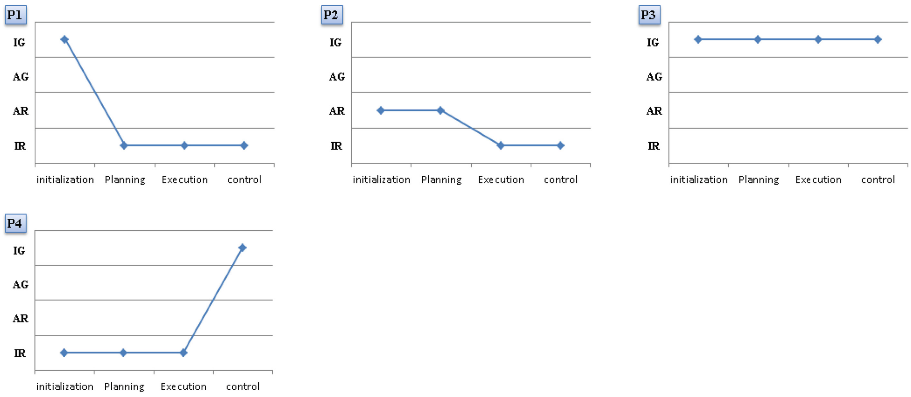


Fig. 6. (*continued*)

6 Conclusions and Remarks

Risk assessment for IS projects is traditionally used to analyze the possibilities and magnitude of loss for each risk factor, and produce a rank order list of risks in terms of relative importance. However, risk factors are often interdependent. Given the mutual influences among risk factors, any management action for one factor can have an effect on the others. This study provides evidence that better understanding of interrelationships among risk factors is essential in risk assessment. Moreover, a multi-phase analysis of risk influence could be a more suitable alternative than a single-phase analysis in risk management of ISD projects, as shown in the empirical study. This study had certain limitations. First, the importance or non-importance of risk factors was not considered. Second, the uncertainties from competition and markets were excluded from analysis in this study, which possibly affected the results of the project risk influences. Third, this study used an empirical case of UISD project to illustrate the applicability of the proposed approach. This case merely reflected the evidence of educations. Thus, promoting the approach to ISD projects of a wide range of industries is recommended. Fourth, the relationship between Wallace et al. [3] and our proposed approach did not assess formal statistical analysis.

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Integral Knowledge Management System in Health

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Abstract. This paper describes the results of the design of an Integrated Knowledge Management System in Health (IKMSH), including the description of a methodology for implementation; the system focuses on strengthening the provision of health services at the regional level and supported by knowledge management and information and communication technologies. This system allows the dynamic integration of existing or new information systems with knowledge management applications, supported in an interactive knowledge portal as an interface between the user and intelligent agents; the system is also supported by a knowledge repository integrated under specific data mining techniques and intelligent agents to provide reliable, secure and verifiable information and knowledge in the management of health decisions.

The proposed system is *integral* because it includes the necessary parts of the *General Social Security System in Health* at the governmental level: Assurance, management, provision of services, surveillance and control, supervision, evaluation and other components of *health care*.

Taking into account the magnitude of the system and that governmental support is required for its implementation, a series of strategies are proposed for its development, organization and implementation.

Keywords: Health · Information systems · Knowledge management
Knowledge management systems · Innovation · Technology

1 Introduction

In Colombia, the deficiencies of health information have been the constant during the more than twenty years of the General Social Security System in Health, to the point that even today there is not an adequate integral and integrated model of information management and knowledge health, involving and relating to all stakeholders, all processes and all results, standardized reports, in accordance with existing regulations, with the business demands of today's world and with the demands of users.

Current regulations in the country, which is very rich, very thorough and extensive health, has developed few aspects are essential for the proper functioning of the health system, but unfortunately these regulatory developments have not translated into

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operational processes, so that, in real life, is not transparent to the end user (patient and family) the health service as a support for their conditions and quality of life.

Processes for attention, not only direct health services, but all assurance, the promotion and prevention, induction demand and worse as education and information, suffer from all kinds of failures and end they generate frustration, discouragement, restlessness and anxiety, both in patients and their relatives, increasing dissatisfaction, demands and guardianships that make the Health System inefficient, expensive and "deficient".

Although technology today provides all the possibilities to do things right, even its implementation is very poor and limited, especially for the optimal functioning of the Social Security Health System. Likewise, the technical capacity of health personnel for the use of ICTs is very deficient and does not allow their use.

For all the above reasons and the others explained throughout this document, the project aims for the integration of knowledge management, innovation, creativity and training at all levels (formal and informal), to correct and contribute to the overcoming of such shortcomings and the continuous improvement of the social security system in health.

2 Conceptual Framework for Knowledge Management and Health

Knowledge management aims to create structures and organizational dynamics based on knowledge, so that knowledge from the experience of each individual impacts the entire organization and becomes assets that are an integral part of the organization. The integration of these models privileges the organization, management and use of information, the creation of flow mechanisms and the tools that guarantee knowledge management in organizations [1].

Knowledge Management (KM), which is conceived as the process of capture, distribution and effective use of knowledge, promotes a comprehensive approach to all information activities in an entity to generate value and new opportunities [2].

The KM allows managing the asset - intellectual capital, turning KM into a social fact that occurs in formal networks and, above all, in informal ones, favoring the latter, and generating their integration that ultimately catalyses and normalizes them.

Another concept of European consensus defines it as the "Planned and continuous management of activities and processes to enhance knowledge and increase competitiveness through better use and creation of individual and collective knowledge resources" [3].

There are many concepts of well-known authors about what knowledge management means, but in practice we can summarize that it is a concept used in companies, which aim to transfer the knowledge and experience existing in employees, so that it can be used as a resource available to others in the organization.

The KM system in health aims to preserve knowledge, take advantage of the experience and expertise of the people within the system and make them available to the same organization and other institutions that require it. Facilitate innovation and organizational learning, generate connectivity among people within the system, as well as interoperability between different health subsystems (public and private), and allow the generation and development of new ideas about their work performance, conditions of health, health management elements, etc., allowing to improve the identification and solution of complex problems.

The regulations related to e-Health have made it possible to focus on the use of Information and Communication Technologies (ICT), so that the different challenges in the health sector in Colombia can be dealt with more effectively and precisely.

3 Applied Methodology

The methodology that was applied to carry out the project of "Implementation of an Integral System of Knowledge Management in Health" required two fundamental, complementary and continuous phases in some of its activities:

(1) *A first phase properly research:* Where it was intended to achieve a diagnosis of the health sector and as a case study was taken the department of Boyacá, Colombia; for which it was necessary to design and apply surveys, interviews, questionnaires, observation, information and knowledge requirements techniques, and considered: selecting and applying measurement instruments in the health sector; which led to the theoretical formulation, characterization and modeling of an integral health knowledge management system for Boyacá department.

In this phase, a research methodology was applied that integrated the *type of exploratory research* and the *descriptive type* to emphasize the most relevant aspects of the problem and also define the appropriate *procedures and models* for the implementation of alternative solutions in the provision of health services, and also as a basis for characterizing the object of health study in Boyacá.

Specifically, the *exploratory method* sought to observe and evaluate aspects of:

- Normative environment and technical standardization.
- ICT infrastructure for the health sector.
- ICT for access to health services.
- Patient Information Systems.
- Patient safety.
- State of knowledge management and innovation.
- Education, training and dissemination.

To carry out the collection and analysis of the data to answer the research question and test the hypothesis, a quantitative approach based on the *deductive method* was applied. This approach allowed for the numerical measurement, the counting and the use of statistics to establish patterns of behavior in the health sector of Boyacá department.

Therefore, the type of *exploratory research* also allowed obtaining information and determining research aspects of health towards the future. And the *descriptive* type allowed to determine the fundamental characteristics of knowledge management in the health sector in the Boyacá department and ultimately achieve innovation in health care and provision.

(2) *A second phase of design and implementation:* Where the design and application of the integral knowledge management system model was required, supported in a technological platform that allows the future to conclude its applicability and replicability. In this phase, we continued with the application of a conceptual methodology for the implementation of the Integral Health Service through knowledge management with emphasis on Information Technology.

In summary, the project aims to implement a integral knowledge management system in health (IKMSH), from the perspective of "turnkey" technology transfer.

4 Integral Knowledge Management System in Health

4.1 Health Knowledge Management Model

The model is initially based and personified on a level of context or general level (Fig. 1), projected in a pyramidal structure, where the need to interrelate *Health* as the main node is represented, which is represented in the upper vertex of the pyramid and supported on a solid foundation for its effective functioning, that is to say that it rests on the lower vertices that constitute the bases of the pyramid, such as the *health management entities node* (Health Secretary, Healthcare Provider Institutions - IPSs and Healthcare Providers - EPSs) and the *technology node*, which facilitate the different health processes, through a management process based on knowledge. The intersection of these three components or nodes constitute their management through an Integrated Knowledge Management System.

This implies that, in order to achieve a balance between them, institutions and technology must show the capacity to adapt to the social, technological and economic changes of the health environment and in a timely manner or, even more, to induce them and/or anticipate them. through the support of a series of facilitating agents such as *training, development, innovation and research*, which are associated with the knowledge they generate and that they have to manage in an adequate and optimal way.

These three components or main units are represented as interrelated nodes, which also contain resources based on tacit or explicit knowledge, where knowledge is generated or transferred, and can perform various processing or treatment functions required internally or through the links or relationships in a network, which expands into other components or related sub-nodes [4].

The three interconnected nodes: Health, Health Management Entities and Technology, resemble the coexistence and dependence between them, increasingly complex, interconnected and changing, and with a horizon supported by the research they can generate. In addition, a central intersection between them is conceived, which is the core of the entire model: the knowledge management system, which aims to be the engine of inter-institutional strengthening. These nodes constitute vertices that could be called "inter-institutional vertices" in permanent contact and interaction where information and knowledge flows, supported by the technology that facilitates their process. This scheme is framed within the scope of a dynamic and increasingly demanding society.

Finally, another component is outlined that is the reason for the whole model: *the community,* which perceives the different benefits of an adequate health service.

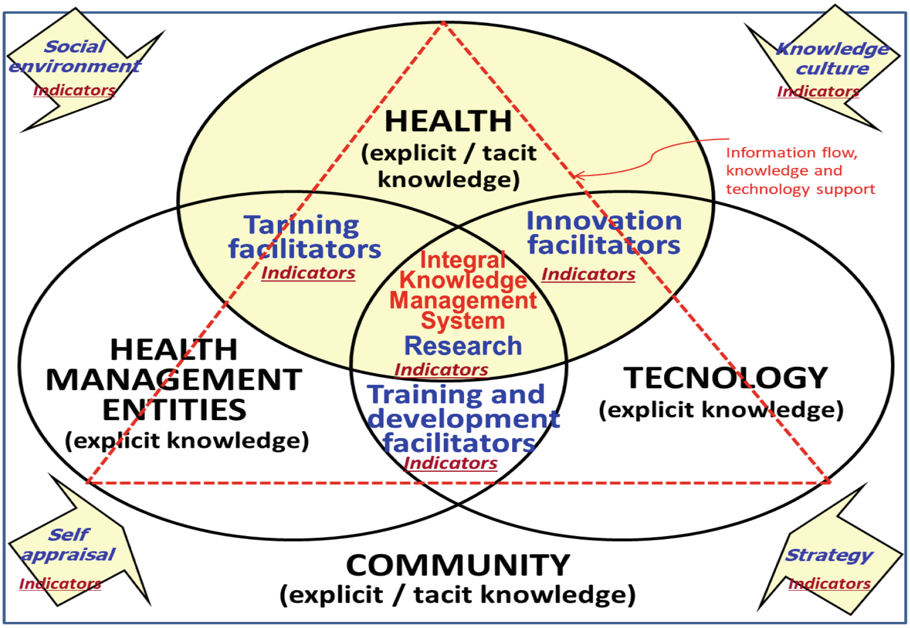

Fig. 1. Health service model basado on knowledge management. Source: The authors.

Conceptually, in the model, organizations obtain results that are arrived at through the behavior of their facilitating agents, that is, the actions of their personnel and the functioning of their processes [5].

In the *Health node* and the *Health Management Entities node*, the *facilitators* are the elements that will allow us to promote the actions of the health organization policy, and the management or fulfillment of said actions it is evaluated according to the behavior of a series of indicators that will facilitate the identification, development and retention of knowledge, and that ultimately will allow to maintain or fulfill the mission of the organization.

As seen in the model, the *facilitators* are associated to a specific node in order to provide a delimited area of knowledge and they can be grouped into different indicators that facilitate decisions on the proposals for the achievement of the strategy. Also, indicators can be understood as units of measurement that allow registering the dynamics of processes and performance, and, therefore, verify compliance with the objectives of an institution, in compliance with its mission [6].

In practice, the model presents an abstraction of the relationships that can be generated between health, health management entities and technology and at the intersection or confluence of the three nodes, knowledge is conceived as a source of power and a central axis capable of adding value to the organization and supporting actions, in the fulfillment of an adequate knowledge management.

4.2 Technological Architecture of the Integral Health Service Based on Knowledge Management

The form of technological integration that was applied, it was that used specifically in the applications functionality, through what can be called application integrator or integrating component of a knowledge management system and information systems, which helps users in the evaluation, interpretation and adaptation of knowledge to a new context, domain or application. This application integrator, as shown for example in Fig. 2 (database/knowledge), supports the sequential flow of explicit knowledge outside the repository. It also provides the means to share knowledge exchange, where members of the user community (for example: employees, doctors, researchers, patients, etc.) share, understand and contribute knowledge through their experiences.

Therefore, the following architecture of the integral health service is detailed through knowledge management and ICT support for the Boyacá department (Fig. 2).

Another very important aspect from the point of view of data, is data storage or "Data Warehousing", online analytical processing (OLAP), and data mining are three of the most important technologies in the field of Business Intelligence [7]. Data storage can be defined as a "large" repository of historical data relating to the organization that supports decisions [8]. OLAP is a technology that is based on the multidimensional analysis of data and data mining is the process of identifying and interpreting patterns in the data to solve a specific business problem [9].

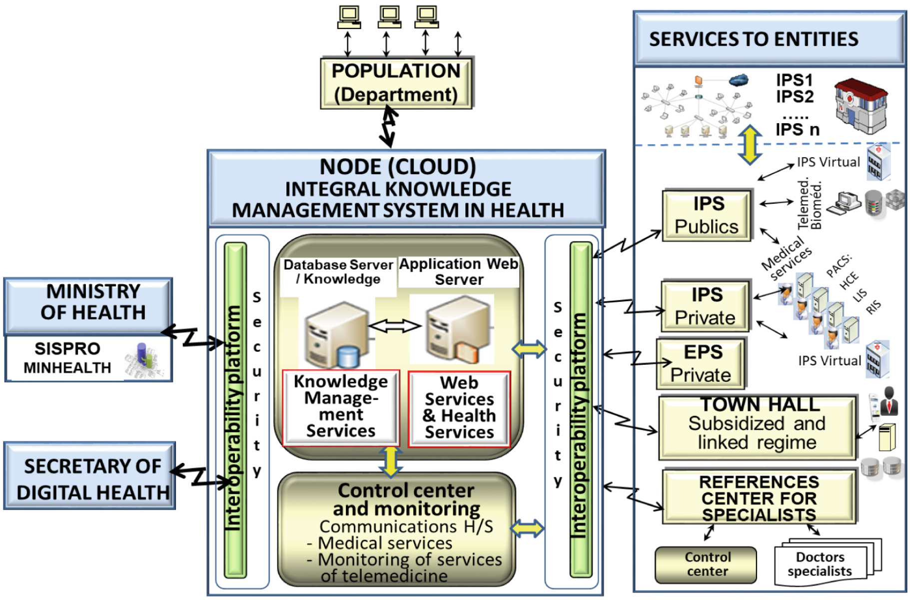

Fig. 2. Technological architecture of the Integral Health Service through knowledge management. Source: The authors.

4.3 Methodology Applied to the Development of Integrated Health System

Once the problem and vision of health is conceptualized in the department of Boyacá [10–12], it is necessary to define what initiatives and in what order they will be implemented. Since the region needs to define and adapt its own knowledge management model, an implementation *methodology* is required.

Based on the analysis of the most widespread methodologies and especially the proposal in the European standard [3], the American approach of Tiwana [13], and at the national level Medina [14], proposes a *personalized methodology* that seeks to involve, in addition to the organizational aspects and technological details, the articulation and support required to adequately manage knowledge in the health sector, taking into account the study and analysis of the recent Departmental Strategic Plan for Science, Technology and Innovation of Boyacá [15].

Conceptually, the personalized methodology (Fig. 3) consists of *phases* that include the initial approach to the situation, with the entire chain of actions that must be carried out until the desired new situation is reached. These phases facilitate the development of a modular procedure, in such a way that in the course of time parts of the system are carried out as independent subsystems that cover their scope of action, but oriented towards an integration of all of them.

The phases are formed by a set of stages that must be carried out when the phase is executed. The stages are disaggregated in turn into *activities,* which do not necessarily have to be carried out successively, but its structure has been proposed as a concurrent and continuous development by groups, which provides savings in terms of execution and costs.

The *activity* is the basic unit that has a content and actions to perform. In general, each activity can be structured in a series of actions such as: available *information sources*, *steps or processes* to be performed or factors that may have an impact on its execution, support tools, *products* or results and *recommendations* to facilitate execution of each activity.

In turn, the methodology *emphasizes a spiral approach that represents the infinite and continuous cyclic development* between its different phases, stages and activities that lead to improvement through an *iterative and incremental* process. It is *incremental* because new plans can be added to achieve the goal(s), it is *robust and stable* since by maintaining the goal it admits changes in behavior if the same goal is maintained and it is modular because the plans are modulars.

In addition, the methodology is based on an abstraction of *"life cycle knowledge"* or *"knowledge value chain",* the most general those to *identify, create, store, share and use knowledge.*

This cycle is considered as an integrated process that supports the processes of the organization and wider service provision. Its integration and performance will be supported by appropriate knowledge management methods and tools aimed at improving the provision of health services.

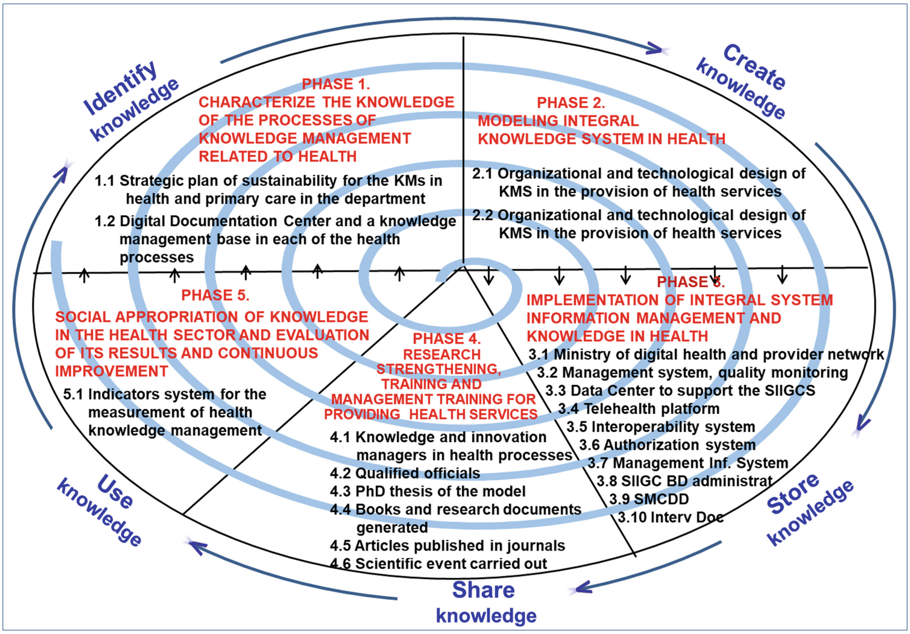

Fig. 3. Conceptual methodology for the implementation of the Integral Health Service supported by knowledge management. Source: The authors.

The phases of the personalized methodology for the implementation of the integral health service supported by knowledge management and supported by information and communication technologies are briefly described, which has been structured in five coherent phases with the general objective raised in the project:

PHASE 1. *Characterization of ancestral knowledge of the processes of knowledge management related to health:* Involves characterize and verify that the entities providing health or Departmental Secretary of Health and hospitals or health centers in each of the 123 municipalities of Boyacá, known or it has relied on knowledge management, and if not, raise awareness of its benefits, the effects and advantages it represents for it; and with the perception and motivation from the top management and thus achieve define strategic plans and plan the organizational integration for its implementation.

PHASE 2. *Modeling of Integral Knowledge Management System in Health:* One of the most useful ways to understand, study and represent the strategy of knowledge management in any type of health organization, is through a model that offers a unified vision and complete about what you want to abstract from reality about knowledge management.

PHASE 3. *Implementation of Integral System Information Management and Knowledge in Health:* For the acquisition of software to support the knowledge management system, different techniques must be applied, both software engineering and web engineering and, of course, knowledge engineering.

Information and knowledge management applications must be acquired and implemented, designing interfaces for their interaction and integration, as well as intensifying and integrating the different repositories of information and knowledge, which were described in the Technological Architecture of the Integral Health Service.

PHASE 4. R*esearch strengthening, training and management training for providing health services:* In this phase it is intended that researchers make public and promote the findings obtained and the knowledge achieved, is socialized and becomes the heritage of the scientific community and the public in general. The dissemination of the results of the research will be carried out through its publication in scientific journals or in the form of books. It also contributes to the socialization of the research results, the presentation in scientific events, although with a more local and perishable character. In addition, training and training will be carried out in the effective management of health.

PHASE 5. *Social appropriation of knowledge in the health sector and evaluation of its results and continuous improvement*: Once the integral health knowledge management system has been implemented, either as a pilot project or a specific area, it will be scaled and implemented in the different public IPSs of the department, municipalities with incidence in each of the processes of health knowledge management, for which it is necessary to evaluate their respective management.

The adage that "it is well known that what can not be measured can not be managed" is applied, a measurement model based on the quality of knowledge and continuous improvement must be developed.

5 Methods and Tools for the Evaluation of Knowledge Management in the Health Sector

Given that health organizations obtain results that are arrived at through the behavior of their facilitators, that is, the actions or actions of their personnel and the functioning of their processes, the method that will be applied for their evaluation is based on the concept of *indicators associated with these facilitators*.

By *indicators* is understood the systematic process of measuring and valuing the knowledge of the organization in relation to its results in health care, social, training and intellectual production and compliance with its strategic objectives of the organization.

It is necessary to develop a set of indicators that can be incorporated into the organization's usual scorecard and that provide periodic information on the functioning of the processes put in place. These indicators will be a source of additional information to the periodic diagnosis of the state of knowledge management in the organization.

We can also understand the *indicators*, as units of measurement that allow recording the dynamics of processes and performance and, therefore, verify compliance with the objectives of an institution, in compliance with its mission.

The indicators are constructed in order to record the significant events of a specific area of performance and thus have a rational and concrete argument, a clear and precise vision of the management of each unit. They allow an adequate control of the activities developed, so that they are carried out in accordance with corporate interests; they also serve to define policies, objectives, strategies and goals that ensure the consolidation of the objectives of the Institution, in the medium and in the sector that corresponds to it.

Consequently, the indicators for the health sector must be integrals, complex, of quality and not simply or exclusively of efficiency and effectiveness. In the project, different conceptions and proposals of the indicators model were researched and designed and will carefully examine these issues.

Therefore, the approach of the proposed indicators is conceived from the base of integration in the pursuit of the same goal: *the strengthening of the Intellectual Capital of the health organization.* Special clarification is made, which is not about applying only indicators to carry out an exhaustive description of the management of all possible human, structural, relational or technological assets, but also to determine those that are really capable of adding value to the organization and support actions, in the fulfillment of adequate knowledge management.

In order to determine *the tools* that will be applied, it is necessary to bear in mind that it is often very difficult to directly measure the impact of KM activities. However, this could be useful in making the efforts of the organization (rather than the results only) in the KM area more transparent, for example, when transmitting information, managers of a health organization should indicate the effort that has been made to support KM processes, more specifically these should indicate what has been done to stimulate the processes and the correct organization, to build a supporting (technological) infrastructure and, what is more important, to inculcate the appropriate culture and the appropriate system of behaviors of the organization. Another example is related to managers trained in two ways: one in the awareness of the effects and benefits of knowledge management, and the other direction is addressed in the training of the use of technology to strengthen the processes of provision of the different health services (in every sense: services and patient care).

Initially, a *diagnostic tool for knowledge exploration* should be applied to measure how the organization is currently situated with respect to the processes of basic knowledge and attention to health services that are part of the KM framework, for example, in the cycle of the coherent knowledge process with methodology applied to project development: identify, create, store, share and use knowledge. For each of these five processes, a series of diagnostic questions are asked, which are related to the "7S model" where the Institute [16] focuses on Strategy, Shared vision, Style, Personnel, Skills, Structure and Systems.

In addition to this, questions are asked that relate to the organization as a whole, that is, without focusing on aspects of knowledge in isolation, so that it can be observed if the knowledge aspects of the organization are relatively strong or weak points.

Finally, for each knowledge process, it is asked how their personal attitude and behavior at that time are questioned and related to knowledge processes.

Each respondent is asked for a score on questions ranging from one to five (1 = does not agree at all, 5 = totally agree).

In the analysis of the questionnaire it is important to identify the questions scored more positively and negatively and compare the responses of the different individuals, teams, departments, etc. It would be wise to conduct the exploration on a regular basis, so that progress can be monitored and corrective actions can be initiated.

In *the final stage of the project*, the knowledge exploration tool will be re-applied with the relevant adjustments, evaluating its results and defining strategies for continuity and sustainability of the model applied in the project.

Through the *verifiable indicators* of the beneficiaries, the system (109 of IPSs, in 123 municipalities and the Ministry of Digital Health, the coverage and compliance of the beneficiary population of the department of Boyacá will be guaranteed.

6 Considerations for System Validation

For the system validation, time and evaluation of results in the medium term is required, which is being implemented, why cannot yet present in this paper.

In the system presented in this research, the dynamic analysis of systems with knowledge management methodology proposed by the European Guide is combined and aims to create an assessment instrument of knowledge management network in the introduction incremental innovations in product, service and process for a enterprises, that deploy a range of possibilities for development and innovation of social technologies. Therefore, that leads organizations, increase their competitiveness and reduce socio-economic difficulties that afflict both.

Furthermore, it is possible to deduce that the competitiveness of an organization it increase when the lines of knowledge and methodologies act synergistically in conjunction with contextual factors as the country's trade policies, tax policies, investment security and others, achieving an economic and productive development in the organization.

7 Conclusions

In this research work, a health management model supported by knowledge management was proposed, which demonstrated the need to change or improve traditional or classic structures by a more functional, agile and efficient operating model that allows resizing spaces for the production, diffusion and transfer of knowledge, with the support of new information and communication technologies.

Health depending on the health management entities; and undertake organizational and financing reforms. In other terms, the model raises in essence the need to generate an adequate relationship between health, health management entities and technology all this in order to strengthen knowledge management in order to obtain benefits of impact for the community.

With the development of this model, the administrative, logistic and academic components are integrated, seeking to consolidate a scientific and technological research center in engineering of a higher institution, taking as reference other existing research institutes.

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Usability Testing of Conferences Websites: A Case Study of Practical Teaching

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Abstract. Usability testing is a key activity of the user interface design (UID) process and software development. The paper presents the results of evaluating the usability of international scientific conference website using heuristics evaluation proposed by Nielson. The selected website for scientific conference was a successful example of a case study that used in Human Computer Interface (HCI) course. Seven participants (i.e. students) registered in the HCI course were involved in this study and asked to play the expert's role. The case study results show that UID is given less importance by website developers and designers. This study also resulted in a greater appreciation of UID from the students, as they presumed that designers implicitly apply heuristics and guidelines as a premise, which, in reality, is overlooked as resulted in this study. For practical implications, this study emphasizes that instructors need to incorporate real life examples in the classroom when teaching HCI course material in order to put the theoretical concepts into real practice. In addition, it asserts that applying heuristics and other UID guidelines should be applied as a core element of website development process. Furthermore, it provides directions to improve the usability of the conference website by solving the identified problems.

Keywords: Human computer interface · HCI · Heuristics · Usability testing Case study · Teaching

1 Introduction

Usability testing is considered an essential activity in the software development lifecycle (Shneiderman and Plaisant 2010). It is a critical element in system success, given that if a system is functional but unusable, it will more than likely fail (Mason and Plimmer 2005). Usability is defined by ISO 9241 (ISO 9241-11 1994, p. 10) as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". Three measurements are mentioned in this definition: effectiveness, efficiency and satisfaction. Effectiveness refers to how exactly and completely the user can achieve his goals. Efficiency measures how many resources (e.g. time) are consumed to achieve the goals. Satisfaction measures the attitude and feeling of the users toward the interface. Nielsen (1994), a frequently cited usability engineering expert, stated five attributes of usability, which also include the above measurements: learnability, efficiency, memorability,

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errors, and satisfaction. Usability testing methods can be classified into expert evaluation (expert-based methods), which can be applied without user involvement. These include heuristic evaluation, consistency inspection and formal usability. The second is user usability testing (or user-based methods), where representative users are selected to test the interface; this includes universal usability testing, competitive usability testing, paper mockups, field tests, and remote usability testing. These methods involve techniques like ethnographic observation, focus groups, survey, and think aloud.

Several research asserted that HCI course should be taught using realistic case studies and group projects (Koppelman and Dijk 2006; Brown and Pastel 2009; Kolski et al. 2012; Pastel et al. 2012). For example, Brown and Pastel (2009) stated that "real" projects provide an effective pedagogy for learning to work on complex problems. Carroll and Rosson (2005) also advocated using real case studies for teaching HCI course. They view cases as "evocative narrative descriptions of a specific real-world activity, event or problem". They pointed out that case-based approaches are highly compatible with usability engineering. They put course content into realistic system development contexts that engage students. Rosson et al. (2004) also propose that practice with realist projects in HCI is crucial to stimulate the students' interest. Furthermore, the case-based learning activities would provide students with opportunities to audition the real roles that practitioners play in system development work. This is basically motivating to students who might see system development as a potential career (Carroll and Rosson 2005).

In this paper, a group of students registred in HCI course were asked to play the expert's role and apply heuristic evaluation to a real case study (i.e. IADIS website). This paper reports the findings wich might be useful for intstructors who teach HCI/web design as well as professionals in this field.

The remainder of this paper is organised as follows: Sect. 2 introduces heuristic evaluation. Section 3 provides a background of the case study, and Sect. 4 presents the research methodology. Section 5 provides the evaluation results identified by the particiapants (i.e. students). In Sect. 6, a discussion of the research issues is provided. Finally, Sect. 7 presents the conclusion and recommendations.

2 Heuristic Evaluation

Heuristic evaluation was developed by Nielsen (1994). It is a usability engineering method for finding the usability problems in a user interface design. A heuristic evaluation session takes one to two hours for each individual evaluator. The output from applying the heuristic evaluation is a list of usability problems in the interface, with reference to those usability principles that were violated. These can be considered in the second version of the interface (prototype), and provide guidance for redesigning the existing interface. There are many studies have showed that the design feedback provided by heuristic evaluation is valid and useful for improving the design. These studies have adapted Nielsen's principles and created a specialised heuristic for various fields such marketing websites, educational websites, healthcare and medical systems, games and virtual reality (Peng et al. 2004; Astani and Elhindi 2008; Afacan and Erbug 2009; Papaloukas et al. 2009; Toit and Bothma 2010; Kientz et al. 2010; Chan et al.

2012; Hasan 2013; Khowaja and Salim 2015). Table 1 lists the heuristics proposed by Nielsen and a description for each item.

Table 1. Ten usability heuristics from Jakob Nielsen (Nielsen 1995b)

Ten usability heuristics
Visibility of system status The system should always keep users informed about what is happening, through appropriate feedback within a reasonable time
Match between system and the real world The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order
User control and freedom Users often choose system functions in error and need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo
Consistency and standards Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions
Error prevention Even better than effective error messages is a careful design that prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action
Recognition rather than recall Minimise the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate
Flexibility and efficiency of use Accelerators—unseen by the novice user—may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions
Aesthetic and minimalist design Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility
Help users recognise, diagnose, and recover from errors Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution
Help and documentation Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be performed, and not be too large

3 Case Study Background

The selected case study is the IADIS Multi Conference on Computer Science and Information Systems (MCCSIS 2011) website. IADIS (International Association for Development of the Information Society) is a non-profit organisation that aims mainly to promote the study, research and dissemination of news related to the Information Society, as well as to organise seminars and conferences in Europe, and publish paper journals in the field. It also aims to address subjects related to computer science and information systems fields, including e-commerce, e-learning, e-society, human computer interface, wireless communication and telecommunication, informatics, data mining, image processing, game technologies, intelligent systems and other emergent fields related to ICT (http://www.mccsis.org). The main functions and features in the IADIS (MCCSIS 2011) website are providing information about the association and each conference, membership, advising friends of the upcoming events and conferences, contacting the secretary, and subscribing to the events newsletter. This website was selected intentionally by the author to deliver the purpose of the HCI lesson; applying the heuristics evaluation on a real example interfaces by enabling students to play the role of experts.

4 Research Methodology

The current paper applies problem-based learning approach to a real case study which requires students to apply specific methods to solve interfaces design problem. Problem based case activities usually resulted in the highest levels of student recall at the end of the semester and after they graduate. According to Bentley et al. (2002: 107), “authentic real-world problems in a professional context help students to take ownership of the learning experience.” Problem-based learning enables student to take more control over his or her own education rather than just relying on the instructor’s delivery of the course. In a typical problem-based learning class, students work together in small groups to analyze and solve real-world problems. It is an iterative process that engages students to identify problems and apply their knowledge to solve them. The role of the instructor is to assist students with their thinking and guide them towards reasonable courses of action. This approach of teaching is effective as it increases student’s learnability.

Data was collect from students who registered in HCI course at university located in the UAE. Seven third-year students (5 females and 2 males) were involved in this study. All students were knowledgeable of the HCI guidelines and principles. Participants were also informed about the purpose of the website and its domain. They were invited to play the role of expert evaluators. In one session, which took one and a half hours, each individual participant was given enough time to examine individually the interface by checking the heuristics that applied and the ones that were violated. Each evaluator wrote his/her criticism and comments on a sheet of paper and then the author shared the evaluations with the evaluators. He then requested each participant to verbalise each point by giving a demonstration on the website interface. After that, the author combined and refined them, as some of the problems were encountered by more than one evaluator. This conforms to Nielsen (1995a) in that involving more than 5 evaluators will result in repetition of the same problems.

5 Usability Testing Results

A number of problems emerged during the usability testing session. Table 2 presents the results of the evaluation, specifically, which heuristics were violated and were not applied to the website. Demonstrations were also provided, as shown in Fig. 1, to indicate where the usability problems occurred. A reference number (R1 to R7) was assigned to each problem concerning the website's interfaces, which is also presented in Table 2. All evaluators have the ability to find information about certain conferences and the IADIS association. All evaluators were able to easily find that information, given that none of them had previously visited or heard about the website. All of the participants tested the "Tell a friend form" to send the website link to a friend. However, some of them found that the form interface did not work well when a user attempted to send an actual email to a friend (see the problems in Table 2). The participants also attempted to find information about the membership. Some found it difficult to know the specific details like the fess, as they were not mentioned in the web interface. Rather, they were mentioned in a RTF/PDF document. The participants also preferred to have an online registration page, as it provides more accessibility than a PDF/RTF or doc format.

Table 2. Usability problems and violated heuristics

Problem	Ref.	Violated heuristics
No displayed message/feedback appears to inform the user that the email was sent successfully	R5	Visibility of system status
User is unable to register online; only Pdf/doc format available, which requires an application to open these documents	R7	User control and freedom
Misleading links in the navigation bar such as "Home" and "Conference homepage" lead to the same page. This confuses users, as they expect a different page when they click on "Conference homepage"	R1 & R2	
Different color and logo appears when a user clicks on "what is IADIS". The home page includes the MCCSIS banner (orange color), whereas the "What is IADIS" page includes a different banner (blue color)	R 1& R6	Consistency and standards
Membership link is not present in the navigation bar on the home page, but it is present in the navigation bar on the iadis webpage	R1 & R6	
Unorganised display of the conferences list	R4	
Form fill-in: no error checking in case users forget to enter their email or include the @ in their email address	R5	Error prevention
No flexible option provided (online membership registration), only doc/Pdf format for registration	R7	Flexibility and efficiency of use

(*continued*)

Table 2. (*continued*)

Problem	Ref.	Violated heuristics
Image is not displayed when users click on the events newsletter, and no alternative text is displayed	R3	Aesthetic and minimalist design
The list of conferences does not have an appealing interface in terms of order or alignment	R4	
Form fill-in: No help was given; i.e., no default values were given (the author entered sample data in the form)	R5	Help users recognise, diagnose, and recover from errors
No reversal/clear button provided		
No indication of mandatory fields like the email address	R5 R5	
FAQ is missing, which is important, especially for first-time visitors who have many questions		Help and documentation

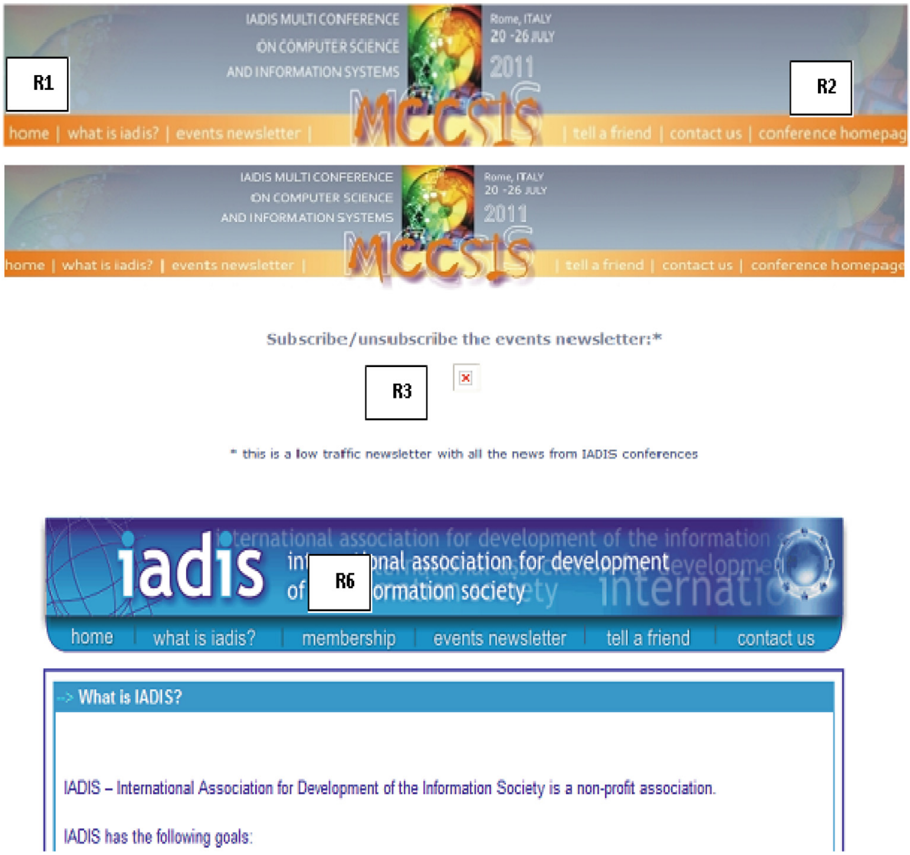

Fig. 1. Interfaces of IADIS website including a reference to usability problems

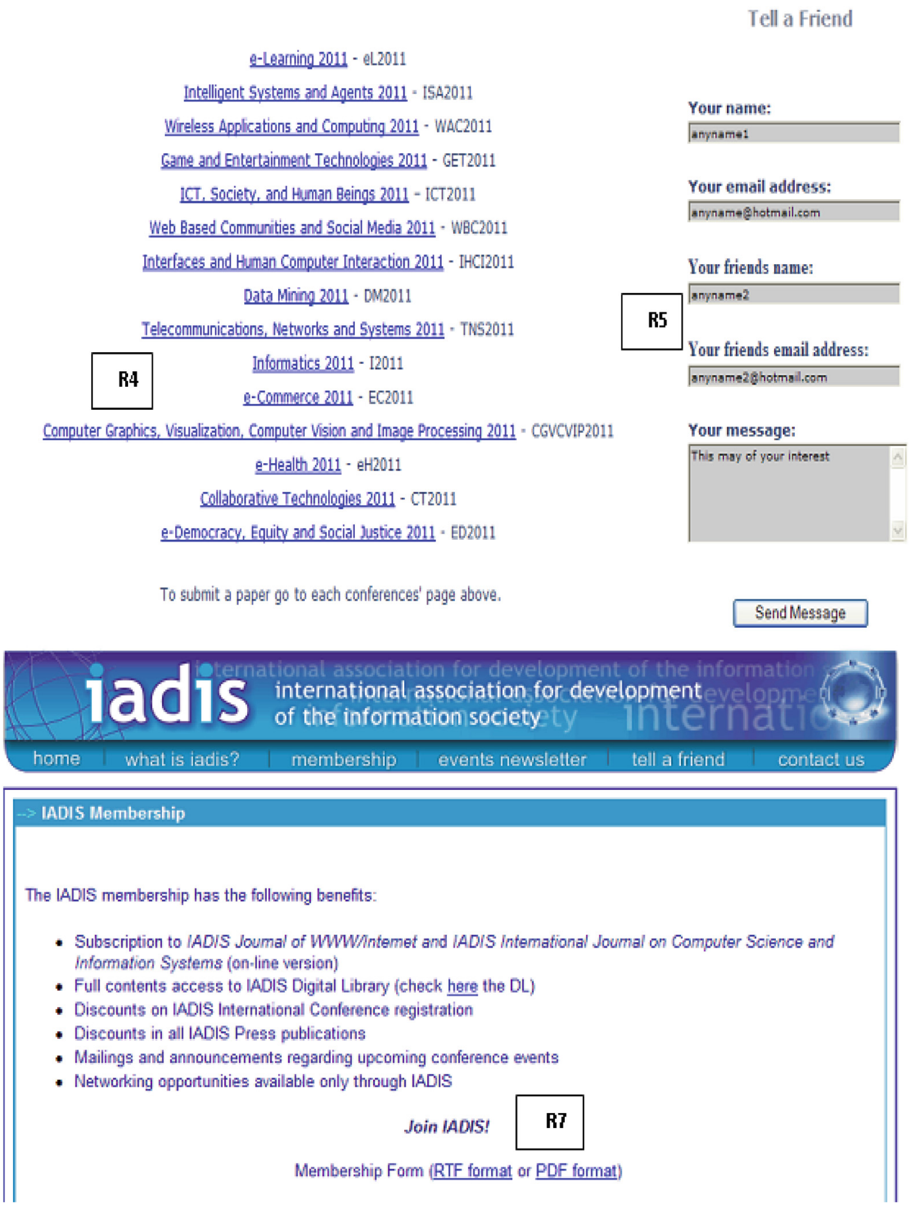

Fig. 1. (*continued*)

6 Findings Discussion

The purpose of this study was to provide students an opportunity to play the role of the experts by providing them a real case study to evaluate the usability of an existing website by applying heuristic evaluation. Many issues have been raised through the evaluation session. Firstly, some participants wondered if the website was intentionally designed with these faults and shortages in order to deliver the purpose (providing a case study to evaluate the website using heuristics). Therefore, the author informed them that this real case was selected randomly. Secondly, the participants were surprised that the main theme of the international association is computer science and information systems, and that has a website with these deficiencies. Some pointed out that it would have been acceptable if those problems were found on a website for an association concerning with another field. However, the website design should be usable, irrespective of the field. Thirdly, another issue raised whilst sharing the evaluations was the degree of commitment of the developers and designers to apply the UID heuristics and guidelines. These should be prepared before developing the website. They should not be checklist examined after the application is developed, but rather checked during the development process. They should also be created at the early stages and considered a part of the software development process. Fourthly, the participants discussed the consequences of the usability problems found on the IADIS website. IADIS may lose some of its prospective audience. For example, when a current member wants to send the website link to a friend, he/she may not receive the email even though the sender thought it was sent successfully. The reason is that the form contains no accurate check (@ symbol) for email delivery. In addition, users who do not have MS Word or Acrobat Reader to open the .doc/rtf or PDF files cannot register online. Therefore, they may give up or register later. Furthermore, users may feel confused when they fill out the form and click "send" but no acknowledgment or message is displayed, or when they click on the "Home" and "Conference homepage" links in the navigation bar, as there is no difference between them. Consequently, why include both, as there is no need for any extra buttons in the interface that do not deliver a message. More importantly, they distract the users' focus and attention, which should be paid to something else. In addition, users may feel frustrated when they try to download the RTF/PDF document, as it usually takes time to download and open. Hence, the response time can be reduced, if the web form format is provided to users. As a result of this exercise that was given to the students in the classroom, students found that playing the role of the expert reviewers is an interesting way to comprehending the HCI topics (e.g. heuristics evaluation) as they apply the theoretical knowledge in a real web interfaces. Some pointed out that they will not forget such practical examples when they work in the industry. Indeed, the above case study was not only given to students as an example of website that violated the heuristics. Rather, students were placed in a position of expert reviewers to play their role as some will do the same when they start their carrier.

7 Conclusion and Implications

This study presented a case study of usability testing using heuristics evaluation by applying Nielsen's ten principles as a theoretical base for this evaluation. These evaluation principles were effective tools to assess the usability of the IADIS website and identify any problems that needed to be improved. This study also provided evidence that the developers and designers must pay more attention to the user interface design. IADIS is an international association that organises computer science and information systems conferences, and its members are researchers, scholars, and professional people from the industry. Therefore, such a respectful organisation should have a professional website that adheres to user interface design heuristics and guidelines. This study emphasises using real examples for evaluating the usability of user interfaces and integrating this information when teaching HCI course material in the classroom. This was a useful example for HCI students to make them appreciate the process of UID and usability as a core activity of any website and software development.

One limitation of this study is that the IADIS website was tested by participants who acted as evaluators and were knowledgeable of HCI heuristics and principles. Therefore, another usability test could be conducted by implementing user-based methods and involving real users to test the website. Feedback gathered from the users will complement the heuristics evaluation as real users often encounter problems we do not expect.

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Human-Computer Interaction in Currency Exchange

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Abstract. Technology has changed the way in which humans interact with each other. Many activities that before required human interaction can now be performed using a machine. It can be said that the way in which human beings relate has changed altogether. One of the main difficulties in communication between humans occurs when they do not speak the same language. This problem becomes more acute in situations where the understanding of both parties is essential, for example during economic transactions. Computing can help improve this process by promoting understanding between the customer and the seller, contributing to better consumer experience. This paper presents a case study in which human-machine interfaces are used in the exchange of currency at airports, where customers are of multiple nationalities and the vendor does not always speak the same language as the customer. The system was evaluated at a real airport and very positive results were obtained.

Keywords: Human-computer interaction · Currency exchange
Software system

1 Introduction

It is evident that technology has changed the way people relate with one another. Using computers or laptops to transmit information from anywhere in real time has become a common part of life. In addition, there are many possibilities and can be essential for both work and personal matters.

We can already interact with a variety of systems, social networks [28] or instant messaging. We can even consult robots to obtain recommendations on our supermarket shopping [19]. Human-computer interaction has significantly contributed to the social change we are experiencing. Although effective on their own, human-machine interfaces can be even of greater benefit when used as an element of support in communication between people who speak different languages. These situations most commonly occur in tourist areas and in places where there is high passenger traffic, such as airports. Our study focuses on this type of scenario.

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The business models of all currency exchange companies have airports as the main market for their services. Thousands of international customers pass through exchange offices every day. The tellers that work at exchange are highly qualified and fluent in different languages, they assist and advise clients on the economic operations [6]. However, large airports provide long-haul flights and the passengers that arrive can speak several dozen different languages, this makes it impossible to find staff that would be capable of attending all customers in their native language.

Therefore, it would be very helpful to use a system that will act as an intermediary and will make interaction between the customer and the teller easy and clear. By using the language the client knows best to perform currency exchange operations will make them feel comfortable and secure about what is happening. As clients will understand all the transaction conditions, they will be more willing to exchange their money using such as service.

In this regard, the system proposed in this work acts as an intermediary between the client and the teller. A case study was conducted in order to investigate the impact it had on currency exchange operations. The developed system allows to identify the general profile of the customer (their nationality, age, etc.) as well as their specific profile that enables the system to make personalized offers, providing customers with better exchange rates and encouraging them to exchange greater amounts of money.

The system with which the client interacts consists of a self-order kiosk that allow to read the customer's identification document, make the payment and print a proof of the transaction, all this in the client's preferred language, so interaction with the teller of the office is limited to the verification of the customer's identity and the delivery of the money in an exchanged currency. On the other hand, the office teller can visualize in real time all the information introduced by the client and the options they choose [7].

This system has been tested at Sydney Airport (Australia), where a Spanish currency exchange company called Global Exchange is the only operator. The results of the study confirm that the use of technology improves customer experience and has a direct and very positive impact on the company's profits, as both the number of customers and the volume per transaction increase.

The rest of the article is structured as follows: Sect. 2 reviews state of the art systems that used novel HCIs to improve their performance. Then, Sect. 3 describes the proposed system. The results are outlined in the Sect. 4 and finally, Sect. 5 concludes the work and describes future lines of research.

2 Background

The way in which our society communicates has changed over the last two decades. This change has come about as a result of diverse technological advances which have provided the world with new possibilities. Social networking [3,23], instant messaging systems [5] and physical devices like robots [4,13,31], played a major role in social change [30], influencing the way we share and connect with others, both personally and professionally [29].

In terms of economy, previous studies analyzed the impact that the use of HCI has on commercial sectors. A large part of these works focused on the industrial sector, for example [8,9,18]. The use of HCI-based techniques allows to learn about the use, maintenance and repair of machines, which proved to have a very positive impact on the industries that adapted the HCI model [30]. Kiosks have also been used to provide service to customers in hotels and measure their satisfaction with the hotel and the HCI-based system [20]. The most well known use of self-order kiosk is their installation in restaurants [15].

Self-order kiosks are meant to speed up the ordering and purchase process in any kind of commerce [2,16], and thus help to boost sales. In addition, with self-order kiosks, customers no longer need a waiter to take the order for them.

In this case study, the fact that the implemented system makes the service faster is an important aspect as the company is located in a busy environment, where customers are in a hurry [1]. However, the main purpose of the system is to improve communication between the customer and the teller. This can greatly improve user satisfaction. A positive customer experience increases loyalty and there is a greater chance that the customer will go back to using the company's services.

In addition, the inclusion of technology in the process of making a purchase provides valuable information to the company that can analyze in real time to send offers tailored to the consumer's profile [27]. To this end, it is common to apply machine learning and artificial intelligence techniques [12,22,25] that classify or create clusters with customer profiles [33].

For the present case gradient boosting is used [14], which is a machine learning technique commonly used in regression and classification problems. In this case it produces a prediction model based on a decision tree. Like other boosting methods, the model is build in a stage-wise fashion and it generalizes them by allowing optimization of an arbitrary differentiable loss function [17].

This project has been designed in collaboration with the international currency exchange company Global Exchange. Global Exchange is the world's third largest company specializing in providing currency exchange services to the tourist public at international airports and other popular tourist destinations. At present, it has a network of more than 150 offices located in 46 international airports in 21 countries and 4 continents, with a staff of more than 2,200 employees who serve 4 million customers each year. Among its innovations are its services for online currency reservation with home delivery or airport pick-up, as well as the currency exchange service for managers and employees of companies. Global Exchange has a new subsidiary in Sydney Airport, Australia, with about 150 employees of which 80 per cent are bilingual and 40 per cent speak a third language. However, it is not enough to cover the possibility of communicating with each client using his/her native language. This project was born to respond to the need for a system to eliminate possible language barriers in currency exchange, reduce errors in communication and reduce time.

3 Proposed System

All the aspects of the HCI system are of vital importance to building customer loyalty as these will have a positive economic impact on both the customer and the company. Therefore, it is necessary to consider all the factors that contribute to customer satisfaction, these include system availability at all times and to all customers, starting the operation in the moment the customer arrives i.e. the customer does not have to wait for the service, provide solutions to the possible difficulties that people with disabilities may encounter in using the system.

To describe the proposed system, it is necessary to understand the scenario in which the system is used. A simplified scheme of how it is deployed in a real environment is shown in Fig. 1. The amount of HCI devices deployed in each exchange office varies depending on its characteristics. There must be enough devices to supply service to all customers at peak attendance times, this will optimize customer waiting time [21].

Secondly, to provide more efficient customer service, it is recommended to hire one sales assistant for every three self-order kiosks deployed in the exchange office, since the average time spent on site to verify the identity and deliver the money is three times less than the average operating time per customer in the self-order kiosk.

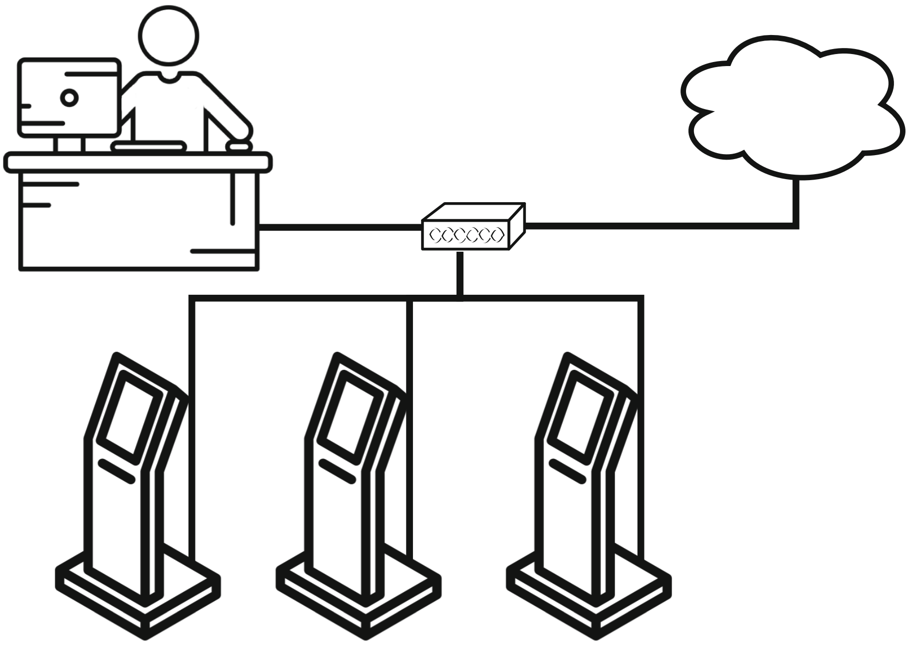


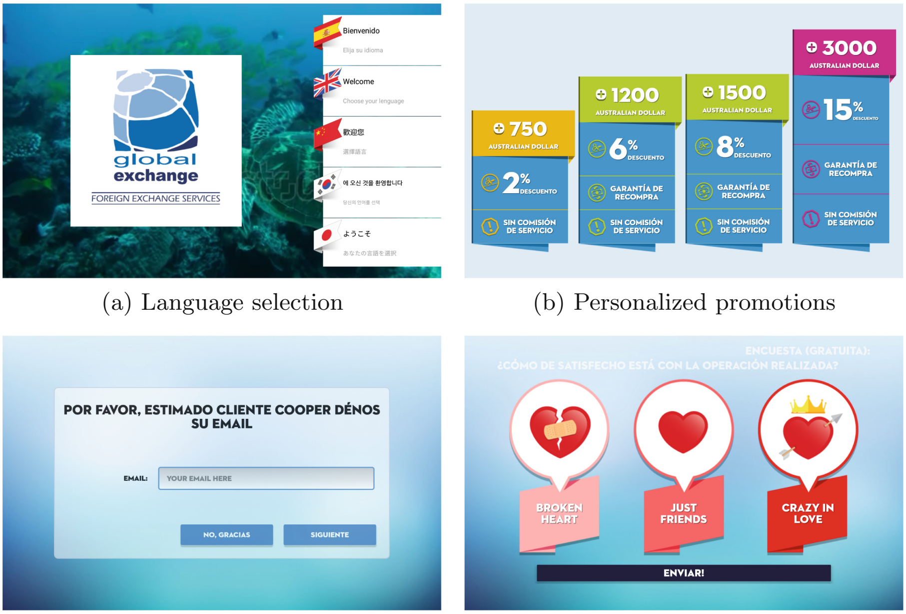
Fig. 1. Case study scenario schema.

Finally, due to limited or prohibited use of WiFi at some airports, communication between devices through Wi-Fi is ruled out. Thus, it is necessary to make a wired installation that will connect the computer inside the office with the self-order kiosks and also with the rest of the system, in a cloud environment [10]. The part of the system which runs in the cloud provides currency pricing information tailored to each office, runs the client profile analysis algorithm, verifies the customer's identity and searches blacklists, and ensures that the customer complies with the currency exchange and money laundering laws in force in both the country of exchange and his or her home country [32].

In the self-order kiosk with which the customer interacts, the developed application is shown, which offers different functionalities that are described below:

- Language selection: as shown in Fig. 2(a), the first step allows the customer to select the language preferred by the client. A method of voice and audio control is available, which can be activated by voice indicating the preferred language.
- Quantity selection: The system allows the customer to select any source currency and the currency they want to exchange it for. The customer is provided not only with the official price, they also are informed of parameters such as margins with which each office works or the lowest value currency available in the office (which in many cases obliges to cash rounding).
- Introduction of personal data: once the amount that the customer wants to change is selected, either via a virtual keyboard or by scanning the customer's official document, the basic personal information is provided to the system [26].
- Range selection: as shown in Fig. 2(b), different exchange rate options are presented to the customer, they vary depending on the amount being exchanged. Offers are presented in a much more intelligible way than if the teller at the office explained them orally. Moreover, the customer can take their time to decide, without feeling feeling pressured by the teller to exchange a larger sum of money. In addition, thanks to the analysis of the user's profile (origin, age, whether or not they have previously exchanged currency with the company, the amount of currency they wish to exchange, the type of currency they want to obtain, etc.) the gradient boosted tree is calculated and classified so that the customer can receive (or not) a personalized offer that will help improve the customer's exchange experience with the company and, at the same time, encourage the customer to exchange a greater amount of money.
- Subscription to offers: e-mail is requested (Fig. 2(c)) to send out personalized currency exchange promotions, which is very important for customers who exchange currency on their outbound trip and feel they need to change the money left once they return to their home country. This way the system can provide offers to customers, such as currency repurchase at the same exchange rate if it is changed in less than 15 days. The information that the HCI system provides to the company has increased considerably.
- Feedback: It is very important that the client evaluates their experience with the proposed system. so that we can introduce new functionalities or

improvements. For this reason, it is requested that the exchange rate be rated separately from the self-order kiosk providing the exchange service (usually few customers are very satisfied when a commission is charged, so the exchange rate is not considered in this study) (Fig. 2(d)).



(a) Language selection (b) Personalized promotions

(c) Email gathering (d) Feedback survey

Fig. 2. Developed app.

One of the main objectives of the system is to increase business profits by encouraging the customers to exchange more money than they had originally thought they would. This is why offers play a very important role in exchange offices, as they do in the majority of today's shops.

In this regard, the "Range selection" step is very important and our investigation was focused mainly on this area. In this step, artificial intelligence methodologies are applied to calculate which amount is the most appropriate to offer to the user and get them to exchange a greater amount of money than the one they had originally planned to.

To this end, among the wide range of machine learning techniques (like those used in [24] or [11]) that could be used to predict the offer to the user, regression trees and random forest regression (see Fig. 3) were used as they best adapt to the nature of the variables dealt with in this work, providing the most accurate offers.

In the present system, the algorithm must estimate the maximum amount of money that a client could exchange if they were presented with a good offer. To

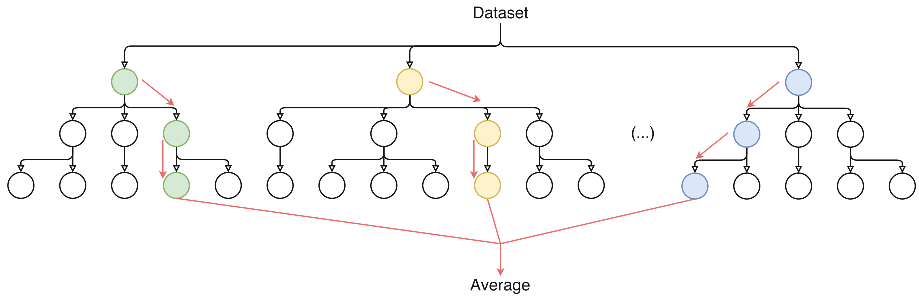


Fig. 3. Random forest example.

this end, the regression tree algorithm is applied to the dataset, this is because it is capable of predicting a quantitative variable. Using this technique, it is possible to create a regression model from historical transaction information stored by the company. On the basis of this model, the exchange price that will be offered to the customer is predicted.

The solution offered by this type of algorithm is characterized by its low predictive power compared to other regression or classification techniques. In addition, the result tends to have a tendency towards an over-adjustment of the data. However, the combination of multiple trees through bagging techniques, significantly improves the quality of the prediction offered by these models. In this way, random forest algorithm appears as the most suitable solution since its result is based on the average of all regression trees.

Thus, starting from input variables such as nationality of origin, country of exchange, age of the person, amount indicated, currency of origin, currency to receive and ID of the company's office, prediction of the offer and the exchange amount at which this offer will be available to the user, from which 4 sections will be created with discounts of 2%, 6%, 8% and 15%.

4 Results

This section describes the conducted experiment and presents the obtained data, which allow to evaluate different aspects of the system, such as the time it takes each client to do the transaction or the amount of money they exchanged.

4.1 Experiment Description

To evaluate the performance of the developed system it was necessary to obtain all the related information. This information was also necessary for the personalized bidding systems which make user profiles. The case study consisted of two different phases. The first phase was a baseline period and it lasted two months. During this period the traditional exchange method was used and information on customer transactions was collected. The system was deployed in the second phase and it also lasted two months.

Transaction and customer profile data collected in the two phases were compared. System evaluation results are presented in Sect. 4.2.

In total, the transactions performed by 11,175 customers were evaluated. In the first phase, data were generated by 5,483 customers (transactions without the proposed system) and by 5,692 cusìtomers in the second phase (transactions with the proposed system).

The system was evaluated at Sydney Airport (Australia) where Global Exchange operates on an exclusive basis, so that during operating times it is not influenced by the volume of passengers in nearby offices but from different companies. This means that volume variation and variation in operating times are the direct and unique consequence of the designed system.

4.2 Evaluation

To evaluate the influence that the designed system has over user experience, 4 different variables have been evaluated: (i) the total operation time of the company's personnel; (ii) the waiting time of each customer, which includes both the waiting time to use one of the self-order kiosks, and the waiting time for the office assistant to attend to them; (iii) the user's satisfaction wit exchanging their currency with the system; (iv) the average amount of currency exchanged by each customer.

The operating time of the company's personnel was considerably reduced due to the fact that the highest load of the operation is carried out in the self-order kiosk. Thus, it lowered from 319 s to only 84 s.

The user wait time was also reduced from 276 s to 128 s, which combined with the improvement in the operating time of the company's personnel, means that the attention capacity per office increased considerably.

With regard to the satisfaction of users with the system, the form presented in Fig. 2(d) has been used, where three options are given: negative, neutral and positive. The responses from all 5,483 users are shown in the Table 1, where it is clear that only 8 percent of users had a negative experience.

Table 1. Satisfaction of users

	Negative	Neutral	Positive
Number of answers	440	767	4,276
Percentage	8.02%	13.98%	77.98%

The last variable studied is the average amount of currency exchanged for each customer, which increased by 27% with the system compared to customers who did not use the system.

Finally, as part of the evaluation, although it was not set as one of the study variables since the company operates exclusively at the airport and therefore this variable does not depend solely on the system offered, the number of customers who have operated with the new system, as opposed to the number of customers who had in the same period (of 2 months) during the previous year, has increased by 8.32%, well above the 3.58% average increase in the previous 10 months.

5 Conclusions and Future Work

The obtained results are approximate to those pursued at the beginning of the project. The reduction in staff assistance time, will not influence on the number of office employees, it is aimed to improve the service offered to the customer and on reducing the customer's waiting time.

The obtained results are promising for the company's future and the aim is to install these exchange systems in its offices around the world. Before that, however, different hardware level adjustments are required in order to reduce the device's production costs. For now the cost of one self- order kiosk is approximately 6,000 Euro which is quite high.

In addition, we are considering the design of a new version of the system, which will incorporate a special evaluation tool for users. This tool will implement the "Net Promoter Score' (NPS) metric, which allows to compare user satisfaction with competing companies.

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Information Literacy is a Key to a Competitive World in Developing Countries

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Abstract. Information literacy (IL) on the workplace is important for the success of competitive organizations. Despite its importance, many organizations in developing countries lack this critical skill. This paper uses secondary data from studies showing why IL is lacking in Tunisia. These studies reveal that because of a lack of IL skills, organizations were not able to engage in Environmental Scanning (ES) activities to collect anticipative information from their competitive environment, make sense of them and generate new knowledge to be innovative and competitive. This paper proposes a conceptual framework for the connection of IL with ES and Knowledge Management (KM) and recommends an IL model taking in account the actual urgent needs and the social and cultural aspects of the country to be implemented.

Keywords: Information literacy · Environmental scanning
Knowledge management · Developing country · Tunisia · Competitiveness

1 Introduction

As we are now living in information age, information literacy (IL) should be part of the essential skills for all students. Information literacy is not only affecting schools, it has important implications for enterprises. This paper is a reflection based on the results of two prior studies within two different Tunisian contexts: A private SMEs context (2005) and a public institutional context (2014). The studies reveal that because of a lack of information literacy skills, businesses were not able to have the knowledge that they need to create new knowledge to promote innovation. We propose an information literacy model that takes into account the actual situation of the IL at the workplace as well as some key issues which need to be included in any national IL policy such as linking to national educational curricula. This paper begins with a brief review of knowledge management followed by information literacy and learning organization. The case study is then described followed by the proposed model for information literacy. The paper concludes with suggestions for further research.

2 Knowledge Management

2.1 Knowledge Management as Access to Information

Knowledge is as the most important resource in organizations and a key differentiating factor in business today. It is increasingly being acknowledged that knowledge

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management (KM) can bring about the much needed innovation and improved performance in businesses. (Egbu et al. 1999). Knowledge management (KM) is referred to as the process of creating, codifying and disseminating knowledge for a wide range of knowledge intensive tasks (Harris and Bair 1998). These tasks can be decision support, computer assisted learning, research (e.g. hypothesis testing) or research support. Knowledge management (KM) is obtaining and using resources to create an environment in which individuals have an access to information and in which individuals obtain, share and use this information to raise the level of their knowledge. In addition to this, individuals are encouraged and enabled to obtain new information for the organization. (Brelade and Harman 2001). Knowledge is information combined with experience, context, interpretation, and reflection (Davenport et al. 1998).

3 Learning and Intelligent Organizations as Generators of Information and Knowledge

3.1 Learning Organization as a Reservoir of Value Creation

Knowledge creation and decision-making can be called a Learning organization. A learning organization has the information and knowledge So that she is well informed, mentally perceptive and enlightened. Its actions are based on a shared and validated understanding of its environments and needs, and are supported by the knowledge and skills available to its members. The learning organization has the information and knowledge giving it a specific advantage and allows maneuvering with intelligence, creativity, and occasionally with cunning (Choo 1996: 336–337). Concept of learning organization whose 'portfolio of competencies, constituted Macro-competences, should be seen as a reservoir of levers with high potential for value creation and difficult to imitate by competition' (Mack 1995: 433).

3.2 Information Use in the Workplace and IL

In their annotated bibliography, on "Information Literacy in the Workplace", Williams et al. (2014), claim that most of the researchers who have dealt with IL for the workplace have done so for exploratory purposes without trying to come up with a definition of the concept.

Even if they didn't find a generic single definitive description of IL in the workplace, they could see that some contextualized descriptions emphasized three dimensions: (1) Social, informal, contextualized processing of information (e.g. 19, 23, 26, 28); (2) Information creation, packaging, and organization (e.g. 1, 16, 29); (3) the transformation of information to knowledge (e.g. 24). Since our investigation relates to the connection between IL and knowledge, we will be particularly interested in the third dimension.

The business community is in a heightened state of awareness about the value of information and knowledge, but at the micro level "workers are floundering with too much information readily available, too little relevant and timely information when they need it, and with few tools or skills to deal with information effectively"

(O'Sullivan 2002). O'Farrill (2008) argues that although some of the literature in management explicitly related to information use for more complex tasks such as decision making and planning, it is not easy to find a comprehensive and coherent approach linking skills of the individual, information awareness, interpretation, and application of information to tasks and organizational aims as part of a learning process. This problematic disconnection between information use and knowledge creation triggers our interest, as researcher, to the importance of information literacy in the workplace.

4 Information Literacy

4.1 IL and Lifelong Learning

The American Library Association defined, *'information literacy is a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information'* (Boekhorst (2013). Information literacy and lifelong learning are the beacons of the Information Society. It lies at the core of *lifelong learning*. It empowers people in all walks of life to seek, evaluate, use and create information effectively to achieve their personal, social, occupational and educational goals. It is a basic human right in a digital world and promotes social inclusion of all nations" (UNESCO 2006). An outcome of the information revolution is that knowledge is now seen to have a central value to workplaces, and it is no enough to be able to locate, access and organize it. Workers must be able to leverage knowledge – to transform information and create new knowledge and to use it as source of new ideas (Ferguson and Lloyd 2007).

4.2 IL in the Workplace

The literature review shows that most models of IL developed were designated for educational contexts (Gendina 2013), we found few research dealing with Workplace information literacy (WIL). Information in the workplace as the learning processes implied in knowledge creation and transfer (Davenport and Prusak 2000; Nonaka and Takeuchi 1995) is associated with skills development of IL. The connections between IL and KM are not very explicit (Abell and Oxbrow 2001). Little research has been done into workplace IL (Lloyd 2006). Authors (O'Farrill 2008; Lloydd 2013; Mutch 2000) question the interpretation of IL as a narrow skill-based approach which is criticized as being inappropriate for the workplace. They consider that what they call "information literacy practice" and "Effective use of information", are more recognized than IL in the workplace. A few authors (De Saulles 2007; Thompson 2003) have proposed that IL is an important aspect of developing organizational capabilities in the information-intensive, knowledge-managed workplace and have argued for more research into this area. According to Tsoukas (2003), competitive advantage as the target of environmental scanning is based in information use and also on sensemaking and knowing in learning action. Lloyd (2006) points out that, *"as the amount of information available to workers and the nature of information access becomes more* *complex, it becomes important to explore the emerging concept of workplace information literacy in facilitating meaningful learning about work and collective practice*".

5 Environmental Scanning and the Urgent Need of Information Literate Workers

5.1 ES as Information Literacy Based Activity

Environmental Scanning (ES) is the acquisition and use of information about events and trends in the environment external to an organization and is a '*fractionalized*' process that includes several progressive stages that results in knowledge that may assist management in planning the organization's future course of action (Aguilar 1967). It is defined as the process of gathering and interpreting pertinent information and introducing the results into the organizational decision process (Smeltzer et al. 1988). More recently, Zhang et al. (2010), started with the most widely adopted environmental perceived uncertainty model of Daft and Weick (1984), as trigger of informational behavior. From the standpoint of the authors, this model did not consider the role of IL skills and that of employees in tracking down and collecting information. In the figure below authors integrated an additional layer of "IL perceived skills" composed of 2 sublayers: (1) employee participants' self- efficacy of IL and (2) Senior managers' perceived overall level of skills (Fig. 1).

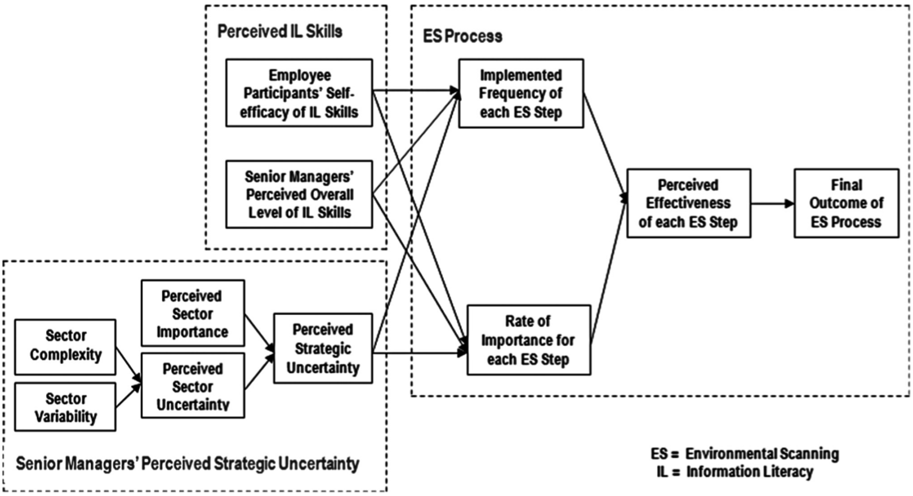

Fig. 1. Zhang et al. (2010) model of ES integrating perceived skills in IL

This block of perceived skills in IL is taken into account for its influence on the frequency and interest of employees in the scanning activities.

5.2 ES as Knowledge Generator Activity

ES as knowledge generator activity is supposed to be assigned to "information trackers" having skills in information literacy: *"Information literacy is a way of knowing the many environments that constitute an individual being in the world* (Lloyd 2010, p. 26)". The author assimilates IL practice to "*Knowledge of information sources within an environment and an understanding of how these sources and the activities used to access them are constructed through discourse"*.

The definition of the IL for the workplace of O'Farrill (2008) seems to be the most appropriate to the context of our research that considers the IL from the standpoint of information management skills, of organizational learning and of sensemaking of the information gathered from the external business environment and converted into knowledge. While the *progressive development of competences* seem obvious in the Western firm contexts where the national educational policies have, for several years integrated the IL in their curricula, in the developing countries, of which Tunisia, IL seems to be assimilated to operational mastering of the 'Information and communication technology (ICT)'. Accessing, critically interpreting and effectively using a variety of languages, codes, semiotic resources is neither taught in the curricula of the education system nor learned in companies through continuous training as a core competency for economic competitiveness.

Our study has no immediate ambition to design a model, but rather to confront the existing models to propose, in the light of the state of empirical research and case studies in the Tunisian context, a way of doing that can initiate an interest that does not seem clearly identified for the IL at the macro level of the public policy.

The concepts presented in the theoretical part of the article justify, as showed through the case studies below, the need for an educational base offering deliverables adapted to the needs of economic enterprises increasingly dependent on their ability to obtain timely information allowing them to anticipate changes and innovate continuously and flexibly.

6 Case Studies from Tunisia

Subsequent section of this paper uses secondary data to describe the studies showing why IL is lacking in Tunisia.

6.1 ICT Literacy

A recent study published by the Francophone University Association in 2016 was conducted to identify the needs of training in ICT for southern French-speaking countries. The aim was to propose a francophone strategy for the training of trainers in the field of digital education for the French speaking universities, particularly in developing countries. The purpose of the study was to understand the current situation in the training of trainers and perspectives proposed by different actors. Having identified the competencies, a governance scheme for each type of training, proposals for monitoring and evaluation mechanisms were considered. The main purpose was to ensure that the pedagogical objectives of each training cycle can be achieved.

A survey was distributed on-line to the ‘Francophone’ and Academic communities in the South. It was structured with targeted questions depending on the specificities of each of the four categories of target audiences:

– Decision-makers: those who decide to implement a project in the field of Digital education. They may be rector or university president, vice-rector, Director of the institution, etc.
– Teacher-researchers;
– Non-teaching staff responsible for the implementation of digital Universities;
– Administrative staff, research engineer and design engineers.

The analysis of the results showed that the French speaking countries of the Maghreb region has registered the higher numbers of ICT and Education ICT training sessions during the last three years. 38 respondents from Tunisia participated in the survey administrated to 319 respondents from 33 countries. The most important community of respondents after Madagascar with 42 respondents is the Tunisian community of university teachers. The results confirm an urgent need for IL; the mastering of access to Scientific Library information and documentation was ranked third and was reproduced 60 times.

6.2 The Need of IL in Education

The Tunisian Academy of Sciences Letters and Arts, organized in 2015 a national symposium about Science and technology in the reform of education systems Schools are urged to review its teaching methods and formal content to meet the needs of future citizens (Kamoun Chouk 2015). Among a list of KM failure factors of a cognitive dimension found in the literature review, Mansour and Gaha (2004) confirmed the low level of IL skills among the staff of companies and engineers in Tunisia. Their results are consistent with our findings in prior researches (Kamoun Chouk 2008, 2014) about the need of support for this area.

6.3 SMEs in Tunisia Need Information Literary Skills

The intervention research (Kamoun Chouk 2008), showed that the main failure of economic intelligence in the Tunisian industry SMEs, is a result of the lack of information literacy skills among the employees of the organizations. Employees of these organizations were unable to identify the required information, to know where to obtain the information and evaluate the obtained information to be used to sort problems effectively. Exploring IL among SMEs in UK and USA, De Saulles (2007, analyzed UK policy documents to determine how government policy addressed information literacy amongst SMEs. One of the findings of this study is related to the time wasted looking for information that SMEs cannot find estimated at £3.7 billion.

7 The Proposed Approach to Enhance IL Value Added in Tunisia

7.1 Factors to Take into Account

To overcome the above problems, Tunisia needs to take actions at the highest level of the nation. In a country were more than 90% of the economic sector is composed of SME and Very Small Enterprises (less than 10 employees), the role of public policy is crucial in the creation of an enabling environment for IL. Currently the developed models are mostly geared for western cultures. The construction of an education curriculum of media and information literacy have to prevent the risk of inequalities regarding information seeking and use among learners (Cordier and Lehmans 2013); The importance of evaluation and accreditation is highlighted by Villavicencio et al. (2013) and Boekhorst (2003) sees three main competences to consider when implementing IL: (1) the competence to use ICT to retrieve and disseminate information (2), the competence to find and use information independently (3), the process of recognizing information needs, retrieving, evaluating, using and disseminating information. The International standard model of MIL proposed by the UNESCO organization[1] as shown in the diagram below is an integrative model that can support the promotion of the individual skills of access to knowledge over the life learning cycle (Fig. 2).

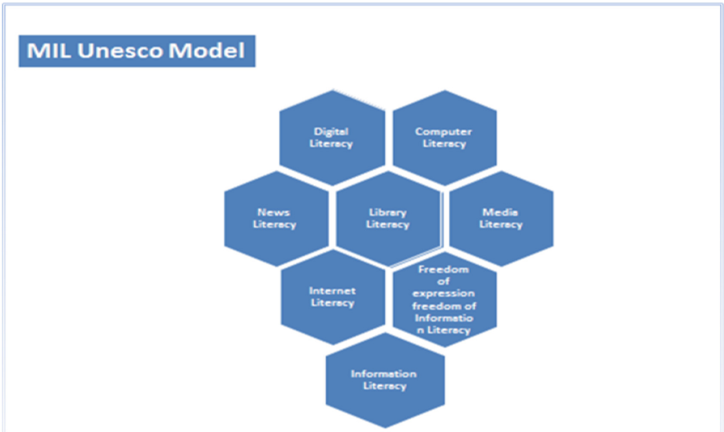

Fig. 2. MIL UNESCO model

At this step of our exploratory study, we consider that the UNESCO international framework could be beneficial to get technical support and bring the country closer to others that already have experience in this field. The need for a prior diagnosis of the inventory is essential for any action and UNESCO's model is extended by an assessment accompanying tool.

[1] http://www.manifestoformediaeducation.co.uk/2011/02/ruth-zanker/

7.2 The Assessment Accompanying Tool

The accompanying assessment model (UNESCO Global Media and Information Literacy Assessment Framework 2013[2]) gives support to the implementation of an IL National policy. Four competences needed in the workplace, are considered: (1) define and articulate information through a variety of resources; (2) Search and locate information and media content associated to the subject; (3) access to information, media content from information providers; (4) retrieve and hold/store/retain information and media content). They able to:

- Search for, to access and retrieve information and media content;
- Understand, assess and evaluate information and media;
- Create, utilize and monitor information and media content for the four associated competencies.

As a member of UNESCO, Tunisia can use the MIL model and its Assessment framework to develop Information Literacy skills, through the education curricula. Two approaches are possible: the embedded approach or the detached approaches. In the embedded approach, IL can be integrated in the subject matter to be taught. Conversely, IL skills can be taught as a separate subject in the curriculum. Each strategy has its own advantages and limitations. The choice will depend on the context assessment. Where resources are limited, the embedded strategy would be preferred. This transversal integration of the IL in the curricula has the merit of preparing the basis of a generalized competence which cannot be ensured by punctual answers to immediate needs. Targeted and operational training that has been shown to be more effective in some countries, such as the United Kingdom (De Saulles, etc.), could be a parallel or subsequent step in countries where there is no IL public policy.

8 Conclusion

To show how "Information literacy is a key to a competitive world in developing countries" we used the literature review to build a framework highlighting the crucial role of the connection between IL, ES and KM to support the Tunisian organization competitiveness. The role of education public policy in the creation of an enabling environment for IL is presented as a determinant success factor since Information literacy is crucial for organizations if they want to remain competitive and innovative. The case studies show that the lack of information literacy skills have created barriers for Tunisian organizations to be innovative and competitive. It is important that information literacy should be introduced in the school curriculum if the Tunisian organizations want to survive in a competitive world. Employees of all organizations need to be trained in information literacy. Information literacy learning should be taught as part of the educational curriculum.

Having studied the different models for the learning of information literacy, we have decided to recommend MIL model of UNESCO. We have found that this model

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[2] Table 6 *"Summary of MIL components, subject matters and competencies"* p. 59

provides an integrative view of blending media literacy, information literacy, ICT literacy and digital literacy. The four illiteracies help developing critical and reflective thinking by emphasizing the critical evaluation of information and media content, as well as requiring an understanding of the functions of media and information providers (products, services and processes) in society.

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A Quintuple for Describing Complex Information Systems

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Abstract. The analysis, design, implementation, maintenance, and enhancement of a complex information system is a long-term iterative process involving legacy systems and subsequent upgrades that need to avoid being bundled by a single hardware vendor, software vendor or system integrator. Stakeholders need a divide-and-conquer approach to help them find problem boundary, focus on the issues of concern, make rational decisions, and make reasonable requirements. Based on the concepts of IaaS, PaaS and SaaS in cloud computing, this paper presents a quintuple method for describing the structure of complex information systems, which can help all stakeholders analyze and participate in each phases of an information system life cycle.

Keywords: Information system · Stakeholder · Cloud computing
Internet of things · Big data

1 Introduction

Complex information systems, such as Cloud Computing (CC), Internet of Things (IoT) and Big Data (BD) systems involve computing resources, storage resources, network equipment, system software, application software, and terminal devices for information perception, data acquisition, and human-computer interaction.

The stakeholders involved in complex information systems, especially decision-makers and end-users, generally lack sufficient IT knowledge background and lack resources to understand the technical details of the system involved. They need a clear divide-and-conquer approach to help them analyze the structure of the information system (IS) they are involved in, put themselves in the right position based on their roles in the software project, focus on the key business they should deal with, cooperate with other stakeholders in the same ease of understand and ease of use IS description model, make rational decision, and take right actions.

CC is a possible solution. It puts all IT applications into three forms: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) by virtualization, pooling resources, automated resources allocation and personalized custom resources. Using CC as an approach enables ubiquitous, convenient, on-demand

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network access to a shared pool of configurable computing resources (e.g., networks, servers, storages, applications, and services) that can be rapidly provided and released with minimal management effort or service provider interaction [1].

Based on the concept of IaaS, PaaS and SaaS in CC, we developed a quintuple method for describing complex information systems, which can help professionals and non-professional stakeholders to analyze requirements, design systems, make rational decisions, present reasonable requirements and collaborate with each other in the lifecycle of a system.

The paper begins with a brief review of the concepts of CC, IoT, BD and Cloud Computing Node (CCN), and then we propose a quintuple ***IS (I, P, S, T, F)*** method for describing complex information systems followed by a case study and discussion. The paper concludes with conclusion and suggestions for further design, development, maintenance, and enhancement of complex information systems with the quintuple method.

2 Related Literature Review

2.1 Cloud Computing

CC refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide these services. The services themselves have long been referred to as SaaS. The datacenter hardware and software is what we call a Cloud. When a Cloud is made available in a pay-as-you-go manner to the general public, it is called Public Cloud; the service being sold is Utility Computing. The term Private Cloud refers to internal datacenters of a business or an organization, which not made available to the general public. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [2].

The most often claimed benefits of Clouds include offering resources in a pay-as-you-go fashion, improved availability and elasticity, and cost reduction. Clouds can prevent organizations from spending money for maintaining peak-provisioned IT infrastructure that they are unlikely to use most of the time [3]. Cloud-based applications offer businesses the chance to deliver products that save time and money, and make it simple to access data from anywhere employees need to access it.

2.2 Internet of Things

IoT is made up of devices connected through the Internet to gather and collect information about the environment using sensors connected to things. These devices communicate and interact together to acquire, process and storage information in intelligent way. In the IoT environment, millions of devices are connected to each other which need to exchange information through the network (i.e. Internet) with huge capabilities such as high bandwidth, processing and storage capabilities. These huge capabilities can be provided by cloud computing [4].

Haller, Karnouskos and Schroth define the IoT as "a world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes. Services are available to interact with these 'smart objects' over the Internet, query their state and any information associated with them, taking into account security and privacy issues" [5].

2.3 Big Data

BD is a term utilized to refer to the increase in the volume of data that are difficult to store, process, and analyze through traditional database technologies. The nature of big data is indistinct and involves considerable processes to identify and translate the data into new insights [6]. BD is an abstract concept. In general, big data means the datasets that could not be perceived, acquired, managed, and processed by traditional IT and software/hardware tools within a tolerable time [7, 8]. In 2010, Apache Hadoop defined BD as "datasets which could not be captured, managed, and processed by general computers within an acceptable scope" [8]. The core of BD is to study the acquisition, storage, processing and display of complex data.

2.4 Cloud Computing Node

Paper [9] discusses a kind of Cloud Computing Node (CCN) from logical topology, physical topology and application based on virtualization and network engineering technologies, which can supplies IaaS, PaaS and SaaS services. A typical Cloud Computing Node topology is shown as Fig. 1.

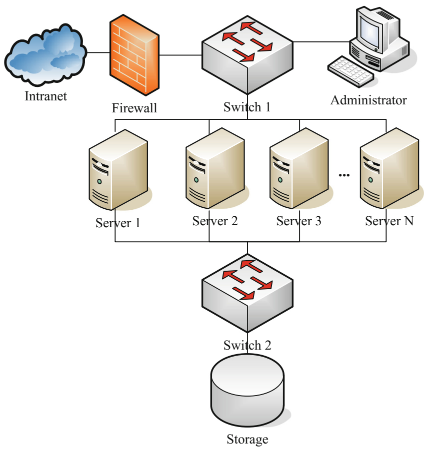

Fig. 1. This picture shows a typical Cloud Computing Node topology described in [9]. With the use of Cloud Computing and Network technologies, Hundreds of computer servers and network devices were managed through campus network and was used to provide virtual machines (VM) to LIMS.

This kind of CCN can be used as a container for web servers, software development and test environments, DB runtime environments, and back-end management of Internet of things. The CCN details and usage can be found in [9].

So far discussions on CC, IoT and BD have been rather vague; it is hard to be used by stakeholders directly. This paper proposes a quintuple method by which the structures of information systems can be firmly grounded in terms of mathematical set theory.

3 A Quintuple for Describing Complex Information Systems

Stakeholders involved in an IS not only need to be concerned with system implementation and document refinement, but also an effective approach to analyze the structure of the system, update their knowledge about the system, understand the system status, and guide their activities. Herein, we developed the Quintuple ***IS (I, P, S, T, F)*** to overcome the limitation.

3.1 The Four-Tier Services in a Complex IS

A complex IS refers to lots of hardware, software, users, physical environment and relations between them. With the help of the theories and technologies from CC, IoT, and IS, Various entities and their relationships within a complex IS can be explained by a four-tier services model, as shown in Fig. 2.

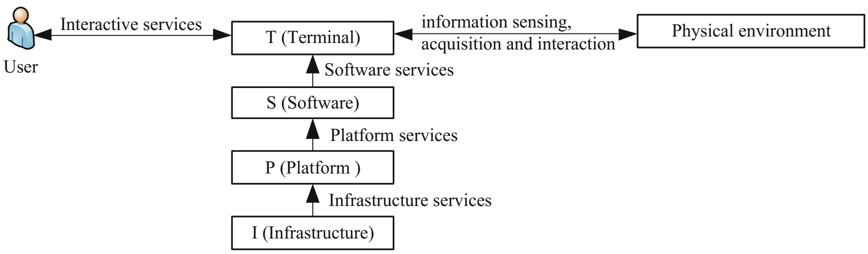

Fig. 2. This model shows the entities and their relationships within a complex IS, in which the structure of an complex IS can be divided into four tiers of services, each layer providing services to its upper layers, the terminal layer provides interactive services to users, and interacts with the physical environment through information sensing, acquisition, and interaction devices.

Infrastructure refers to a set of computing resources, storage resources, network equipment resources integrated through infrastructure management software and hardware. Infrastructure layer supplies physical or virtual hardware to a IS and can be get form public cloud or private cloud. Paper [9] presented the design, implementation, and application of a private cloud computing node, which can supplies Infrastructure services in the form of virtual machines.

Platform refers to the system software, DBMS, and run-time environments, such as OS, LAMP, MySQL, and Spark environment.

Software refers to application software, such as portal, MIS, and CMS, that the user directly accesses or interacts with a terminal device.

The focus of IoTs is on the perception, acquisition, transmission, and man-machine interaction of information, so IoTs is a complement to the concept of CC. When we design a IS, we have to concern with terminal devices, such as various sensors, data acquisition devices, and interactive terminals, such as temperature Sensor, Sound pick, network camera, Smartphone, PDA, and PC.

3.2 A Quintuple for Describing the Structure of a Complex IS

After the upper analysis of a complex IS, we can use a quintuple ***IS (I, P, S, T, F)*** to describe the structure of a complex IS.

Infrastructure services can be represented by a finite non-empty set $\boldsymbol{I}$. $\boldsymbol{I = \{i_1, i_2, \ldots i_j \ldots i_n\}}$ $\mathbf{n \geq 1}$, where the $\boldsymbol{i_j}$ is used to represent the Infrastructure service $\boldsymbol{j}$ that comes from a private cloud owned by the customer or a public cloud that can be used by the customer, including the computing resources, storage resources, network bandwidth it needs, the services it provide (such as VMs, computing resources, storage capacity and the information of operating systems that can be deployed).

Platform services can be represented by a finite non-empty set $\boldsymbol{P}$, $\boldsymbol{P = \{p_1, p_2, \ldots p_j \ldots p_n\}}$ $\mathbf{n \geq 1}$, where the $\boldsymbol{p_j}$ is used to represent the platform service $\boldsymbol{j}$ that owned or can be used by the customer, including ***Power (I)*** that it relies on, the services it provides.

Software services can be represented by a finite non-empty set $\boldsymbol{S}$. $\boldsymbol{S = \{s_1, s_2, \ldots s_j, \ldots s_n\}}$ $\mathbf{n \geq 1}$, where the $\boldsymbol{s_j}$ is used to indicate the software service $\boldsymbol{j}$ that the software services can provide, including ***Power (P)*** that it relies on, the services it provides.

Terminal devices can be represented by a finite non-empty set $\boldsymbol{T}$. $\boldsymbol{T = \{t_1, t_2, \ldots t_j, \ldots t_n\}}$ $\mathbf{n \geq 1}$, where the $\boldsymbol{t_j}$ is used to indicate the terminal device $\boldsymbol{j}$ belonging to the customer, including ***Power (S)*** that it relies on, the functions it provides,

The descriptive information of ***i, p, s,*** and ***t*** and their operation and maintenance costs, usage, management information and service prices can be stored in relational tables.

The dependent relationships of ***I, P, S,*** and ***T*** can be represented by a finite non-empty set F, which includes dependent functions **pi**, **sp**, and **ts**.

pi: Query its dependent ***power (I)*** from input ***p***

$$\forall \boldsymbol{p}\ \exists \boldsymbol{Power}(\boldsymbol{I})\ \mathbf{pi}(\boldsymbol{p}) = \boldsymbol{Power}(\boldsymbol{I}), \boldsymbol{p} \in \boldsymbol{P}\ \mathbf{and}\ \mathbf{Power}(\boldsymbol{I}) \subseteq \boldsymbol{I}$$

sp: Query its dependent power (P) from input s

$$\forall s \; \exists \boldsymbol{Power}(\boldsymbol{P}) \; \mathbf{sp}(\boldsymbol{s}) \; = \boldsymbol{Power}(\boldsymbol{P}), \boldsymbol{s} \in \boldsymbol{S} \text{ and } \mathbf{Power}(\boldsymbol{P}) \subseteq \boldsymbol{P}$$

ts: Query its dependent power (S) from input t

$$\forall t \; \exists \boldsymbol{Power}(\boldsymbol{S}) \; \mathbf{ts}(\boldsymbol{t}) \; = \boldsymbol{Power}(\boldsymbol{S}), \boldsymbol{t} \in \boldsymbol{T} \text{ and } \mathbf{Power}(\boldsymbol{S}) \subseteq \boldsymbol{S}$$

3.3 Complex IS Structure Analysis Flowchart

When we analyze or design a complex IS, we should start from problem, budget, and requirements, and the operation, maintenance, and enhancement should also be concerned with. Figure 3 shows a flowchart of using this quintuple to analyze the structure of a complex IS.

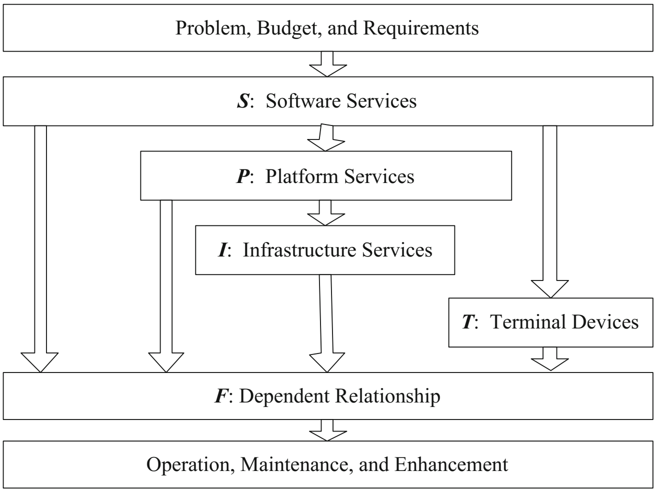

Fig. 3. This picture shows the process of analysis and design the structure of a complex IS, the input of it are problem, budget, and requirements; the output of it are operation, maintenance, and enhancement. The input and output were not concerned in this research, we put them here is to show that they are the bundle of the IS structure analysis approach.

We designed a 3-D coordinate system to present the structure of a complex IS (See Fig. 4). Relationships between them can be sorted by relational tables.

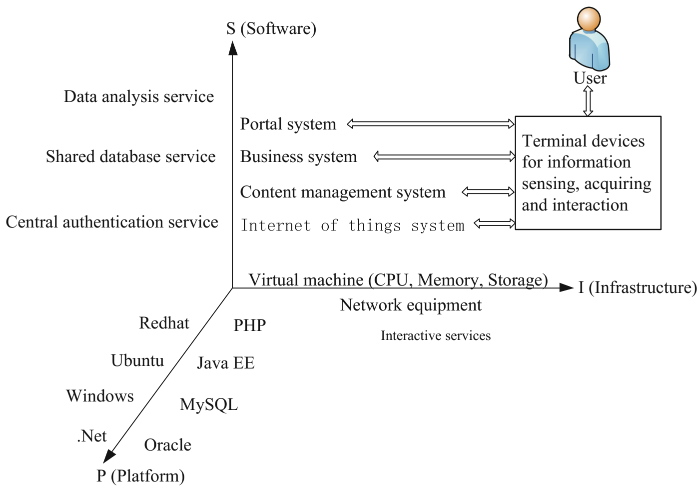

Fig. 4. This 3-D coordinate system shows a complex IS decomposition method, in which we divide a complex IS into infrastructure, platform, software, and terminal devices.

4 A Case Study: The Analysis the Structure of an LIMS

This case study shows an example of using the Quintuple approach to analyze a Lab Intelligent Management System (LIMS) in our university, which is designed to manage all labs in our university, used hundreds hardware [1, 9–11]. There are more than 2000 universities in China as potential users of the project. It is therefore necessary to carry out an in deep analysis of the project to guide stakeholders in the following phases of this project and to share our knowledge for similar projects.

4.1 The Design of the LIMS

The LIMS was divided into Campus Network, University-level and School-level. The architecture and software services are shown in Fig. 5.

The campus network supplies Application Programming Interfaces (APIs) of Central Authentication Service (CAS) and University Shared Database to the LIMS. The university level platform is the lab portal of whole University. The school Level Platform is a set of Building Nodes. Each Building Node is the lab portal of a School.

Figure 5 clearly presents the architecture and software services of the LIMS, but the relationships between ***I, P, S,*** and ***T*** are not clearly analyzed. Therefore, we need a more clearly analysis approach to analyze the structure of the LIMS.

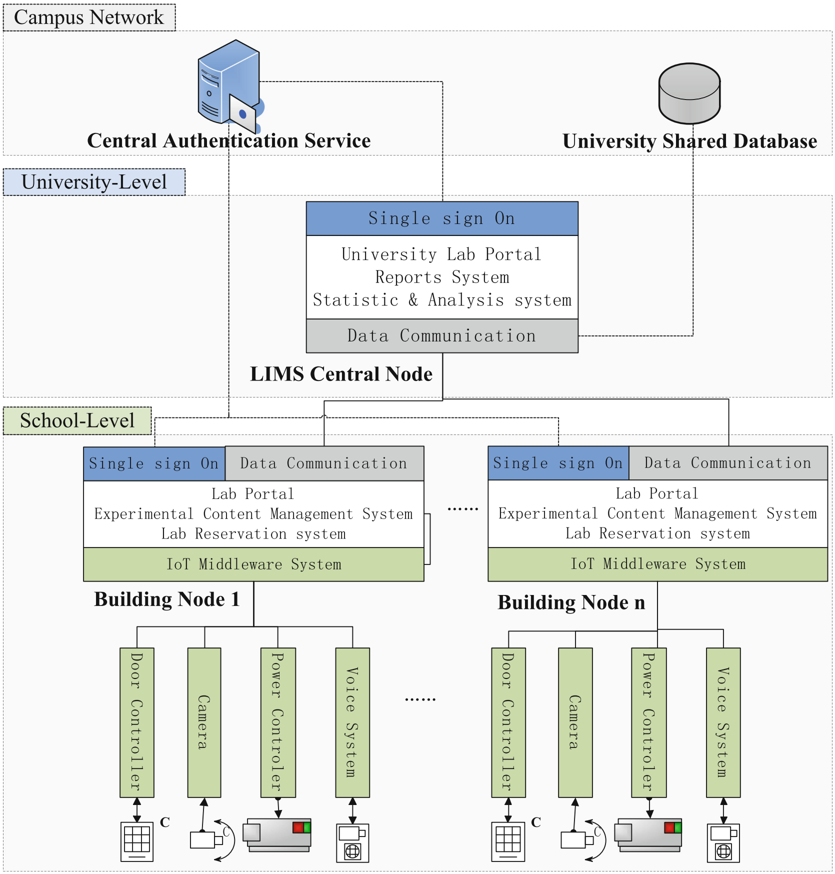

Fig. 5. This picture shows the architecture and software services of the LIMS. The Central Authentication Service and the University Shared Database service are maintained by our University Information Center. The lab portal, the experimental content management system, the lab reservation system, and the IOT middleware system are the main services of the LIMS

4.2 The Structure of the LIMS

With the use of the quintuple approach to analyze the structure of the LIMS, the ***I***, ***P***, ***S***, and ***T*** are shown in Fig. 6.

Then, the ***I***, ***P***, ***S***, ***T*** and ***F*** can be listed in a relation table. All parts of the LIMS were clearly illustrated, and all stakeholders can think about the LIMS in the concept of quintuple ***IS (I, P, S, T, F)***. The analysis of the LIMS is shown in Table 1.

As shown in Fig. 6 and Table 1, computer servers and network devices were organized as CCN (See Fig. 1) and were deployed in each building of the university. These CCN supply ***i*** in form of virtual machine (VM) to the LIMS. The LIMS used a large amount of Terminal devices for information sensing, acquiring and interaction. Door controllers, cameras, power controllers, and voice systems are used as ***t***. The dependent from ***P*** to ***I,*** from ***S*** to ***P,*** and from ***T*** to ***S*** are recorded in the form of APIs of

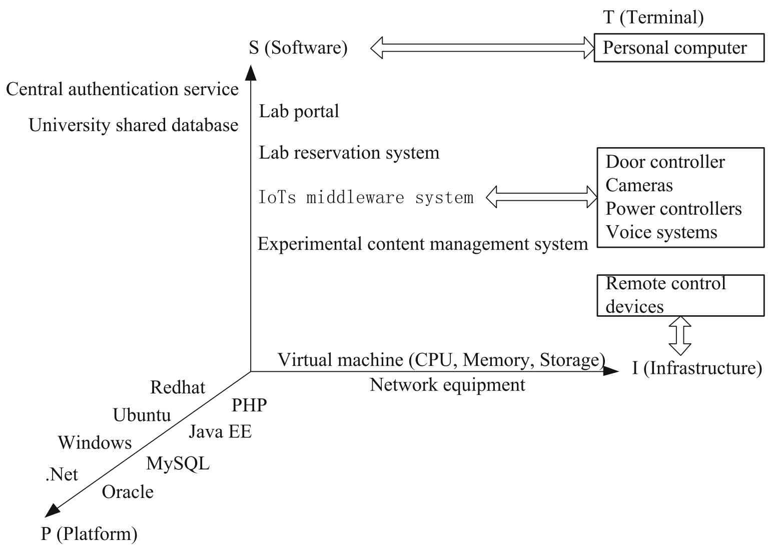

Fig. 6. This picture shows the services of LIMS. The platform services in the LIMS include OS, DBMS, and runtime environments, such as Ubuntu, RedHat, windows, MySQL, PHP, Java EE, and .Net. These platform services were installed in the VM supplied by the CCN.

Table 1. A LIMS quintuple analysis table

	Campus network	LIMS center node	Building nodes
I	Servers Storages Network devices	Servers Storages Network devices	Servers Storages Network devices
P	OS DBMS Runtime environments	OS DBMS Runtime environments	OS DBMS Runtime environments
S	CAS University shared database	University lab portal Report system Statistic & analysis system	Lab portal Experimental content MS Lab reservation system IoTs middleware system
T	Remote control devices	Remote control devices	Door controller Cameras Power controllers Voice systems Personal computer
F	APIs of CAS and university shared database Maintenance documents	APIs of data communication Maintenance documents	APIs of data communication Maintenance documents

Data Communication and Maintenance Documents, for system maintenance and subsequent enhancement. ***F*** is used to represent these APIs and maintenance documents.

4.3 The Structure of a Video Surveillance System

Figure 7 shows an interface of a video surveillance system in the LIMS, which is a typical IOTs Management System in our LIMS. The management software of the video surveillance system was deployed in the VM of ***P***, and cameras are installed in different labs. The video surveillance system is an ***s*** and cameras are ***t*** in the quintuple method.

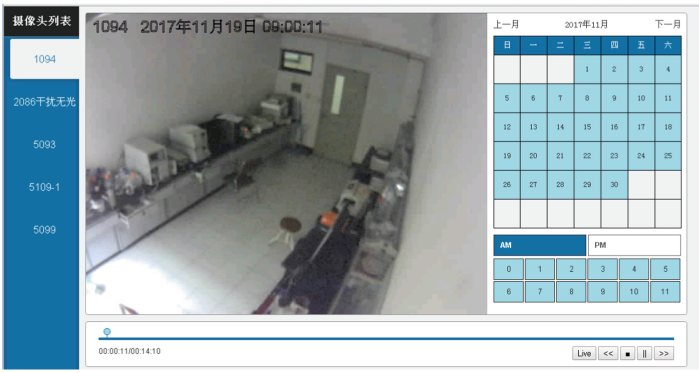

Fig. 7. This picture shows an interface of the video surveillance system within our LIMS. The menu on the left is used to select different cameras, the right calendar is used to monitor video playback by date and time, and the middle main window is used to play the laboratory live scenes or historical scenes. Currently it shows the situation of a laboratory in a Sunday morning (9 am, November 19, 2017). Managers can view the laboratory's real-time or historical scene through internet.

5 Discussion

Stakeholders involved in complex information systems, especially decision- makers and end-users, generally lack sufficient IT knowledge background and lack resources to understand the technical details of the system involved. They need a clear divide-and-conquer approach to help them analyze the structure of the IS they involved in, so they can efficiently make decision for their following actions.

As shown in the case study, with the use of the quintuple method, all entities and their relationships in the LIMS was analyzed clearly. Each instance ***i*** in ***I*** came from different hardware providers and were integrated by system integrators, Each instance ***p*** in ***P*** came from different commercial software or was open source software and was maintained by system integrators or internal IT departments, Each instance ***s*** in ***S*** was developed and maintained by internal or external development teams, ***T*** described external devices connected to ***S,*** and ***F*** was used to describe internal relationships and external service interfaces in the LIMS. In the following phase, stakeholders, such as hardware suppliers, software providers, system integrators, asset management, information management, decision makers and end users, can discuss issues in this quintuple semantic environment. When a new project about new requirements is planned, stakeholders can design and plan it depend on the current ***IS (I, P, S, T, F).*** For example, when a new project ***s*** is planned, stakeholders should understand whether they have the ***Power(P)*** and ***Power(I)*** that it relies on, if the required ***Power(P)*** already exists and the capacity of ***Power(I)*** that the ***Power(P)*** depends on is sufficient, then stakeholders can just focus on ***s*** itself. Otherwise, a new project ***p*** and/or a new project ***i*** also need to be considered at the same time.

The case study also shows that the quintuple method is helpful for the stakeholders to understand and discuss problems their concern in a divide-and-conquer way. With this quintuple method, Decision makers can clearly plan the overall system at the beginning of a project. In the project implementation phase, participants can analyze, design, develop, test and deploy ***i, p,*** and ***s*** independently. In the project integration phase, system integrators integrate the systems according to ***T*** and ***F***.

In order own an effective and efficient IS, all items in the quintuple ***IS (I, P, S, T, F)*** should be clarified at the beginning of an IS project and looked back through the whole life cycle of it.

6 Conclusion

The quintuple method proposed in this paper provides a clear common background for information system (IS) ecosystem. By using it, all stakeholders (such as hardware vendors, software providers, system integrators, asset management departments, information management departments, decision makers, and end users) can discuss problems in the quintuple context. Hardware vendors discuss ***i*** with integrators and customers, system software vendors discuss ***p*** and ***Power(I)*** it relies on with customers, software manufacturers talk to customers about ***s*** and ***Power(P)*** it relies on, and customers focus on the ***s*** they needed.

The quintuple method benefits stakeholders to effectively and efficiently analyze, evaluate, and refactor a legacy IS, to design, implement, and maintain a new IS, to avoid redundant construction, and to separate the various links within a IS logically, so as to help stakeholders focus on solving the concerns. The method can help decision-makers to plan and present requirements in a macroscopic way, as well as provide system design and collaboration guidance for other stakeholders. System designers concern with the overall system, such as the computing and storage capacity in ***I,*** the kinds, numbers and functions in ***S***. System architects and system analysts plan for the specific content of ***I, P, S, T*** and ***F***. End users only need to focus on the services provided by ***s***. Developers only focus on the implement of ***s***. Maintenance personnel maintain the system according to ***F***.

For example, the quintuple method can be used to design or analyze a BD system. BD is a term utilized to refer to the increase in the volume of data that are difficult to store, process, and analyze through traditional database technologies. The core of BD is to study the acquisition, storage, processing and display of complex data, which can be subdivided into data acquisition, data storage, data integration, data parallel processing, data analysis and data application. Logically it is similar to the traditional database application, for the storage and processing of data belong to $\boldsymbol{P}$, and the analysis and presentation of data belong to $\boldsymbol{S}$. A BD system needs to run on one or more $\boldsymbol{i}$ (Infrastructure service), and provides services through one or more $\boldsymbol{s}$, it generally involves the information perception, information acquisition and human-computer interaction devices, which are belong to $\boldsymbol{T}$.

In IS domain, different stakeholders have different needs, values, and interests. Divide-and-conquer and ease of use frameworks are needed for them to effectively plan, organize, analyze and participate in the life cycle of an IT project. It is our intention to further carry out research to develop frameworks and case studies that can be used to help organizers, designers, developers and other stakeholders to co-create value.

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Prototype Design of a Metamodel for Pedestrian System Planning Based on System Dynamics

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Abstract. The ongoing economic and social transformations in urban spaces have raised the attention of policymakers and planners in favor of non-motorized transport, such as pedestrians. In Latin America, the traditional planning takes into account those most influential aspects of transport systems, usually measured in terms of economic impact and, through the years, directed efforts to improve motorized transport systems and its infrastructure in most urban centers. In general, urban transport planning has aimed at building infrastructure and specific pedestrian features and its internal dynamics are not considered. Therefore, this study aims at presenting a model of collective intelligence based on system dynamics that allows represent the features relationships within the pedestrian system of Bogotá, at different levels of decision, integrating databases, aiming at a systemic analysis for decision-making. The methodology used for the research was descriptive and case study, based on bibliographic, documental and fieldwork investigation. The main result of the study is the design of a prototype meta-model proposing a methodology for planning pedestrian system, based on the development of collective intelligence, recognizing human interaction, that can be adopted by transport planners.

Keywords: Computational cultural modelling · Collective intelligence
Transport planning and design · Pedestrian system · Bogota

1 Introduction

During the nineteenth century the relationship between transport and urban development, where the "road city," replaced the "city for pedestrians" was strengthened. But it is in the twentieth century where the "tire city" or "city highway" really arose. These changes generated improvements in socioeconomic indicators and on the other hand, gave the conditions for people move and not being forced to live near their workplaces. Despite all means of transport available, as cities become more geographically extensive, increases also pedestrian movement, becoming sometimes forced to displace longer for accessing to mass transit, among other reasons, to avoid vehicular congestions.

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The complexity of pedestrian behavior comes from the patterns of collective behavior (such as crowd together, railing and queue) as a result of interactions between a large number of individuals [1]. The ability of human communities to evolve into an order of complexity and greater harmony, both through innovation mechanisms as differentiation and integration, competition and collaboration, what was called collective intelligence, recognizing human interaction beyond a microscopic vision, which is the one that is analyzed in this study on pedestrian systems.

2 Collective Intelligence in Pedestrian Systems

Urban traffic in general evolves continuously, depends on many variables, considering it as a dynamic system with high dependence on people. Studies have been conducted to represent the behavior of pedestrians [2–10]. Nevertheless, those approaches have been not enough to elucidate all concerns, limiting on explaining partially, taking into account that although pedestrian systems have rules and structures, the behavior of people is not standard.

On the other hand, on intelligence analysis of pedestrian systems, there are other factors that affect performance and overall performance. Overall social organizations are highly influenced by cultural factors; collective intelligence begins with culture and increases with it [11]. The cultural level of the pedestrian system is reflected in collective behavior patterns what reflect on overall pedestrian system statistics.

2.1 Definition of Variables

The identification of key variables is taken as a starting point of structural analysis, considering that a model of intelligence for pedestrian systems should allow the representation of the relationships of variables that occurs in the system, which will support decision making. For the definition it was used a hybrid technique between MICMAC (for the French acronym "cross-impact multiplications matrix applied to classification"), the methodological proposal of Godet [12], and the proposal developed by the SES group [13]. First, it was based primarily on impact matrices; the second, based on expert analysis and the relationships of influencing variables. Basically, the proposed technique consists of two stages: the construction of bases and identification of variables and the identification of key sectors.

In this case, 67 incidents related variables were taken in. Performing a first process of affinity between variables, sectors of interest to the group were identified: Accidents, Statistics/Accident Statistics, Behavior, Culture, Politics, Budget, Structure, Standards, Campaigns, Fines, Information Systems, Experiences and habits. The variables of each sector are shown in Table 1.

Table 1. First affinity variables

Criteria	Associated variables
Accidents	Accidentally [14–18]
Statistics/Accidents	Deaths, Injury, Disability, Invalids [14, 17, 19, 20]
Statistics	Social cost, deaths cost, disabilities cost, injury cost, disability cost [21, 22]
Behavior	Walk down the right, Yielding, Stopping in groups, banned groups crossing, overtaking [1, 3, 7, 22–29].
Culture	Ideas, values, norms, habits [15, 22, 24, 28, 30–35].
Public policy	District budget, Mobility Budget, budget policy, fine value, Infrastructure policy [33, 34, 36–39]
Budget	Advertising budget, collection of fines, Investing in education, investment in the information system, infrastructure investment, Investment in control, investment in transit infrastructure Budget, Budget Signs, Traffic lights Budget [19, 28, 34, 36, 39–43]
Maintenance	Maintenance of bridges, tunnels maintenance, maintenance platforms, signaling maintenance, maintenance of traffic lights, keeping other works [42, 44–46]
Laws and guidelines	Regulations, laws [28, 32]
Campaigns	Advertising, Messages, Forgetting, Remembrance, Number of prevention campaigns, Number of information campaigns, number of corrective campaigns, campaigns cost [47–49] Recordation [19, 22, 50, 51]
Fines	Fines [28, 40]
Information system	Regulation of deaths, injuries regulation, cost of injury, deaths cost [14, 21]
Experiences	Witnessing accident, learn about an accident, reprimand, fines [15, 19, 34, 41]
Habits	Habit of invading spaces, forbidden habit of making crosses, towed habit, habit of obstructing vehicles, Other negative habits, habits enforce rules [19, 28, 34]

2.2 Metamodel of the Pedestrian System

Once the variables were aggregated by sectors based on the methodology of Godet, it was analyzed the involvement among the identified variables (the iterations produced a total of 4489 relationships among the variables). In general, the Accident variable is to be the highest degree of incidence in the study, showing consistency in the opinion of experts taken into analysis and methodologies employed.

The relationships between the sectors are not a sign of how important they are but allow to highlight the complexity of the system and how influential and how they can be influenced by each other. Then, following the methodology of Godet, sectors should be related to hierarchical levels and then must analyze the degree of affinity, as shown in Fig. 1. In an additional exercise it was analyzed the incidence relations of the sectors excluding the Mega-sector information system.

Collective intelligence is reflected in the behavior of groups, that is, which is not only a reflection of the sum of the individuals but is affected by the interactions and influences including displaying the existence of a performance and therefore knowledge as a group. It can be said then that the knowledge and performance of the group, reflect its collective intelligence.

Knowledge can be understood as an object and as a stream [52]. Even considered that knowledge as flow, it can be considered explicit type [53] and the transmission of each other individuals is complex. Forrester [54] identifies six different types of flows used for the representation of systems, but within these, the flow of knowledge is not evident. In the technical dimension flows they are tangible, but in the social dimension it is intangibles representing people.

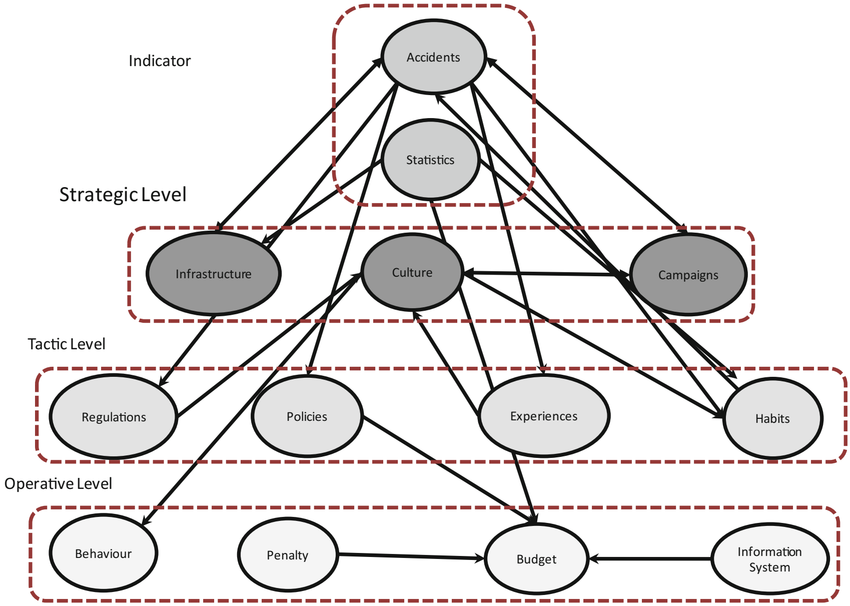

Fig. 1. Hierarchical levels of sector and variables

Forrester [54] states that the basic structure of dynamic models of industrial systems, consists of levels (are accumulations within the system, are the current values of the variables resulting from the cumulative difference between inflows and output), flows (carrying the contents of one level to another), decision functions (controlling flow rates between levels) and information channels (connecting functions decision levels). In addition, it was identified six interconnected networks that allow the representation of industrial systems and each of which has a flow: the network of materials, orders, money, personnel, capital equipment and interconnection information.

This logic and systems representation can be extended to planning, based on the analysis of influencing factors presented in the previous section. Figure 2 may represent compounds sectors in turn by the level associated with each factor with its entry rate, corresponding to the relationships that exist between factors and/or input variables and output rate, which corresponds to the output level. The levels associated with the level decision in the sector and indicators is affecting should be taken into account.

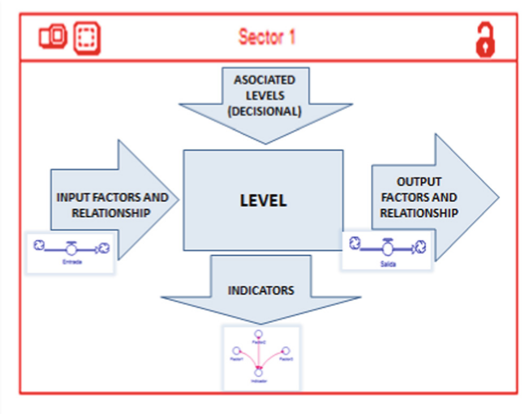

Fig. 2. Systems representation

The information network is considered unique and superior to the others, because it can extend from a level of any of the six networks at a rate in the same network or another, but the information flow does not necessarily cause changes in the levels of system [54]. For example, in the case of pedestrian systems, individuals may have information about traffic rules, but do not act on them. However, a publicity campaign accident figures, may cause sensitization can do to change their behavior. Acquired consciousness, going beyond the information and what is considered knowledge.

The system proposed by Forrester [54], the phenomenon of distortion of information, is perhaps the first approach to the flow of knowledge in the dynamics of industrial systems, because it recognizes that decisions are affected by everything that affects the flow of information, which suffers distortions beyond those caused by delays and amplification. Furthermore, it was recognized that the information is interpreted in different ways by various individuals and organizations, while containing errors, random and unknown disturbances from external sources or noise [54].

Recognizing the existence of intelligence in some groups or social groups can show in them also the existence of knowledge. Then latter it happens to belong to individuals, to social groups as a whole, and it can be expressed as such through their emergent conducts. However, understanding knowledge as something positive in social organizations can say that it is possible to go through their cultural level and can experience the diffusion phenomena, modification, relearning, increase or decrease flows. A proposal by the representation of the flow of knowledge as a basis of collective intelligence of pedestrian systems is shown in Fig. 3, which is based on structural previously showed.

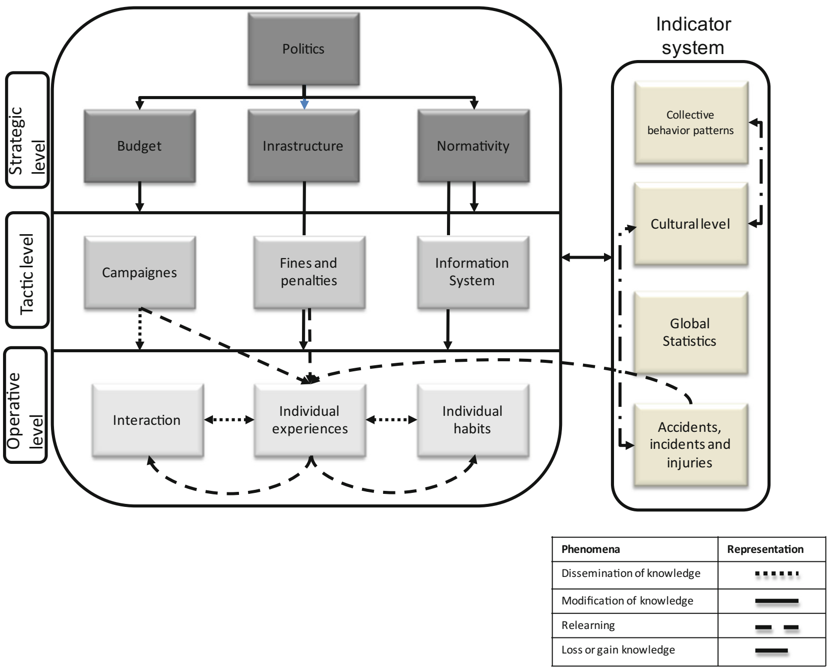

Fig. 3. Collective intelligence representation

The dissemination of knowledge is given from the tactical level to the operating, seeking the involvement of all this level and not the involvement of a particular individual; because unlike closed organizations, systems of social type by its open nature does not make a tactical deployment consequence of a single level, but its influence goes on the operational level and may have a spillover effect on other individuals who have not been directly affected. Diffusion is understood, like all socialization that seeks to create awareness in the individual, such as when information campaigns on accident figures are made. Knowledge is also disseminated through the interaction among people, through their habits and individual experiences, such as when the imposition of a subpoena is presence to another person for having violated a rule. The characteristic amplification, as that which determines the behavior of systems of information feedback and causes decisions to respond to the fluctuations and own systems delays, may be an example of response to the phenomenon of diffusion of knowledge, because tries to anticipate fluctuations seeking to be done properly deploying system policies.

The modification of knowledge happens mainly on the factors related to operation, specifically in the strategic and tactical levels. Policies directly change the overall design of the system in terms of structure, budget and regulations. The tactical level is completely affected by the last two, while the structure directly affects fines and penalties, coverage identify geographically specific regulations. Information systems, fines and penalties, modify the knowledge of the system at the operational level, because the regulations unfold through the latter and information systems are linked with what is considered important to measure and take the “memory” of the system. A modification of knowledge is understood as a global rethinking of a truth, as a new definition of something that was considered true globally. For example, when a new offense defined, is being recognized as “undesirable” behavior that it once was. Furthermore, the indicator system modifies the knowledge in the sense that modifies what is conceived as the current state of the system, through the analysis of the global behavior feedback.

Re-learning are ‘local modifications’ of acquired or defined by each individual’s knowledge, but ultimately affects to some degree the system knowledge. The re-learning process is given at the operational level, and they are related only to pedestrians and specifically with their individual experiences. It can be started by campaigns; whether corrective or preventive outreach; or it can be through fines that have been imposed or information of accidents, incidents and injuries. In fact, individual experiences because the phenomenon of relearning factors affecting individual habits and interaction with other individuals.

The loss or gain of knowledge within the system is given by modifying collective behavior patterns and levels of accidents, incidents and injuries without judging this knowledge as good or bad. Note that the relationship between the cultural level and each of these factors is bidirectional, because it is considered that the involvement occurs in both directions, but with delays to be taken into account later.

It is then understood the cultural level as the representation of current knowledge available to the system of pedestrian traffic, which spreads when disclose global statistics, through information campaigns and during interaction between pedestrians. Factors related to the regulatory authority, seeking to modify the knowledge of the system, often through “global impositions” as policies and legislation. In the deployment of the latest, fines and penalties seek a relearning of knowledge causes, initially at the individual level, affecting previous experiences, but this relearning is also given through corrective campaigns and during interaction with other pedestrians, as culture spreads through learning from each other [31] for example, when the person is witness of an accident.

Information network recognized by Forrester [54] can be considered at the technical level, while the network of knowledge transcends social and it is inherent in human nature. It can be extended by different factors filtering the flow of information, influencing the behavior of social groups to make it as most appropriate; either by the system in general by the creators of policies or individuals themselves, finally reflected in the emerging system comportments.

A model of intelligence can serve as a basis for the design and modification of infrastructure standards as a basis for designing strategies to modify pedestrian systems and as a tool for understanding such systems. In addition, it is possible to deploy models, especially continuous simulation, enabling decision-making on the pedestrian system. The following section describes the deployment model of collective intelligence for policy analysis in Bogota pedestrian system, using system dynamics.

A part of the representation of the pedestrian system of Bogota is shown in Fig. 4, which shows one sector of nine (using Ithink simulation software). As input elements was used the budget sector as an example (mobility budget), which comes from the

District Budget, where the percentage of the total budget is allocated to the Mobility. Similarly, the budget allocated to the Mobility of Bogotá, comes from capital resources, transfers from the state and the current income. The truth, they are composed of the tax on gasoline, vehicle tax, penalty fees and other income.

On the other hand, the budget are generating in the decreased level. These investments consist of education in the information system, in infrastructure, in control, in transit, and even for debt service. Likewise, investment in education is composed as intended for corrective, preventive and publicity campaigns. Considering it is a representation for simulation, each element is represented by equations that are the result of actual data analysis system or corresponding approaches from the findings of experts.

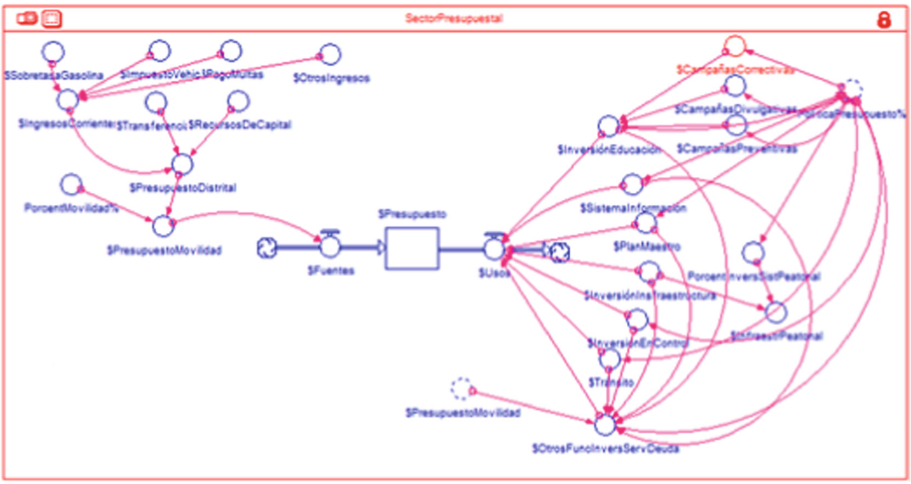

Fig. 4. System dynamic representation

3 Final Considerations

A model for pedestrian systems intelligence can improve the processes of decision making, understanding and overall performance through the identification of knowledge flow relationships that occur globally.

A new scale of collective intelligence, in addition to those proposed by Atlee, which are groups of activities, organizational, network, neighborhood, community, city, county individual, interpersonal or relational identified or county, state or province, regional, national or entire society, groups, networks or international organizations, and global humanity. The scale is given in social systems and subsystems, where you can identify emerging behaviors and self-regulation, which show the existence of collective intelligence.

Identifying diffusion phenomena, modification, loss or gain relearning and knowledge, allow analysis and modeling of knowledge flow of pedestrian systems. Through the intervention of these phenomena, its flow is affected by modifying the collective intelligence of the system.

The representation of a complex system like the pedestrian system of the city of Bogotá requires structural analysis to represent the interrelation of its factors. An approach to the representation of collective intelligence can be made based on the representation of the influential factors with a level of detail as to allow aggregate and desegregate using a continuous simulation model.

Determining factors to assess, based on the relationships of influential factors identified by experts, allows the representation of the different actors and influence each other, without distinction of roles. The proposed meta-model allows modeling of different sectors of pedestrian systems, in order to analyze their relationships and later intelligence levels through the determination of system indicators and emerging behavior's at different levels of associated decision. The proposed planning methodology allows the creation of models to evaluate policies to be implemented for pedestrian systems.

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Knowledge and Technology Management

Risk Management Framework as Technovigilance Support at Sterilization Unit in the San Jose Hospital (Colombia)

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Abstract. The article seeks to design a risk management framework at the Sterilization Unit in the San Jose Hospital according to the ISO 31000 guidelines as outcome of a research project between the Catholic University of Colombia and the Fundacion Universitaria de Ciencias de la Salud. This proposal can generate knowledge to improve the making-decisions into the medical processes to achieve the Patient Safety Policy. In addition, Risk Management is linked with the Patient Safety Policy, laws and normative in health sector, but in the literature review realized in Scopus, Science Direct and ISI Web of Knowledge databases risks and sterilization are not linked with Quality Management System and Knowledge Management in research publications. Furthermore, several research and review articles have a lot of information about technical information while the need on holistic approach is not appear in these databases. The methodological design was structured in accordance to the ISO 31000 guidelines and legal normative in a Colombian sterilization unit that realize sterilization by autoclave, hydrogen peroxide and ethylene oxide and it is processing 200 packages daily approximately. On the one hand, the risk management framework has seven foundations and five risk criteria to identify and evaluate them. On the other hand, the risk management framework had applied into sterilization processes and we identified and evaluated 15 risks on 14 sub-processes. Risk management began in washing and disinfection process and finalize in storage packets. In addition, sterilization risks have several impacts on organizational objectives and key indicators. Risks analysis tools must be included to generate scenarios and reports to take decisions. People who works in sterilization unit must use lessons learned to incorporate it in the risk management framework. Quality Management System for Medical Devices is an opportunity to improve the performance on the sterilization processes.

Keywords: Process · Risk management · Sterilization · Technovigilance

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1 Introduction

Risk management has been reviewed by international organizations of standardization for many years and it has applied in different kind of sectors to generate strategies according to the opportunities, weaknesses, strengths and threats. Thus, many companies should periodically approach internal projects, as mean for changing and adapting to the market requirements [1].

Some authors explain empirical and validated methods and frameworks to implement knowledge management systems with risk management in healthcare processes [2–6]. However, there are many definitions of risk and risk management, but the definition set out in the ISO Guide 73 is the most accepted in the world. The ISO Guide 73 states risk is an effect may be positive, negative or a deviation from the expected, and that risk is often described by an event, a change in circumstances or a consequence [7]. In contrast, Vant [8] explains risk management is not an exact science and the emphasis is on risk estimation and not risk calculation. Furthermore, literature and ISO Guidelines establish risk management requires critical thinking and intuition to detect and evaluate the risks.

ISO 31000 suggests ways to set out the risk management framework linked with external and internal context of the organization. In addition, risk management is an integral part of new standards of certification and it is necessary to take over awareness and go about on daily actions by the employees on the processes to mitigate the risks and its impacts. For health institutions is relevant count on a risk management policy that must be articulated to its value chain, strategic and support processes to manage the knowledge about the risks identified in all organizational levels. Furthermore, knowledge management and risk management are coherent from the strategic, tactic and operational levels where employees implement actions, develop strategies to address issues and bring about the organizational competitive advantages.

Sterilization facilities that uses disinfection or sterilization for medical devices are constantly undergoing evolution and development. In addition, Tabibzadeh [9] explain the importance of patient safety as a main aspect of quality of care in the healthcare industry.

Medical processes require sterilization methods to assess the quality products in invasive and no invasive medical procedures. In this way, Rutala [10] mentions all invasive procedures involve contact by a medical device or surgical instrument. Furthermore, the level of disinfection or sterilization is dependent on the intended use of the object (Table 1):

Medical processes and sterile instruments that involves sterilization processes and risk management are critical to achieve Safety Patient Policy in hospital and clinics. To explain it, Casey [11] presents data to describe effectiveness, complications and evaluation about Hysteroscopic sterilization. Zhao, Sezdi and Dağsuyu [12–14] demonstrate tools to identify and evaluate risks applied in sterilization processes. Basu [15] relates how wet packets can be dangerous for patient safety and its causes, increasing costs, infections, work load and cancellation of procedures. All of them have included risk management and generate knowledge management, indirectly. Nowadays, risk management and knowledge management have been implemented

Table 1. Level disinfection, description and process disinfection or sterilization

Contamination level	Description	Process
Critical	Items that contact sterile tissue such as surgical instruments	Sterilization
Semicritical	Items that contact mucous membrane such as endoscope	High-level disinfection
Non-critical	Devices that contact only intact skin such as stethoscopes	Low-level disinfection

Source: [10]

simultaneously using the "Total Safety Management" concept, whereby quality management systems (QMS) provide strategic guidance in the process standardization [16].

On the one hand, QMS have been implemented to improve process performance, customer satisfaction and standardization. In addition, health organizations and state government agencies demand risk management to identify hazards and mitigate risks. Patel and Ayuso-Murillo [17, 18] suggests organizations must have a Quality Manual, Standard Operating Procedures, work-instructions and identification and monitoring indicators (in a framework ISO, EFQM) to enable preventable adverse effects to promote patient safety in healthcare organizations. On the other hand, Kontogiannis et al. [19] stated risk management is not already oriented to decrease the risk level, medical issues or products/services safety, on the contrary, Total Safety Management try hard to engage into business development. At the same time, authors claim risk management could hold up and increase the efficiency in tasks and its hazards, improve the knowledge transfer, rationalization of risk matrix and decrease the quantity of safety control strategies.

Technovigilance is a special concept in sterilization processes. It must identify, advert and avoid incidents or adverse outcomes related to Medical Devices supported in the cause analysis and risk management to decrease morbi-mortality indicator. At the same time, Technovigilance must identify risk factors to notify, record and evaluate systematically the frequency, impact and incidence to avoid them [20].

World Health Organization [21] describes life-cycle medical devices: Research and development, normativity, effectiveness evaluation, efficacy evaluation and management. Thus, if the organization establishes a risk management framework would reduce the probability and consequences of other risks such as environmental, occupational health and safety and quality requirements. According to the literature review and legal normativity, it is necessary to establish an optimal risk management to achieve organizational goals and technovigilance requirements [22, 23].

Cleusa [24] mentions risk management in hospitals is a new proposal to enabling avoid the risks that affects patients which may be associated with human errors or process failures.

Specifically, the case study is a sterilization unit that uses three types of process: autoclave, hydrogen peroxide and ethylene oxide. It production capability is 500 packets per day and it have 30 employees (students in practice are included).

Furthermore, it applies biological and physical control to assurance quality process and final product [25].

In the literature review, has not found information about a risk management framework in sterilization units. Finally, to improve prevent conditions in the sterilization unit is mandatory design alarms to alert employees about risks and other control parameters included in the risk management framework [26].

In the specific case of the San Jose Hospital, the risks have not been evaluated using a structured methodology and it has not provided information to take decisions effectively. Hence, it is necessary to build a framework adjusted to the organizational needs and requirements. The article seeks provide a framework to the risk management (including the identification of actions that avoid or decrease the risk impact). Finally, we stated a treatment plan based on the risk assessment process defined to the case study.

2 Methodology

The methodology is based on risk assessment framework stated in the ISO 31000 guidelines, conceptual and legal criteria. This standard was selected because is the most well-known and well-accepted body of knowledge about risk management by the several benefits using ISO 31000 guidelines to enhance the knowledge management capability [4]. This is a qualitative, exploratory and longitudinal study, notwithstanding, it that uses quantitative data to risk measurement [27] to prioritize treatment on risks in the Sterilization Unit. Lathrop [28] address a system approach to risk analysis validation for risk management using data to validate its risks while other authors emphasize in a multicriteria selection decision [29]. The risk management framework in sterilization unit had designed in seven steps such as describes the ISO 31000 (Fig. 1).

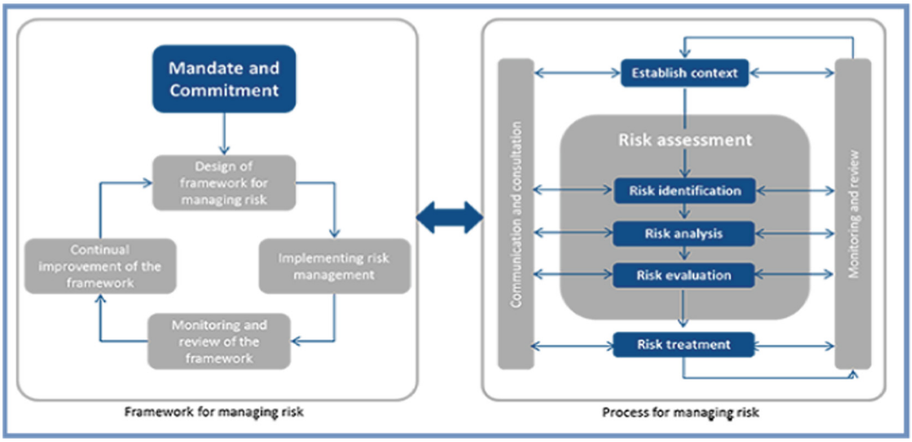

Fig. 1. ISO 31000 Risk framework and principles. Source: [31]

By the time authors has developed risk management frameworks that contains a plan of implementation according to the ISO 31000 guidelines [30]. As is shown in [31] and represented in Fig. 1, risk management is a systematic process that reduce the risks, but it can create action plans to improve situations and generate knowledge using learned-lessons [2–4].

In agreement with Hansson and Aven [32–34] the connection between facts and values in risk decision-making are provided by evidence and knowledge base (Fig. 2).

Fig. 2. A model for linking the various stages in the risk informed decision-making. Source. [Based on 32, cited by 33]

The unit of study is a Colombian hospital located in Bogota which provides the highest-level healthcare services based on complexity level described by the Health Ministry of Colombia. Nevertheless, the hospital has two branches divided on adult and pediatric assistance. The sterilization unit selected is located in the branch for adult assistance.

3 Results

A. Communication and Consultation

It is essential for Risk Management to become part of the organization's culture know the stakeholders' requirements. Furthermore, permanent communication and consultation is a progressive action to involve organizational development and quality assessment. ISO 31000 guidelines suggests the follow stakeholders, (Fig. 3).

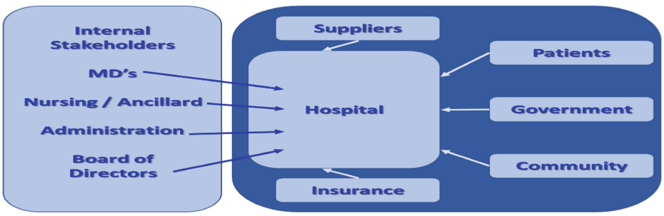

Fig. 3. Stakeholders in a hospital. Source: [34]

Nonetheless, patient or parental expectations has been established reasonable expectations of all parties, which naturally include the specialist [34], both are linked.

The aspects to consult are presented as sterilization requirements as national laws, safety patient policy and patient needs. As a result, sterilization team identify the followings aspects:

- To accomplish the Patient Safety Policy and laws.
- To ensure workers health conditions.
- To decrease risks which can affect people, patient or environment.
- To identify action plans and residual risk treatment.

B. Establishing the Context

To define the context, it is necessary identify external and internal risks that result from environmental, market, processes and regulatory conditions. On the one hand, sterilization unit had defined general context and it deploy into sterilization processes.

Thus, Phillips [35], describe errors or malfunction of technology and medical equipment devices can introduce new risks and it is important to report and then health professionals can learn, improve and understand accident in relation to how they occurred. On the other hand, organizational objectives were defined in four aspects to focused efforts as is shown in the Fig. 4.

Fig. 4. Aspects to apply organizational strategies in the sterilization unit. Source: Authors.

Vant [8] supports the figure mentioning risk management plays an integral role in a medical device quality system and business strategy.

C. Risk Identification

Risk identification is the previous step to provide qualitative information about types and categories of risks. Also, this allow recording and monitoring activities to assimilate as lessons learned. The objective of risk identification is the early and continuous identification of events that, if they occur, will have negative impacts on the project's ability to achieve performance or capability outcome goals [36].

In the sterilization unit, risks were identified using an event list to determinate possible causes and consequences in the processes defined on organizational process map. At the same time, it was mandatory identify activities of the processes to be clear on risk identification. Then, the Risk Committee proposed four risk categories and their description as follow.

- **Operational:** Type of risk that can affect external or internal stakeholder.
- **Strategic:** Type of risk that affects organizational planning or business unit.

- **Finance:** Type of risk that involves resource shortage to process management or profits.
- **Reputational:** It affects organizational brand by an inadequate public opinion to service delivery.

To provide information and understand risks on processes, employees participated in a workshop to identify qualitative information and the main output is contained in the Tables 2 and 3.

Table 2. Information contained on the project risk management plan

Establishing the context	Organization objectives
	Stakeholders identification
Process	Sterilization
Sub-processes procedures	- Material requirement planning - Autoclave sterilization - High level disinfection - Instrumental storage - Ethylene oxide sterilization - Hydrogen peroxide sterilization - Instrumental picking and packing - Instrumental receipt - Instrumental classification according to the type of picking and sterilization method - Commercial sealers tracking - Satellite storage auditing - Biological control recording - Instrumental disinfection and washing - Instrumental delivery
Responsibilities and functions	Risk owners
Risk management documents	Risk breakdown structure
	Risk register
	Templates

Source: Authors, 2017

Table 3. Inputs, tools and techniques, and outputs defined to use on identifying risks

Input	Tools and techniques	Output
Reviewing all documents of processes, meeting's records, etc.	Brainstorming meetings Audio or audiovisual recording of meetings Documental revision	Risk register Risk breakdown structure

Source: Authors, 2017

D. Risk Analysis

Risk analysis is a process that helps to estimate risk value. It can be complex, but is useful to preview the current situation. Authors has been validated risk scales or matrixes to take out special issues to academic community demonstrated by theoretical, methodological and empirical contributions [37]. In addition, risk analysis is a structured, multidisciplinary and iterative process to assist the assessment and mitigation risk [38].

Risk analysis has estimated using probability (P), Impact (I) and Risk Value (R) as shown in the Table 4.

Table 4. Scales to evaluate risk, probability and impact

Probability	Value	Description
Almost certain	5	It has a probability between 90% to 100%
Probable	4	It can occur sometimes. It has a probability between 65% to 90%
Moderate	3	It has a probability between 30% to 65%
Improbable	2	It has a probability between 10% to 30%
Unusual	1	It has a probability between 0% to 10%
Impact	Value	Description
Catastrophic	5	It has a probability between 90% to 100%
Greater	4	It can occur sometimes. It has a probability between 65% to 90%
Moderate	3	It has a probability between 30% to 65%
Lower	2	It has a probability between 10% to 30%
Insignificant	1	It has a probability between 0% to 10%

Source: Authors, 2017

To facilitate risk evaluation, we designed a risk map (or heat map) that allow a quantitative analysis. Quantitative analysis is suggested to measure qualitative analysis in parallel with the identification risk. Freund [39] explain how it is a decision tool to capture outcomes in the categories defined in the case study: operational, strategic, finance and reputational. Furthermore, the matrix was used to measure what are the risk rating on the processes and goals as is present in the Fig. 5.

Consequence						
	5	High	High	**Extreme**	**Extreme**	**Extreme**
	4	Medium	High	High	**Extreme**	**Extreme**
	3	Low	Medium	High	**Extreme**	**Extreme**
	2	Low	Low	Medium	High	**Extreme**
	1	Low	Low	Medium	High	High
		1	**2**	**3**	**4**	**5**
		Probability				

Fig. 5. Probability Impact Matrix. Source: Authors, 2017 (Color figure online)

Probability and Impact combination (Table 5) defines inherent risk on processes and activities, and the risk severity conforming to the color where risk is located.

Table 5. Risk scale.

Low	Medium	High	Extreme
1	2	3	4

Source: Authors, 2017

E. Risk Evaluation
This stage content the special activities that contains risk management because the planning about emergent risks must estimate to decision-making [40]. In the case study, risk evaluation was embedded into the organization deciding which action take it. Each individual risk should be attached, having one record per risk:

- Risk ID and description.
- Assumptions that involve the risk, such as the risk causes.
- Possible risk results on organizational objectives.
- Risk responsibility: identify the risk owner and entities involved on the risk occurrence and response.
- Intervention action: all the actions to be taken to risk response are described; the resources needed are estimated, as well as the costs and the delays of every response.
- Communication: the communication moments along the risk responses are defined.
- Risk and responses interaction: identification of the secondary risks that may arise as response to the primary risk.

F. Risk Treatment
Risks localization in the Probability Impact Matrix allows to establish type of responses that must be considered to take an action responses (Table 6).

Table 6. Relation between the risk impact and risk response.

	Organizational impact	Monitoring	Response
	Extreme	Urgent attention. Mandatory control and treatment.	Preventive: Avoid
	High		
	Moderate	Periodic revision.	Contingency: reduce / mitigate
	Low	Control	Corrective: Mitigate / Accept

Source: Authors, 2017

Control Identification

According to the risk and its causes we identified controls as follow types:

- **Current controls:** This kind of control are implemented currently to mitigate or avoid the risk.

- **Proposed controls:** This type of control is proposed after risk evaluation.

At the same time, this classification contains preventive and corrective controls. Firstly, preventive controls act to eliminate risk causes and avoid its probability. Secondly, corrective controls admit activity reestablish after event detected or allow action modification to eliminate probability.

Thus, Corporate Government has defined risk appetite in four categories:

- **Avoid the risk:** It is the most applicably of these treatment actions using an improve, redesign and eliminate tool.
- **Reduce the risk:** If the level risk cannot be decrease, it is necessary to reduce at the minimum level. The organization can apply improve processes or control implementation.
- **Transfer the risk:** The organization have to find a partner to share the responsibility on risk management. For example: take an insurance contract.
- **Assume the risk:** Before the risk has been reduced or transferred can appear residual risk. In this case, owner process accepts residual risk loss allowing action plans design.

G. Monitoring and Review

Annually, process leaders have to reevaluate the risks in keeping with the reports to determinate:

- Adjust risk prioritization.
- Re-evaluation risk management in progress.
- New risks can be included in consonance with the needs.
- If some risks have to excluded, actions must have disappeared.

Action plans must have recommendations by Quality Department and Medic Auditory, legal requirements, adverse outcomes, patient satisfaction survey results or any similar record, committee and improvement team's tasks.

H. Control Evaluation

Control evaluation includes scope, frequency and control's documentation to increase the effectivity of the risk management framework (Table 7).

Table 7. Qualitative risk control evaluation.

Scope	Anyone
	Partial
	Total
Frequency	Sporadic
	Periodic
	Continuous
Control's Documentation	No documented
	Documented partially (draft or other)
	Documented (documented, divulgated, implemented)

Source: Authors, 2017

Moreover, evaluation control has a category to decrease the impact on processes as shown in Table 8.

Table 8. Quantitative risk control evaluation

Name	Minimum	Maximum	Quadrants to decrease	Color
Low	1	2	0	
Medium	2.01	3.54	0	
High	3.55	5	-1	

Source: Authors, 2017

I. Risk Management Framework

In agreement with [41] Tabibzadeh proposal, patient safety is a main aspect of quality of care. There is little doubt that process safety regulations can establish minimum standards that all covered facilities are expected to meet, and therefore should reduce the likelihood of catastrophic releases of highly hazardous chemicals across the regulated communities [42].

On the one hand, Ho [43] suggest a new perspective about the leadership in healthcare system to deliver a better service. On the other hand, Rivera [44] mentions human factors and system engineering methods as an improve gap in the patient safety.

The risk management framework was structured using the previous steps and it is presented in the Fig. 6.

Fig. 6. Risk management framework in the Sterilization Unit of the San Jose Hospital. Source: Authors, 2017

Finally, were identified 15 risks in the follow categories: operational, patient safety, occupational and health safety (Fig. 7).

Consequence	1	2	3	4	5
5		EST011	**EST12**		**EST01** **EST02**
4	EST10				
3	EST04	EST14			**EST09**
2		EST03 EST08	EST15		
1	EST05 EST06	EST07		EST13	
	Probability				

Fig. 7. Consequence and probability matrix. Source: Authors, 2017 (Color figure online)

4 Discussion

The Risk Management Framework of the San Jose Hospital was included in the Quality Management System. Therefore, the major risks are related to the patient safety policy, but other risks must be mitigated by the economic costs such as: safety and security, administrative, legal, infrastructure, knowledge and management. A holistic risk approach can to balance the equation of estimation on organizational goals and stakeholders' expectations. Furthermore, the risk framework provides information to manage the processes with a knowledge management approach.

To enhance the efficacy of the Quality Management System, the Hospital must implement tools that allow identify risk faster: Failure Mode and Effect Analysis (FMEA), Fault Tree Analysis, and Hazard Analysis and Critical Control Points (HACCP). Risk review should be performed on periodic basis as part of the quality management process, and the sterilization unit have to validation and rigorous acceptance criteria on sterile instruments. Additionally, statistics analysis on critical variables could support the quality control in the sterilization processes.

A key driver to empowering people is lessons learned as improve tool. These activities can be included to evaluate and measure behind impact in the sterilization processes. In the experimental stage, we changed activities and processes to achieve the assessment in concordance to laws and normative.

In summary, risk management and knowledge management could be a useful tool that provides real-time information and it shall to implement using a vertical strategy to impact the missional processes.

5 Conclusions

This paper presents the risk management framework defined for a sterilization unit. Undoubtedly, some methodological and processes changes can be appearing to prove efficiency. This framework was tested, implemented and documented in the San Jose Hospital Quality Management System.

During the methodology application and risk management we had changed sterilization processes and work-methods to be more effective and assess the parameters.

Our research suggests risks in sterilization units have an important impact on organizational objectives. There are probably several factors can be modified conditions, but a correct identification and evaluation risks may adjust future scenarios to avoid undesirable situations.

A special item that helps to assess methodology results was employees' participation because practice and knowledge were needed to understand and interpret risks outcomes and actions. These actions are mandatory to create a consistent system to feed the risk knowledge management and advice to the people.

A key challenge is related on the results and risk evaluation, having a focus on risk estimations and predictions with large uncertainties. In addition, it is linked with time and process dynamics can be simulated using a probabilistic approach [33]. For further projects on sterilization about risk management, it is an opportunity to address an issue that concern ISO 13485:2016 requirements to process certification [45].

Finally, outcomes are going to include in the next stage of the Knowledge Management System to process management of the Sterilization unit at San Jose Hospital.

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The Strategies to Build Quality Culture Based on Knowledge Management in Higher Education

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Abstract. The development of higher education quality assurance system has not reached the quality culture level, but still at the standard development and quality assurance standard. In addition, the requirement implementation of higher education quality assurance system should have developed the quality culture. The research is considered as a case study with a qualitative approach. The results conclude that STKIP Singkawang has implemented 30 National Standards of Higher Education, owned 24 national standards and set up the internal standards covering the domestic and foreign cooperation, Academic Atmosphere, Student, Student Affair, graduate, Administrative Management and Leadership, Hygiene and Safety, as well as Promotion and Publication standards. The development of the higher education quality culture may not be separated from the cultures of the surrounding communities. Thus, the development of quality culture should be based on the needs of higher education, including its rectors, lecturers, students and educational personnel integrated in the cultures developing in their environment. Not only does the higher education quality culture become a part of the surrounding environmental cultures, higher education should be able to function as the environmental culture development agency. Higher education with its functions as an agent of cultural changes need to formulate the cultural development strategies, quality standards, implementation of quality culture development strategies as well as monitoring and evaluation.

Keywords: Higher education quality culture
Implementation of higher education quality culture development
Quality culture development strategies based on knowledge management

1 Introduction

There are five parts of quality assurance institution consisting of quality assurance system, higher education standard, accreditation, higher education data improvement and service institution. Each university in Indonesia refers to the minimum standards. The National Standards of Higher Education refer to the National Education standard units. The previous researches and studies conducted by Retnoningsih [1] show that the Research and Community Service Institution (known as *LPPM/Lembaga Penelitian*

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dan Pengabdian Masyarakat/) is a part of higher education which is always required to make various innovations to create knowledge through researches conducted by the researchers and lecturers. Due to its management, knowledge sharing is highly required and considered as a problem in knowledge management that requires long and time consuming processes, including behavioral changes of all *LPPM* members and knowledge management conducted using discussion and work flow.

The previous research conducted by Mursidi [2] stating that higher education is one non-profit institution which is recently facing various challenges. Higher education management is required to have sophisticated knowledge and management skills. Higher Education quality management may be realized through internal quality assurance system. The research results [3] conducted by the Scientific Information Documentation Center (known as *PDII/Pusat Dokumentasi Informasi Ilmiah*) of Indonesian Science Institution (known as *LIPI/Lembaga Ilmu Pengetahuan Indonesia*) concludes that the organizational knowledge creation ability depends on the ability of individuals in one organization to access ideas, information, and experiences of other employees even through intranet or other off organization parties. The access is then improved by giving the alternative advices, such as the utilization of DSS (decisions support systems). Knowledge sharing is periodically, systematically and continuously facilitated through the training center in meeting the latest developments. Knowledge sharing and combination is priceless. The previous research results on the strategic formulation in managing STKIP Singkawang include: (1) a full commitment of the head of STKIP Singkawang and Foundation in managing the Higher Education, (2) having a strategic plan as a guidance in managing the Higher Education, (3) having a strong base in creating the higher education's vision and missions, (4) conducting analysis on STKIP Singkawang environment on both internal and external aspects, (5) formulate the higher education's objectives in meeting the higher education's vision and missions, and (6) establishing comprehensive operational strategies and objectives [4]. Higher education as a human resource development agent plays an important role in the development, especially human resources. The economic and political orders rapidly and sustainably change the international association, placing the position of higher education on a strategic role in producing highly competitive graduates. The knowledge-based community development strategies of the nation require rapid, precise and strategic responses [5].

Quality is described as the service characteristic totality on its ability to satisfy needs. Quality assurance is closely related to satisfaction or service quality. The simplest way to understand quality assurance is by knowing the students' satisfaction to their higher education service quality [6]. This development shows the changing improvement rate in the entire life aspects since the impacts of globalization and development of information technology is extremely fast. This condition encourages higher education to find new ways in responding to the development. Higher education should improve the quality of its human resources as one response to the rapid changes due to the science superior role as only with the knowledge, all changes may be well overcome. It means that education plays a greatly important role in preparing the qualified and competitive human resources. Due to the implementation of knowledge management in the company, intense global competition, especially in the economic field has encouraged business organizations to deeply think their business management strategies and qualified human resources dealing with the knowledge acquisition. Knowledge management is a set of activities used by an organization to identify, create, explain, and distribute knowledge to reuse, acknowledge and learn within organization. Knowledge is information combined with experience, context, interpretation, and reflection [7].

Knowledge Management is implicit and mostly based on apprentice-journeyman-master model. Schools and universities mostly have the missions to provide education. The development of higher education quality assurance system in Indonesia has not been at the level of quality culture, but still at the standard development and quality assurance system. One implementation of the quality assurance system (known as *SPM/Sistem Penjaminan Mutu*) requirements the higher education should have developed is the quality culture. This research aims at investigating how to build the quality culture of higher education based on knowledge management.

Research Problems

1. How is the development of quality culture of higher education in Indonesia?
2. What strategies can be implemented to build the quality culture of higher education based on knowledge management?

2 Literature Review

2.1 Definition of Knowledge Management

Knowledge management refers to the organizational discipline processes and information technology utilized to acquire, create, disclose, and provide knowledge in enabling the company to achieve its mission (achieving the strategic or business goals). The knowledge management components consist of human resources, practices and processes, as well as information technology (IT) which move and change the ways of data, information, and knowledge. These three components may form an entity called company [8].

The knowledge management concept includes human resource (HR) and information technology (IT) management aiming at encouraging the corporate organization to have more capabilities in winning the business competitions. The development of information technology plays an important role regarding to the knowledge management concept. Almost all activities of human life are equipped with the mastery of information technology that when it comes to knowledge management, it may not be separated from management. Waltz [8] states that Knowledge Management refers to the organizational disciplines, processes, and information technology utilized to acquire, create, disclose, and provide knowledge that enables a company to achieve its mission (Achieving the strategic or business goals). The knowledge management components consist of human resources, practices and processes, and information technology (IT) which move and change. With the implementation of knowledge management, it means that the organization has implemented knowledge management which should be able to transfer knowledge, vision and missions of the company regarding to its human resources, the utilization of information technology.

Furthermore, Walts [8] mentions that there are three components which become one entity in the implementation of knowledge management, including (1) that the existing human resources should be in accordance with the quality culture developed within organization which is collaboratively built with good decision making and problem solving; (2) the knowledge management processes should provide a supporting work environment for changes, discoveries, and knowledge utilization, and (3) IT technology which may access human resources in developing the knowledge.

There are 2 types of knowledge management covering tacit and explicit [9]. Tacit knowledge is based on common sense, while explicit knowledge is based on academic achievement in which both are underutilized [10]. Within organization, explicit knowledge is not a problem as it is easily documented, archived, and coded. On the other hand, tacit knowledge is a challenge because knowledge is often considered very valuable to share and use in the right way. Understanding the differences of both knowledge types is greatly important, and it should also be noted that the implementation to transfer both knowledge types has different ways.

Explicit knowledge usually refers to the knowledge expressed in words and figures. Such knowledge may be formally and systematically shared in the form of data, specifications, manuals, images, audios and videos, computer programs, patents, and so forth. Conversely, tacit knowledge includes insight, foresight and intuition. It is difficult to express and formulate that it is also difficult to share. Tacit knowledge is more likely to become personal and based on individual experiences and activities. The research results show that the analysis [11] on knowledge management (KM) strategies based on knowledge management sources indicates that companies may obtain benefits from knowledge management by implementing the external or internal strategies. The combination of tacit-internal and external-oriented knowledge management strategies has a complementary relationship. It means that knowledge management strategies and synergies may influence performance. The factors related to both knowledge seekers and holders as well as the cultural distance between them have a significant impact on the foreign partners' marketing knowledge acquisition [12]. Two basic approaches to knowledge management. The tacit knowledge approach emphasizes on understanding the types of knowledge that individuals within an organization have moving human resources to transfer knowledge within an organization and managing key individuals as knowledge creators and operators. Conversely, the explicit knowledge approach emphasizes on processes to articulate the individual knowledge, organizational approach design to create new knowledge, and develop systems (including information systems) to disseminate the articulated knowledge within an organization.

Figure 1 shows the implementation of knowledge management has a narrow perspective with its needs and environments. Due to the number, some focus on sharing knowledge among individuals or ability to disseminate knowledge. Meanwhile, some also emphasize on the use of technology to capture, manipulate, and discover knowledge, focusing more on information management related to knowledge rather than on knowledge management. Knowledge management also focuses on the utilization of knowledge to improve the operational effectiveness and overall company. Meanwhile, others are pursuing to build and utilize Individual competence (IC) to improve the company's economic values [13].

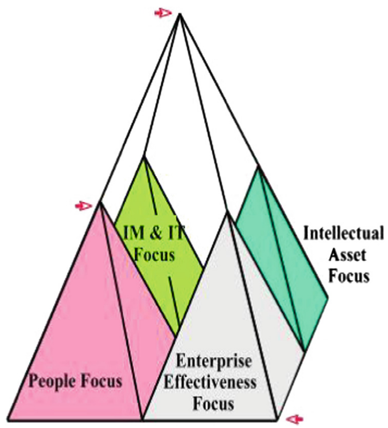

Fig. 1. Comprehensive knowledge management strategy focus area [13].

The research on Strategies in building the Quality Culture Based on Knowledge Management are mostly adopted from applied theories of company knowledge management to be implemented in non-profit institutions, in this case, higher education. This research takes one of higher education institutions in Indonesia which conducts the academic and/or vocational education within the disciplines of science, technology, and/or arts, as well as professional education (if possible). The university used in this study is a higher education and research institution which provides academic degrees in various fields.

2.2 Organization Culture Theory

Dalkir [14] states that "organization culture may also be defined in both cause and effect points of view. Based on the outcome perspective, culture is factual and consistent behavior patterns when observed from all individual groups, or "the ways we do things around here." Tus culture is defined as a consistent way for people to perform their tasks, solve various problems, resolve the conflicts, as well as to treat the customers and employees, etc. Based on the process perspective, culture may also be defined as a set of mechanisms, such as informal norms and beliefs which control how individuals and groups within an organization make interactions each other and with the outsiders. "The development of quality culture within an organization is intended to facilitate employees and staffs to complete their tasks, solve the problems, resolve conflicts, and so forth. In higher education quality culture, it is required to perform the vision and missions.

Morgan [15] finds some key elements of organization culture, such as: the stated and unwritten values, explicit and implicit expectations for the members' behaviors, customs and rituals, group historical stories and myths, typical spoken language used in and around the group, the arising climates created by the members in making interactions with others, outsiders, and their environments, including occupying physical spaces, metaphors and symbols unconsciously embodied in the other cultural elements.

The development of quality culture within organization includes the common and uncommon values in organizations, actions, and expectations for staffs, staff habits, organization history, linguistic patterns, and interaction patterns among employees.

Organization culture theory also means how employees and staffs within an organization share their habits, including values, attitudes, and paradigms. Culture is also one of human interaction patterns, including how humans think, speak, and act, as well as how humans are ability to learn and deliver the knowledge. The quality culture within an organization may be taught to the staffs within organization to receive and appreciate the higher education system.

Some organizations believe that by exclusively focusing on human resources, technology, and engineering, they may manage the knowledge well. Without exclusively focusing on human resources, technology, and engineering, a company may not well maintain its competitive advantage [15]. This research is based on the understanding of quality culture defined by the EUA's Quality Culture Project (2006), viewing it as one reference to the organization culture characterized by the culture psychological elements on one hand, and managerial/structural elements on the other hand. Due to the authors' opinions, it is important to distinguish the quality culture from the quality assurance process, which is a part of the structural elements [16].

Adhocrazy is a type of culture characterized by the flexibility and orientation to the external environment. There is no clear hierarchy and cut crossing the borders of a typical normal bureaucracy that enables the company with culture to make rapid changes in their operational ways [17].

2.3 Higher Education Policy on Internal Quality Assurance System

The underlying Law on Quality Assurance in Indonesia is Law no. 12 of 2012 [18] on Higher Education (Higher Education Law) in which one of the quality assurance system objectives of the Directorate General of Higher Education is to systemically and sustainably ensure the fulfillment of Higher Education Standards in order to grow and develop the quality culture. The intended quality culture is mindset, attitude, and behavioral patterns. The function of higher education quality assurance system is to control Higher Education institutions in realizing the higher education quality. The Higher Education Quality Assurance System is a systemic activity to improve the planned and sustainable higher education quality. The implementation of Quality Assurance System in Law no. 12 of 2012 [18] Article 51, Paragraph (1) mentioning that Higher Education Quality is Higher Education which produces graduates who are able to actively develop their potentials and produce Sciences and/or Technology which provide various benefits to the society, nation, and country. Article 51, Paragraph (2) explains that the government establishes the Higher Education Quality Assurance System (SPM-DIKTI) surely to obtain the Qualified Education.

2.4 Quality Standard Determination

The quality standard is determined to use as a reference to determine the higher education institution quality. The quality standard is a technical specification determined based on the provisions of all related parties by considering the health requirements, development of science and technology as well as experience. Quality standard and its role greatly influence the achievement success of the expected quality.

Standard is required by the higher education as the basic reference in realizing its vision and implementing its missions. The basic reference includes criteria in various aspects related to what the higher education organizes. The quality standard is intended to encourage higher education to improve its performance in providing quality services and as an instrument to encourage the realization of transparency and public accountability in the implementation of its main duties. Quality standard is also a minimum required competence/quality to the related higher education/its graduates measured and described as parameters and indicators. The sustainable quality standard improvement cycle is evaluated, revised, and improved through the sustainable benchmarking.

Higher Education chooses and sets its own high quality education standards for each activity and those within higher education system. The standard selection and establishment are obtained from several aspects called the quality items. Some scopes of standards may be referred by the higher education include National Education Standard (known as *SNP*), Higher Education Quality Assurance System (known as *SPM-PT*), National Accreditation Board (known as *BAN*) and ASEAN University Network Quality Assurance (known as *AUN-QA*). In general, the scopes above standards are not much different since still covering the aspects of higher education activities. When a quality standard is utilized as a reference in the implementation processes of higher education duties, then the development of quality standard is not a once directly conducted activity, but needs to be repeatedly reviewed before becoming a quality standard to use as a reference for each higher education process [19].

3 Method

This research is considered a case study with a qualitative method which describes the development of quality culture in Higher Education and the strategies used in developing the quality culture at STKIP Singkawang based on Knowledge Management. The data are collected through in-depth interviews and observations. The participants interviewed are theoretically chosen (called *theoretical sampling*) to help the researcher best form [20] (Fig. 2).

The process of data analysis was performed with the following steps:

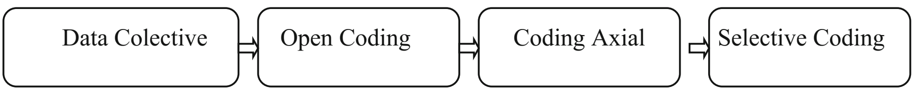

Fig. 2. The process of data analysis

The researcher begins with *open coding*, coding the data for its major categories of information. From this coding, axial coding emerges in which the researcher identifies one open coding category to focus on (called the "core" phenomenon), and then goes back to the data and create categories aroun this core phenomenon. The final step, then, is *selective coding*, in which the researcher takes the model and develops *propositions* (or hypotheses) that interrelate the categories in the model or assembles a story that describes the interrelationship of categories in the model. The theory emerges with help from the process of *memoing*, a process in which the researcher writes down ideas about the evolving theory throughout the process of open, axial, and selective coding.

In-depth interviews are conducted to the Head of STKIP Singkawang who is also a Higher Education consultant as well as to the deputy head of STKIP Singkawang, Head of Research and Community Service, Head of Quality Assurance Institution, Head of Administrative affairs, and Head of Information affairs. The questions addressed are related to the strategies in developing the higher education quality culture based on Knowledge Management. The question indicators cover how the environment is analyzed in building the higher education quality culture, how the internal environmental supports develop the higher education quality culture, how the external environmental supports develop the higher education quality culture, and how the development of higher education quality culture strategies have recently been implemented at STKIP Singkawang.

The analysis conducted by making a detailed description on how the development of quality culture strategies has been implemented at STKIP Singkawang based on knowledge management with the analysis of various answers from the in-depth interviews. The observations are conducted at the STKIP Singkawang environments.

4 Result and Discussion (A Case Study at STKIP Singkawang)

4.1 The Development of Higher Education Quality Culture

One implemented at STKIP Singkawang is a good strategy in delivering the organization quality culture with an effective communication between Higher Education leaders and lecturers, staffs as well as employees. The Higher Education Vision of STKIP Singkawang is to realize a superior teacher training institution in forming educational graduates who are smart, competitive, possessing good ethics, and entrepreneurship social spirit in 2020. The missions of STKIP Singkawang: (1) Producing educational graduates with high commitment to their educational professions, (2) implementing qualified education and learning in order to be able to compete in the National and Regional levels, (3) Conducting Research and Community Service activities in the form of cooperation with schools in improving the school learning quality, (4) Developing educational infrastructure and facilities to support the educational and teaching as well as research, and community service activities, and also develop the information technology and multimedia devices to support the academic activities.

STKIP Singkawang has implemented 30 Higher Education National Standards, including (1) Graduate Competence Quality Standards, (2) Learning Content Quality Standards, (3) Learning Process Quality Standards, (4) Learning Assessment Quality Standards, (5) Lecturer and Educational Staff Quality Standards, (6) Learning Facility and Infrastructure Quality Standards, (7) Management and Learning Quality Standards, and (8) Learning Financing Quality Standards. The research standards are formulated as follows: (9) Research Result Quality Standards, (10) Research Content Quality standards, (11) Research Assessment Quality Standards, (12) Researcher Quality Standards, (13) Researcher Quality Standards, (14) Research Facility and Infrastructure Quality standards, (15) Research Management Quality Standards, as well as (16) Research Funding and Financing Quality Standards. Community Service Standards cover Learning Financing Quality Standards. The research standards are formulated as follows: (17) Community Service Quality Standards, (18) Community Service Content Quality Standards, (19) Community Service Process Quality Standards, (20) Community Service Assessment Quality Standards, (21) Community Service Implementer Quality Standards, (22) Public Service Facility and Infrastructure Quality standards of, (23) Community Service Management Quality Standards and (24) Community Service Funding and Financing Quality Standards. In addition to those 24 nationally implemented standards, STKIP Singkawang has also developed internal standards, covering (25) Domestic and International Cooperation Standards, (26) Academic Atmosphere Standards, (27) Student, Student affairs and Graduate Standards, (28) Administrative and Leadership Standards, (29) Hygiene and Safety Standards, and (30) Promotion and Publication Standards.

4.2 Strategic Models in Building the Higher Education Quality Culture

The development of higher education quality culture may not be separated from the culture of surrounding communities. Thus, the development of quality culture should be based on the higher education's needs in which there are heads of higher education, lecturers, students and educational staffs integrated in the developing environmental culture. In addition, the higher education quality culture is a part of surrounding environmental culture that higher education should be able to function as an environmental culture development agency. Andi Mursidi is a lecturer of STKIP

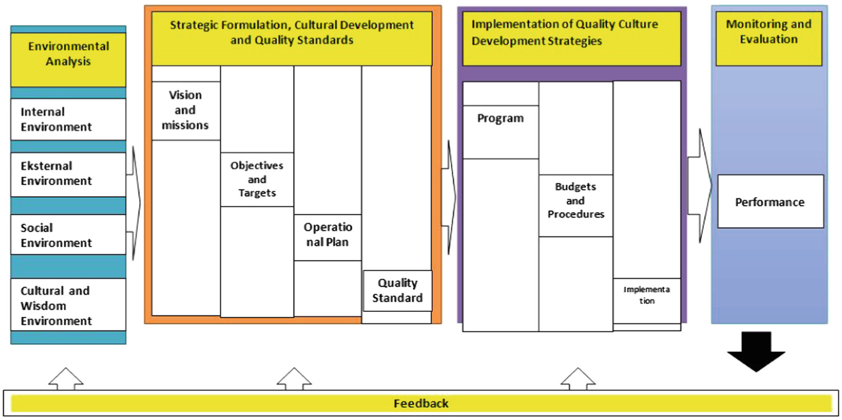

Fig. 3. Strategies in building higher education quality culture model/design: Andi Mursidi

Singkawang highly focusing on the field of Higher Education Management, Quality Assurance, as well as Knowledge and Innovation Management. Andi Mursidi has also become a higher education management consultant since 2006 until now. The strategies in building the Higher Education quality culture is the result of study referred from the related dissertation proposal (still on completion progress).

Higher education in its function as the agent of cultural changes should formulate the cultural development strategies, quality standards, implementation of quality culture development strategies as well as monitoring and evaluation.

The strategies used to build the higher education quality culture implemented at Singkawang College of Teacher Training and Education (STKIP Singkawang) are shown and explained in Fig. 3 as follows:

1. The first step is environmental analysis on internal, external, social, cultural and local wisdom environment. At this stage, the higher education identifies opportunities and threats coming from the surrounding cultures. In addition, environmental analysis is required to identify both internal and external strengths and weaknesses. The social environment analysis is conducted in order to see the level of community support for the existence of higher education itself. The analysis on cultural environment and local wisdom is conducted that the developed higher education quality culture is not in contrast with the existing culture and local wisdom where the higher education is located.
2. The second step is strategic formulation, cultural development and quality standards which cover the determination processes on vision and missions, objectives and targets formulated in the strategic plans, operational plan development, and quality standard establishment through the objective achievement indicator development and strategic targets (key performance index).
3. The third step is implementation of quality culture development strategies, that is, an activity to operationally translate in the forms of activity programs from the prepared operational plan in step two. After operationally formulated, the programs should be integrated with the financing plan, and followed by the technical procedures and implementation to achieve the goals.
4. The fourth step is monitoring and evaluation activities, that is, a step to ensure that all activities are well running according to plan. This monitoring and evaluation principle is not only conducted at the end of the program as a feedback for all activity processes, but also conducted at each activity step. At the end of activity, the achievement of higher education quality culture development may be seen through the comparison between performance and the established key performance index.

5 Conclusion

The results conclude that STKIP Singkawang has implemented 30 National Standards of Higher Education, owned 24 national standards and set up the internal standards covering the domestic and foreign cooperation, Academic Atmosphere, Student, Student Affair, graduate, Administrative Management and Leadership, Hygiene and

Safety, as well as Promotion and Publication standards. The development of higher education quality culture may not be separated from the culture of surrounding communities. Thus, the development of quality culture should be based on the higher education's needs in which there are heads of higher education, lecturers, students and educational staffs integrated in the developing environmental culture. In addition, the higher education quality culture is a part of surrounding environmental culture that higher education should be able to function as an environmental culture development agency. Higher education in its function as the agent of cultural changes should formulate the cultural development strategies, quality standards, implementation of quality culture development strategies as well as monitoring and evaluation.

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Alternative Interoperability Between BPMn and Project Management Tools

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Abstract. This article presents the proof of concept of a proposed architecture that allows building an environment to automate the activities of planning, monitoring and controlling of a project, from the integration of workflow tools and scheduling of project. In order to validate the architecture, it was implemented on the Intalio tool as a workflow and Open Project as a scheduling tool, the first being a business process management platform allowed the coherent integration of the process tasks towards the updating of the scheduling tool in real time. The proposed integration allows to feed a knowledge base from which the system automatically proposes a new timetable for the pending activities, according to the real progress of the project. This makes it easier for the project manager to visualize the real progress of the work, the optimal management of the time resources and the timely making of decisions that leads to the fulfilment of objectives, which, having a knowledge management base, becomes a support for the administration of future related and/or similar projects.

Keywords: Workflow · BPM · Process · Knowledge base

1 Introduction

In the process of project management, several phases and activities are taken into account, for which there are currently numerous computer solutions that allow carrying out tasks of vital importance in this process, among which one can mention the planning, design and the monitoring of processes. However, these tools are not integrated, which makes the realization of the activities of this industry expensive.

To solve this situation, it is necessary to achieve interoperability between the tools, through the use of standards that facilitate communication between programs, as proposed by Rainer von Amon and Cristoph Emmersberge, in their work on the existence of standards for process management [11].

This document presents the description of the problem in the first instance and shows the need and importance of the proposed Project control work, as well as the description of an integrated proposal for the modelling of the process and the monitoring of project activities, then the context used as a use scenario is described and finally the XML generation software for project management tools is described, developed as a support for the automation of the described process.

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2 Description of the Problem

The development of software projects is perceived as one of the potentially promising activities, that is why initiatives driven by governments are being promoted to support companies in improvement programs, so that it allows them to be more competitive in the global market and achieve customer satisfaction [12].

However, making projects successful is a complex challenge that requires discipline, management and technical skills, which means that organizations must define precisely the activities that help to control and monitor the project [13]. Some of these activities are mentioned below:

- Organizations use different methods to capture the processes according to their conditions or preferences. The most generalized way to define the processes is by means of prose descriptions consigned in text documents, or templates that allow a better structure of the text, however, this description is not very intuitive as a working document on the part of the participants and impractical because it hinders its evolution [12].
- As organizations mature, they perceive the need to find appropriate mechanisms to present their processes through diagrams, generated by tools based on BPMn or some other type of graphic notation [1].
- To specify the basic activities included in the project, it is proposed to use a Work Breakdown Structure (WBS), and through it, the scope is defined, serving as a basis for planning, for the timetables they could have a similar procedure [2].
- The control and monitoring of the activities can be done differently and with multiple tools from spreadsheets to project scheduling tools, depending on the technicality of the company.
- Generally, the tools used to construct the process diagrams and the project scheduling tools are not integrated, this disarticulation can cause the following problematic situations [12]:
  - It is not possible to generate the timeline from the process.
  - There may be differences between the planned process and the process that actually takes place.
  - It becomes necessary for the project managers to perform a manual synchronization of the project activities, which implies sub-utilization of the time resource.

3 Methodology

The research in its first part, corresponds to the definition of a non-experimental - transversal - descriptive design, where "the incidence of the modalities, categories or levels of one or more variables in a population is investigated" [13], since they comply with the following characteristics [14]:

- The most representative properties and attributes of the objects of study are investigated and determined, in this case, the time estimation models of the activities in the software development and the types of notation they represent. The process models.
- The fundamental characteristics of the object of study, its detailed description and its classification are selected.

On the other hand, the second phase of the research corresponds to a correlational-causal transversal design that "describes relationships between two or more categories, concepts or variables at a given time, either in correlational terms or depending on the cause-effect relationship" [13], the above because [14]:

- The association between certain events is analysed, providing evidence of the relationship that could exist between two or more entities capable of influencing the prediction of a specific result.
- It is determined how a concept or variable can behave by knowing the behaviour of one or other related variables.

Finally, in the last part of the investigation, the validation and verification of its result is performed, for this, a proof of concept of the model that is intended to be verified is implemented to guarantee its applicability and consistency.

The activities carried out during the investigation were the following:

Definition of the tools that best comply with the characteristics required by the research, to carry out this task three studies are proposed such as: comparison of project management tools, comparison of BPMn modelling tools and comparison of workflow tools.

From this activity, enough information was collected to choose the best tool for each of the corresponding categories, as follows:

- Comparative study of project management tools, an investigation was carried out of some tools present in the market, they were selected and their characteristics were classified, from which the metrics were defined to make the comparison, once the results of applying the metrics to each tool were obtained, it was concluded which is the appropriate one to be used in the development of the research.
- Comparative study of BPMn modelling tools, a set of BPMn modelling tools was chosen, which complied with a high level of reception within the market. As a result of this choice, a set of characteristics in common with all the tools was considered. Once the characteristics were defined, the necessary metrics were developed to evaluate each one of them, the evaluation of each one was carried out, and the result obtained defined the modelling tool that best meets the particularities that the research demands.
- Comparative study of existing workflow tools in the market, this study took a set of workflow tools, the most representative in the market. Based on this selection, common characteristics among these tools were extracted and the metrics and

criteria needed to evaluate each of the characteristics raised were elaborated. Obtaining the results of the evaluation, it was defined the tool that provides the best characteristics to be used in the development of the research.

3.1 Integrated Proposal for Process Modelling and Software Project Monitoring

From the previous activities, the tools that will be used in the design of the environment object of the present investigation are selected, the general activities that followed this phase are the following:

- Definition of Architecture: The structures and technologies necessary to carry out the fulfilment of the objectives are selected.
- Assembly of the technological platform: based on the selected architecture, the installation of the artefacts is carried out.
- Definition of the case study: this should allow the evaluation of the desirable characteristics that are intended to be addressed through the environment.
- Construction of the case study: using the notation and tools selected, design the process described by the case study and the formats or interfaces that are needed.
- Definition of interoperability: through formats and standards it allows communication between the environment and the selected tools.

Tests to the environment: checking of the environment by verifying the compliance of each of the objectives of this investigation.

4 Integrated Proposal for Process Modelling and Software Project Monitoring

The following is the general outline of the proposal for the integration of Software Process Modelling activities (taken as an example of project management) and Project Monitoring [3], having as a basic strategy the integration of Modelling tools of BPMn (Business Process Modelling notation), workflow tools and project scheduling tools through the manipulation of the workflow tool interface as framed by the reference model as defined by the Workflow Management Coalition [4].

It presents the general architecture and its instantiation based on the technology used by Intalio, as well as the scenarios of use of the environment, determined from the process selected in the study case and technologies defined by the bodies in charge of standardizing the workflow tools, as well as the technologies managed by this type of tools [1, 2].

The following schema shows how components that are part of the support environment for the development process of a project through BPM are distributed (see Fig. 1).

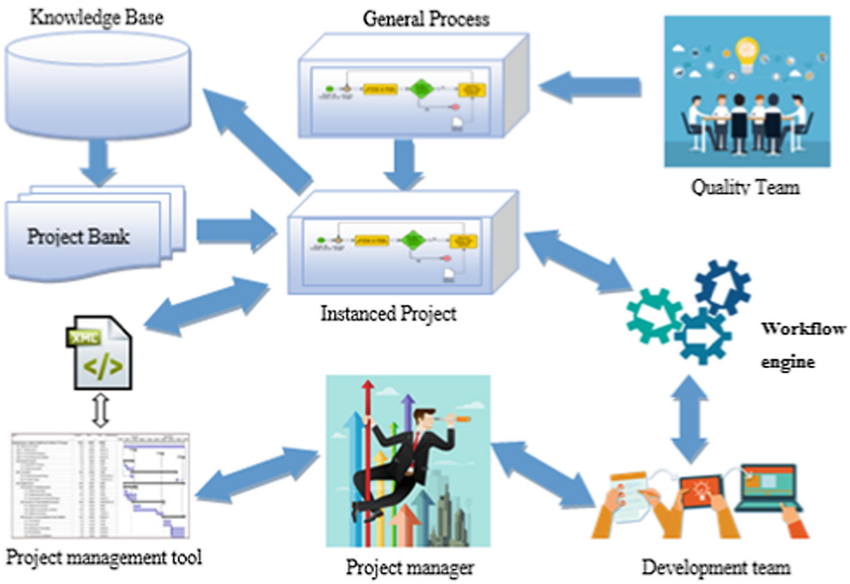

Fig. 1. General schema of the solution.

First, how the quality group is in charge of designing the general processes of the company according to the needs, policies and methodologies they need, this group must also evaluate these processes in order to optimize them, contributing to the continuous improvement of the organization.

The Project Bank contains the description of the projects that must be carried out and those that are in charge of as the Manager, who according to the type of project will select the processes that are suitable.

The moment a process is launched, it is said that the process has been instantiated, with which the members of the team must interact, in order to perform the tasks that correspond to them.

To execute this interaction, the use of a workflow engine is proposed, which is able to host the different instances of the processes that may occur. These are persisted in a Knowledge Base that is also orchestrated by the engine, at this point, the environment allows to monitor the activities of the different members of the work group and to control that the processes are carried out in a proper way, an operation defined by the reference model proposed by the Workflow Management Coalition [2]. But, it is difficult for the project manager visualize the progress of the activities. Therefore a management tool designed for this purpose and communicate them through an interoperability tool based on the XML standard is proposed to be added to the environment.

Solution Architecture

The architecture of the solution on which the development environment of a project is based on BPM [5] is shown in Fig. 2, which has 5 main nodes: Web Server, Database Server, Process Design Tool, Interoperability Tool and Project Management Tool, defined as follows:

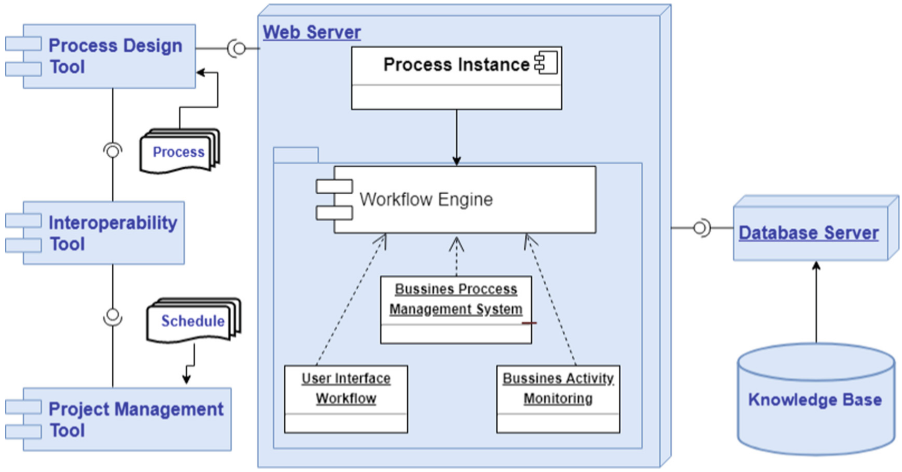

Fig. 2. Solution architecture.

- Web Server: Hosts a workflow package, process definition and possible instances.
- Database Server: Used by the workflow to persist the information corresponding to processes and instances of processes.
- Process Design Tool: Used in the process modelling under BPMn notation.
- Interoperability Tool: Responsible for providing the means of transformation and communication between the workflow and the Project Management Tool.
- Project Schedule Tool: Responsible for managing the resources that are part of the project in a software development.

The flow proposed by the solution is defined as follows:

Using the BPMn modelling tool, a process is designed, resulting in an artefact (process diagram), which must be published within the workflow through a connection port or some structure that facilitates that functionality.

Once the Workflow Engine hosts the process, it is responsible for providing the functionalities capable of instantiating and manipulating it, through components such as [6]:

- User Interface Workflow: Responsible for supplying the communication elements between the processes and the validated users in the system, through forms where the user, depending on their role and activity, diligence in order to provide information that allows the takin of decisions to the workflow engine and thus process the flow designed in the process.

- Business Process Management System: Allows the management of the processes and instances of these supplied by the Workflow Engine.
- Business Activity Monitoring: component that allows monitoring and auditing processes and their instances.

To persist the relevant information of the processes and their instances, such as roles, variables, activities, states, among others, the workflow communicates with a database designed for this purpose, generally the workflow tools [7] allowing users select the database manager, in other occasions, they require to use some specifics or embedded. The Interoperability Tool through the corresponding access ports, gets enough information to create the schedule of the process instances, which will be manipulated directly by the Project Scheduling Tool.

From the study, it is possible to verify the relevance of the use of workflow engines [5] where scalable environments are offered to companies or corporations, to add functionality to the engine through applications provided by the parent company that created the workflow. It is important to note that the possibility of direct access to the engine through APIs is also offered through the environment, which allows its use in the development of information systems.

The proposed functionality is defined as follows:

The proposed solution makes use of MySQL database, which is communicated by default port 3306, with the server that owns the workflow, this server uses the 8080 communication port.

The BPMn modelling tool is Intalio Designer, through which the process diagram is obtained in BPEL format. This diagram is consumed by Intalio Workflow through Apache ODE, web services orchestration system, responsible for organizing and addressing the processes that are written in BPEL language [9].

From this it is possible, through the components of the Intalio Engine, to perform different actions on the processes as follows:

- Ui-wf is responsible for providing the communication elements between processes and users that are part of a system and that have sufficient permissions to manipulate such processes.
- BPMS-Console is responsible for managing the processes and instances they have.
- BAM is the delegated component to monitor the processes and their instances.

The Interoperability Tool can establish communication directly with Intalio Engine, therefore it can access the information of the processes and instances, defined within the workflow [10].

Based on this information, the interoperability tool can generate the Process Instance Timeline, a file defined by XML technologies that will be used by management tools, such as Project.Net, Open Project or MS Project, defined as the Project Management tools that will be used for the implementation of the support environment for the software development process through BPM.

5 Use Scenario

The scenario of using the solution describes the flow of information between the entities involved in the system or actors related to it, then the scheme of the use scenario of the solution is described.

As a starting point of the flow, the actions performed by the quality team are defined, which is in charge of carrying out the Define Process task, this is a sub process that has implicit tasks, such as determining the business rules, assigning roles, among other.

Once, everything related to the process is defined, we proceed to outline it on the BPMn modelling tool [8], in which it is possible to obtain a process diagram, which can have different types of extensions depending on the modelling tool in which the work is done.

- Once the process resides in the Workflow Engine, the Consuming Process task is defined, which allows creation of this instances. The Project Manager is responsible for this task, assigning those responsible for each of the activities that are necessary for the instance.
- Once the process has been executed, the Interoperability Tool generates the interoperability file, which will be interpreted by the Project Management Tool, in order to visualize the initial project schedule.
- At this time, the administration of the process instance by the Project Manager begins.
- The task of Monitoring Instance Process, is responsible keeping track of the states of the instances and the flow of information of each of these.
- From the monitoring of the instances, an interface is provided in order for the managers of the activities report the status of it, this task has a specific time to be carried out, and has two states: completed and not completed. The state is reported to the process of monitoring the instances, from which the end of the instances of the process or a cycle, finished only when those tasks are completed in their entirety.
- Within this flow, if the instances have not been finalized, information on the process instances can be obtained from the Workflow Engine through the Interoperability Tool. Since the Interoperability file has been created, it is enough to be updated with the new information concerning the procedure performed on the instances. Once the above is defined, it is allowed to view the previously created but updated schedule.

Because the monitoring of the instances is carried out in a cyclically way, based on the schedule visualized in the project management tool, it is necessary to define a direct relationship with the monitoring activity of the instances. At this point, it is guaranteed that the monitoring is carried out constantly.

6 Development of XML Generation Software for Project Management Tools

This section describes the development of an interoperability tool between BPM tools and project management tools, for which it was necessary to create a component capable of generating an XML readable by some project management tools.

Once the comparative study of tools was done, it was evident that Microsoft Project, is a tool that presents features to explore, with which interoperation is profitable to improve the processes in software development, besides highlighting the high popularity that of it as part of the Microsoft Office package. To do so, many of the tools offer the ability to import an XML over the schema for Microsoft Project 2003, the framework on which the XML generation tool was based.

The scheme described above, in addition to Microsoft Project, can be used by other project management tools, among which it is possible to mention OpenProj or Project. Net, which offer within their services the import of the file mentioned. For the development of this file, it was necessary to use the JDOM libraries version 1.1.1, which allow to generate the generated XML and perform a validation, which guarantees that it complies with the scheme.

Through the implemented classes (see Fig. 3), it is possible to generate the XML, regardless of the origin of the data, which allows it to be used in any type of projects that wish to generate XML for management tools that meet with the Microsoft Project 2003 XML schema.

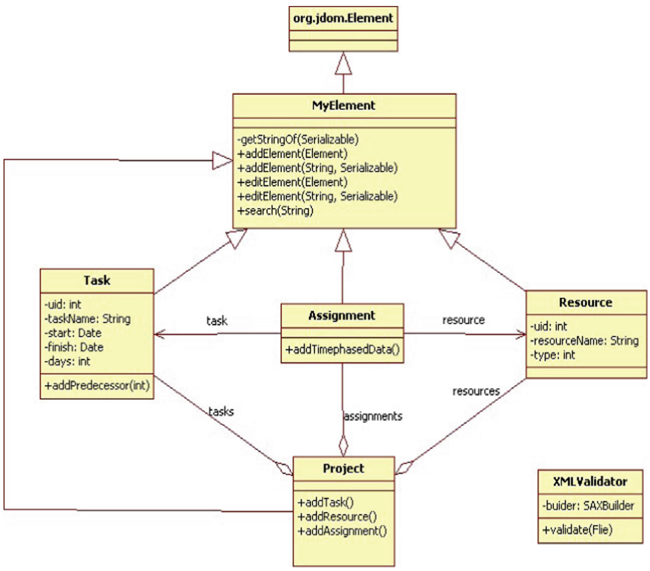

Fig. 3. Class diagram XML project generation tool

Once the XML file is generated, simply load it into the project management tool to view the timeline (see Fig. 4). It should be mentioned that the timetable shown is an example, because this tool has as its only general objective an XML for the schema mentioned above.

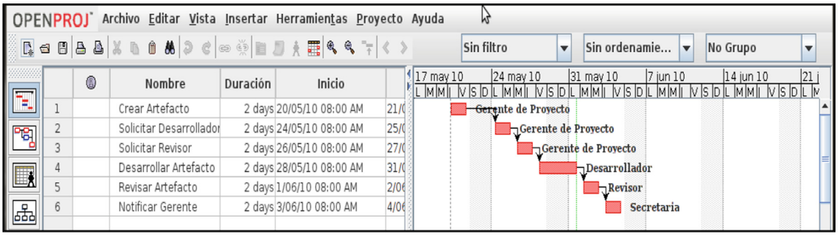

Fig. 4. Activities Schedule generated on the project management tool.

7 Conclusions

The communication between the project management tools with the BPM tool was made through the functionalities embedded in the interoperability tool. This communication was achieved because the workflow tool chosen for the implementation of the environment, has a public API, manipulatable and clear enough to facilitate the obtaining of information regarding the processes and their instances.

Intalio Works is a tool oriented to large organizations, which aim to define their processes through existing tools, because these entities do not want to invest in systems development, but in clearly defining their processes, regardless of the platform where they work.

The interoperability tool developed in the course of the investigation, offers sufficient means of communication to generate a standardized XML file, containing the most important information of the processes and their instances, this information is clearly reflected on the timeline by the project management tools.

Regarding the schedule of activities, it is possible to keep track of the progress, modifications and updates of the information of the processes and the instances of these, information obtained from the execution of the process model on the tool of workflow implemented in the development of the research.

In a production environment, thanks to the union of workflow tools and project scheduling, it is possible to monitor the amount of information related to the processes and their respective instances. This information can be from the instantiated processes, the start and end dates of it, up to the time invested to perform each of the tasks, the pending tasks by users and other elements that allow measuring of productivity of the implemented processes.

It opens a door for the integration of these tools within software developments, which allow to control the flow and times of these, in such a way that not only workflow tools can generate information of the executed processes, but from their own developments such actions can be carried out.

Another important factor that should be highlighted is the importance of standards when communicating different types of tools. Workflows have a high degree of standardization of their products, a fact that is reflected in the management tools, which have taken standard de-facto the Microsoft Project XML scheme, which allows few modifications to export schedules to different tools.

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Data Mining and Intelligent Science

Agent-Based Approach for the Management of Dynamic QoS Violations in the Inter-Cloud Environments

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Abstract. Nowadays, considerable attention has been given by the researchers in the field of Cloud Computing to the emerging Inter-Cloud computing paradigm, where different cloud service providers collaborate or federate to achieve better QoS and cost efficiency. In this context, in order to prevent the unauthorized access of the distributed system components, authentication and authorization functions are to be enforced effectively. In this paper, we propose the conceptual model of the agent-based approach for the identity and access management in the dynamic inter-cloud environments where the Cloud Service Providers or the partners of the inter-cloud federation join and leave the federation dynamically. We further discuss the architectural model for the agent-based approach for solving the policy conflicts in the inter-cloud scenario while dealing with the access requests of cloud consumers in the inter-cloud environments. A few open issues in the area of identity and access management in the inter-cloud environment are also discussed.

Keywords: Access control · Agents · Authentication · Authorization
Inter-cloud · Policy-conflict · Trust

1 Introduction

1.1 Inter-Cloud Scenario

In the inter-cloud or cloud federation environment, different cloud service providers (CSPs) collaborate to provide better services to the cloud users, and thereby increasing their resource utilization and business prospects. The CSPs will have service level agreements between them for the resources and services offered to other CSPs in the inter-cloud environment [1].

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1.2 Need for the Management of Dynamic QoS Violations in the Cloud Federation

Generally, there will be Service Level Agreements (SLAs) between the partners in the inter-cloud or federation to share the resources. Due to the dynamic nature of customer requirements, sometimes a CSP in a federation may urgently need some resources from other CSPs in the federation to meet the customer requirements, as the requested resources are unavailable with the CSP at that time. Since the CSPs in the inter-cloud environment operate by the Service Level Agreements among them, a CSP can get the services as per the QoS agreement in the SLA. Normally, the process of SLA renegotiation is carried out among the CSPs in order to modify the QoS parameters of the services agreed among them. Now, if a request comes to a CSP from another CSP in the federation for some resources whose QoS features are not as per their prior agreement, how to deal with such a request in the federation dynamically without the time consuming SLA renegotiation at that time is an issue to be considered. QoS/SLA violation in the inter-cloud occurs when one CSP requires some service from another CSP whose QoS features differ from what have been agreed in the SLA between them.

1.3 Agent-Based Computing

Agents are normally autonomous programs, which can interact with the environment and act upon it to achieve their tasks [2]. A multi-agent system involves multiple interacting software components known as agents, which can cooperatively solve the problems that are beyond the capabilities of any individual entity.

The rest of the paper is organized as follows: Sect. 2 describes the work done in the area of identity and access management in the inter-cloud environments, highlighting the merits and demerits of various approaches. Section 3 presents the agent-based approach for identity and access management in the dynamic inter-cloud environments. Section 4 discusses the agent-based model for dealing with the dynamic policy conflicts management in the inter-cloud scenario. Section 5 shows the analysis and results mentioning a few open issues in this area and Sect. 6 concludes the paper.

2 Literature Review

The research in the field of Identity and Access Management in the Inter-Cloud environment is still in its nascent stage, and some of the relevant approaches proposed by the researchers in that area is given in this section. In [3], the authors propose the architecture for Federated Identity Management in a scenario similar to the Inter-Cloud environment. The work focuses on sharing of information or resources across all the three cloud service models such as SaaS, PaaS and IaaS. The works carried out in [4–7] present a heterogeneous horizontal cloud federation model, for CLoud-Enabled Virtual EnviRonment (CLEVER). These works use the concept of a middleware component called the Cross-Cloud Federation Manager (CCFM) that could be integrated into the Cloud Manager component of the Cloud Service Provider. This work does not discuss the issue of policy conflict management in the inter-cloud scenario.

The authors presented a blueprint for the design of Inter-cloud in [8–10]. This blueprint is designed considering the Interoperability factor between the various Cloud Service Providers and is focused at the Internet scale. The work in [11] discusses the inter-cloud security considerations. In [12], the authors propose an authentication mechanism for inter-cloud environments using SAML profile over XMPP. The architecture discussed in this work is based on the internet scale. The issue of policy conflict management and the break-glass mechanism is not clear in these architectures. In the work carried out in [13], the Cloudbus toolkit is discussed which includes the various Cloud solutions, technologies and components to build a global Cloud computing marketplace. In the work presented in [14], the authors propose an architecture for the Inter-cloud scenario, which is based on the market-oriented Cloud Computing, an essential part of the Cloudbus toolkit. This architecture requires the Aneka Container to be installed at all the required cloud nodes.

The work shown in [15] discusses a Federated Identity Management approach using Hierarchical Identity-Based Cryptography. The work focuses on the Private Key Generator (PKG) hierarchical model. This model assumes a root PKG for managing the entire Hybrid Cloud. The root PKG generates private keys for PKGs of the member Clouds associated with the hybrid cloud. In this work, the Federated Identity Management functionalities are distributed between root PKG and individual cloud level PKGs [16]. Before applying this model to the inter-cloud scenario, issues regarding the control of the root PKG should be solved. The authors carry out an analysis of the cost benefits of resource sharing in cloud federation in the work presented in [17]. The Cloud Scheduler project explained in [18], focuses on developing a model for resource provisioning and sharing among the various participating Clouds. In this work, the authors concentrate more on the scheduling of applications among the partners in the federation, and not on establishing the federation.

Based on the literature review, it is seen that the proper solution for the issue of IAM in the inter-cloud computing needs extensive research in the area of trust establishment and conflict management of access policies for accessing various resources.

3 Agent-Based Identity and Access Management (IAM) in the Dynamic Inter-Cloud Environments

In this section, we are proposing an agent-based architecture for the IAM in the inter-cloud environment, when the CSPs or the partners join or leave the federation dynamically. Inter-cloud environment is formed with the aim of improving the QoS that could be delivered to the cloud customers. It is an association between different CSPs in order to achieve better QoS and the economy of scale.

But, in this cloud environment, practically, we cannot expect the inter-cloud environment to be static. That means, for example, if we start a federated cloud environment at a time t_1 with n CSPs, where $n > 0$, we cannot expect that inter-cloud environment to remain the same over time, since the CSP's ultimate aim is to increase their revenues by delivering quality services and thereby attracting more customer base. Hence, at any other point of time t_2, the number of partners in that federated cloud environment may change to m, where m could be either greater or less than or equal to n. Also, even if the number of partners remain the same as n, the current partners could be different from those present before.

3.1 Conceptual Model

The proposed high level conceptual model is shown in the Fig. 1. The major elements or actors in our proposed model are Cloud Service Consumer (CSC), Cloud Service Provider (CSP), Access Request Mediating Agent (ARMA) and the Identity Provider (IdP). The proposed high level conceptual model is shown in the Fig. 1.

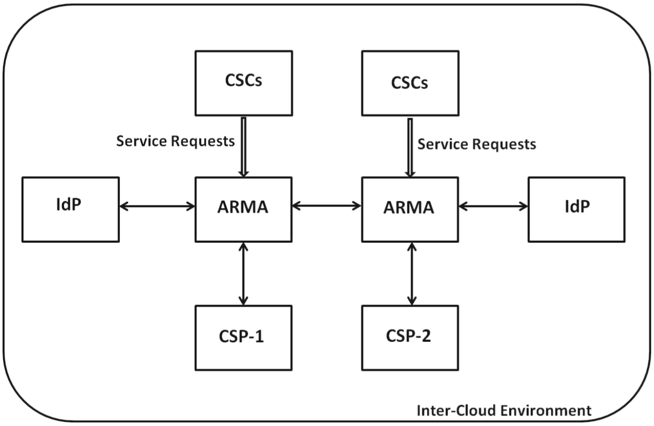

Fig. 1. Agent-based approach for identity and access management in the dynamic inter-cloud

3.2 Components of the Proposed Model

The major functional components identified in the model are:

Cloud Service Consumer (CSC). Cloud Service Consumers are the entities requesting the resources or services from the Cloud Service Providers (CSPs) in the inter-cloud environment. The CSCs need to be properly authenticated and their access rights need to be verified in order to ensure that unauthorized users do not access the services hosted by the CSPs.

Access Request Mediating Agent (ARMA). This agent runs on every Cloud Service Provider which is acting as a partner in the inter-cloud environment. The ARMAs of various partners in the inter-cloud interact with each other as shown in the Fig. 1, where only two CSPs of the cloud federation namely CSP_1 and CSP_2 are shown. The individual users of a CSP in an inter-cloud interact with the ARMA of the respective CSP, which further interact with the underlying cloud layer for resource provisioning.

Cloud Service Provider (CSP). In the inter-cloud, the CSPs have an agreement between them to share their virtualization infrastructure and resources with other CSPs in order to meet the objectives of the cloud federation, and they offer various services such as IaaS, PaaS or SaaS to the various users requesting services in the inter-cloud environment.

Identity Provider (IdP). IdPs are third parties trusted by the CSPs in the inter-cloud environment for providing the identity management of the cloud users. The IdP implements the federated identity management in the inter-cloud enforcing Single Sign-On (SSO).

The ARMA of a CSP perform the various identified tasks or functions involved in the effective dynamic inter-cloud management. The various functional components of the ARMA, and their interactions are shown in the Fig. 2. The required components are:

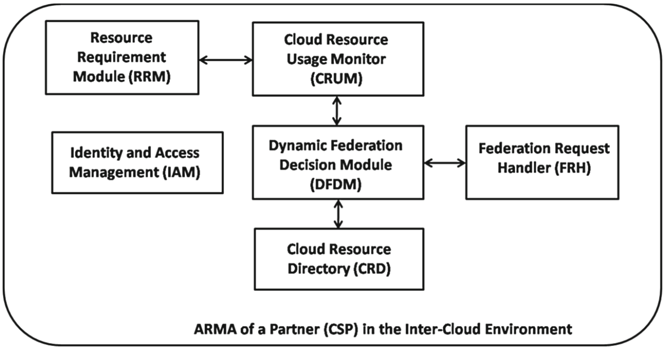

Fig. 2. Access Request Mediating Agent (ARMA) in the dynamic inter-cloud

A. Resource Requirement Module (RRM)

This module of the ARMA identifies the current resource requirements made by the cloud customers at any point of time. It also interacts with the Cloud Resource Usage Monitor Module to know the present utilization level of the cloud resources hosted by that particular CSP. In case the RRM module finds that the resources are already saturated, the module publishes the resource requirement details in the inter-cloud environment so that the information is available to other clouds who are either members of the federation, or who would like to form the federation with the existing inter-cloud. The information should be published using technology or protocol such as eXtensible Messaging and Presence Protocol (XMPP) or Advance Message Queuing Protocol (AMQP) so that the partner clouds can meet the purposes of federation formation.

B. Cloud Resource Usage Monitor (CRUM)
This module helps to identify the resource usage details of the parent cloud where the resource requests are originated by the cloud customers. Also, the resource usage details of other clouds who are partners of the federation could be monitored by this module by interacting with the Cloud Resource Directory (CRD) maintained at the respective CSP in the inter-cloud.

C. Federation Request Handler (FRH)
When a CSP receives a request, this module takes the decision of forming the federation with that requesting CSP. The important components involved in this module are:

(i) Trust Evaluation (TE). The trust value of a CSP could be based on the past behavior and the history of previous transactions with the same CSP. There could be a trust model which should be implemented, and the trust threshold value could be set in the inter-cloud environment. **(ii) Policy Matching (PM).** Before taking a final decision on the request of any CSP to form the federation, the policies of that CSP should match with that of the federation. The various aspects of the policies could include the type of the resources and the services offered, the authentication and the authorization mechanisms adopted by the CSP, the QoS guaranteed by the CSP and also the type of the SLA it makes.

D. Dynamic Federation Decision Module (DFDM)
This module adopts a threshold-based permission scheme to deal with the dynamic inter-cloud formation. The feedback of FRH is communicated to this DFDM module and the DFDM broadcasts the join-request to all the existing partners in the inter-cloud. If k out of n existing partners, where k is the threshold agreed by all the n existing partners in the inter-cloud, permit the new cloud to be a part of the federation, the DFDM module registers the new cloud. In our proposed model, the DFDM of the cloud where a CSP makes the request to be a part of the existing federation, coordinates this activity of accepting the new CSP as a partner. Again, the decision to terminate a federation relationship has to be achieved among all the existing inter-cloud partners and Dynamic Federation Decision module coordinates this activity.

E. Cloud Resource Directory (CRD)
Once the cloud federation is formed, this module of a partner CSP stores the details of the various services offered by other partners in the federation, so that a CSP can identify any other CSP in the inter-cloud that offer similar services as requested by the cloud customers. Whenever there is a new CSP being added to the inter-cloud, or any CSP being removed from the existing federation, this CRD needs to be updated.

F. Identity and Access Management Module (IAM)
Whenever an access request is received by a CSP in the inter-cloud, this module of the ARMA deals with the authentication and authorization processes of the cloud customers. This component of the IAM module involves verifying the identity of the requesting user by interacting with the Identity Provider using SAML assertions. Events of possible policy conflicts, arising out of the various access requests made by different users which need to be satisfied by more than one CSP at a time in the cloud-federation are handled by this module of the ARMA.

4 Dynamic Policy Conflicts Management in the Inter-Cloud Environments

Whenever a service request from a cloud user is processed by a CSP, the applicable policies are considered for determining the access rights of the cloud users specific to a CSP. The major policies of the CSPs like the details of the resources or services offered, the QoS delivered, list of Identity Providers supported, SLAs, the authentication and the authorization mechanisms supported by the CSP etc. are considered while forming the federation with any CSP. In the inter-cloud environment, a CSP who is unable to satisfy the request of a cloud customer might offload the service requests to the partners in the federation who offer the similar services. Suppose that there is an SLA agreed between CSP-A and CSP-B in the inter-cloud. Also, assume that as per the SLA, CSP-B has agreed to give the service consisting of a maximum of n number of VMs of type 'small' to CSP-A. Now, imagine that CSP-A makes a service request of m VMs ($m > n$). Also the type of the VMs requested is 'large'. This is an example of the QoS/SLA violations between the CSPs. Hence, in order to make the best use of the federation, we need a dynamic management of this possible QoS violations among the partners in the federation so that the mutual benefits of the CSPs in the federation, in terms of reliability, reputation and the economic benefits are improved.

In this section, we propose an agent-based mechanism to solve such a scenario of policy conflicts in the inter-cloud environment. With reference to the Fig. 1 in Sect. 3, the proposed conceptual architecture of the ARMA for dynamic policy conflicts management is shown in the Fig. 3. The various functional components in the architecture are:

4.1 The Resource Request Handler (RRH)

This module of the ARMA deals with the service requests initiated by the cloud customers requesting various services from the inter-cloud. The module interacts with the Context Handler (CH) module, and identifies the type of request made by the cloud customers such as the service requested, requested resource details, and various other parameters such as the QoS, duration of the service required, SLA details etc.

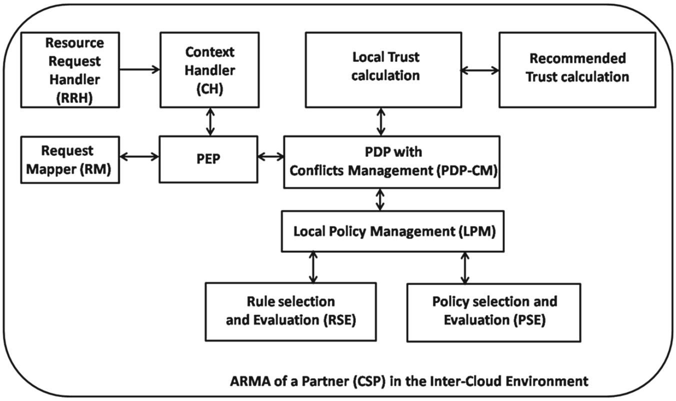

Fig. 3. Access Request Mediating Agent (ARMA) with policy conflicts management in the dynamic inter-cloud

4.2 Context Handler (CH)

This module of the ARMA is required to convert the service requests from the format submitted by the cloud users to a specific format (such as XACML format) which could be used for further processing using access control languages such as XACML, in the inter-cloud environment.

4.3 Policy Enforcement Point (PEP)

This module implements the access control decisions taken by the Policy Decision Point (PDP) module. When the resource request comes to the CSP form a cloud customer, the Context Handler Module converts the request to the common policy format, and the PEP responds to the access requests based on the access control decision of the PDP. The PDP module contacts the Local Policy Management Module.

4.4 Local Policy Management Module (LPM)

This module considers the applicable policies and their evaluation related to any particular access request initiated by the clients. Thus, this module takes the authorization decision of permitting or denying the access request initiated by the cloud customers based on the rules and the policies evaluation. This module updates the PDP with the decision obtained after selecting and evaluating the various applicable rules and policies with respect to the access request received.

4.5 PDP with the Conflicts Management (PDP-CM)

In the inter-cloud environment, if the decision of the Local Policy Management Module is to deny the access request initiated by a CSP, this module comes into action. In order to solve such an issue, in the proposed architectural solution, the PDP is implemented with the Conflicts Management in such a way that it calculates the direct and recommended trust values of the CSP in the inter-cloud environment, and based on the trust value of the requesting CSP, it takes a decision as to accept or reject the access request from other partners in the federation.

4.6 Local Trust Calculation

This module of the ARMA calculates the local trust values of the requesting CSP. This calculation is based on its own experience of working with the requesting CSP in the past. This calculation takes into account various parameters such as how many successful interaction they had between them in the past, and how long the requesting CSP has been a part of the inter-cloud or federation environment etc. If the calculated trust value is greater than the trust threshold maintained buy the CSP, the access request is accepted even if there is a QoS violation between the CSPs in the federation.

4.7 Recommended Trust Calculation

If the trust values calculated by the Local Trust Calculation module is less than the trust threshold, recommended trust of the requesting CSP is calculated. This calculation involves identifying the trusted CSPs in the inter-cloud environment, and then taking feedback of the requesting CSPs from the trusted CSPs. The final trust value can be calculated as the average of the local and the recommended trust values of the requesting CSP. If the final trust value is greater than the trust threshold, the access request is accepted, otherwise rejected.

4.8 Request Mapper

There is a need to map the resource requests initiated by the various cloud users in the inter-cloud to the corresponding format or APIs supported by their respective Cloud Service Providers to get the service done. Hence, after verifying the access privileges of the inter-cloud customers, the Request Mapper module maps the requests of cloud customers to their underlying infrastructure-specific interfaces.

5 Analysis and Results

5.1 Experimental Setup

We have carried out the simulation experiments on a system with Intel (R) Core (TM) i7-3770, CPU 3.40 GHz, 8.00 GB RAM and 32-bit Operating System (Ubuntu 14.04). Softwares used for the implementation include CloudSim-3.0.3, Eclipse IDE version 3.8, MySQL Workbench Community (GPL) for Linux/Unix version 6.0.8 and Java version 1.7.0_55.

5.2 Results

In order to test and validate the proposed approach in the Cloud Federation environment, we have implemented the Cloud Federation of 25 CSPs using the CloudSim toolkit [19]. The Fig. 4 shows the behavior of the proposed Agent-Based Dynamic QoS Management Mechanism. In the figure, the X-axis shows the three cases in solving the QoS violations. In the proposed approach, whenever there is a violation, trust value of the requesting CSP is calculated by the ARMA. Here, case 1 shows the number of requests accepted using the local trust of the CSP. Case-2 shows the number of resource requests accepted by calculating the local and the recommended trust of the requesting CSP. Case 3 shows the number of cases in which calculated trust value was not sufficient to accept the resource request from the CSP in the inter-cloud. (Out of 80 access requests made by CSP-1, 24 times requests were accepted using the local trust of the CSP and 38 times resource requests were accepted by calculating the local and the recommended trust of the requesting CSP. Also, 18 times the calculated trust value of CSP-1 was not sufficient to accept the resource request from the CSP in the inter-cloud. This approach can be extended to analyze the performance of other CSPs in the inter-cloud as well.

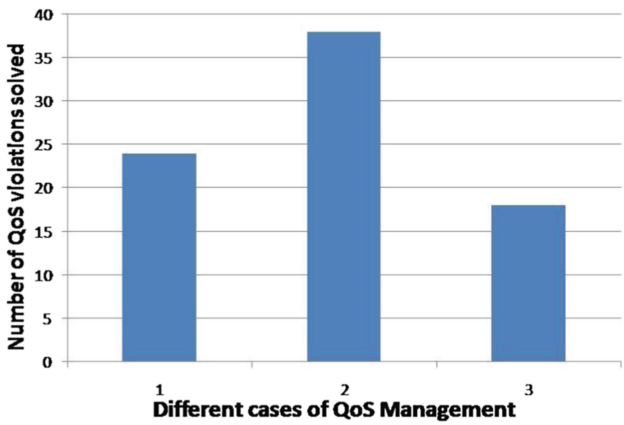

Fig. 4. Graph showing the behavior of the proposed dynamic policy-conflicts management mechanism

Based on the analysis done, it is seen that effective management of the QoS violations is required to improve the efficiency or throughput of the inter-cloud environment. It is also seen that most of the research works do not provide effective solutions, as far as implementing an effective policy conflicts management in the inter-cloud environment. The Inter-Cloud paradigm is considered as the future of cloud computing, and the agent-based identity and access management mechanism has enormous potential for further active research, in order to make the inter-cloud computing paradigm secure, reliable and scalable.

6 Conclusion and Future Work

This paper discusses an approach for the agent-based identity and access management in the dynamic inter-cloud environment with policy conflicts management considering the requirements of the current inter-cloud scenario. We have also analyzed the existing identity and access management approaches, mentioning their pros and cons in the inter-cloud environment. It is seen that, the research activities in the area of identity and access management in the inter-cloud is still in the nascent stage and the effective management of policy-conflicts in the inter-cloud environment is needed for the effective use of the paradigm. A few open issues for further research in the areas of identity and access management are also discussed. As a future work, we plan to simulate and study in detail, the mechanisms for the dynamic inter-cloud management and the dynamic policy-conflicts management mechanisms.

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Knowledge Based Framework for Genetic Disease Diagnosis Using Data Mining Technique

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Abstract. Gene Ontology is a structured repository of concepts that are associated to one or more gene products. The Gene Ontology describes gene products in terms of their associated biological processes, cellular components and molecular functions in a species-independent manner. There are different approaches available to discover the biologically relevant associations between terms of Gene Ontology. Multiple genomic and proteomic semantic annotations scattered in many distributed and heterogeneous data sources such heterogeneity and dispersion hamper the biologists' ability of asking global queries and performing global evaluations. To overcome this problem, we developed a knowledge based framework to create and maintain a Genomic and Proteomic Knowledge Base, which integrates several of the most relevant sources. We have developed an approach using Multi-Ontology data mining at All Levels (MOAL) to mine cross-ontology association rules, i.e. rules that involve Gene Ontology terms present in its sub-ontologies for identifying the gene attacked disease.

Keywords: Gene Ontology · Proteomic semantic annotations
MOAL · Cross-ontology

1 Introduction

Ontologies are specifications of a relational vocabulary. Gene ontology (GO) is a major bioinformatics initiative to unify the representation of gene and gene product attributes across all species. Gene Ontology includes three main sub-ontologies: Biological Process (BP), Molecular Function (MF), and Cellular Component (CC). Each ontology stores and organizes biological concepts, called GO Terms, used for describing functions, processes and localization of biological molecules. Each GO term is uniquely identified by a code, it belongs to only one ontology, and for each GO Term a textual description is also available.

The introduction of high-throughput technologies in molecular biology has produced the accumulation of a large set of experimental data. Such amount of experimental data has been integrated with additional information able to explain such data.

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In order to systematize such knowledge, formal instruments such as controlled vocabularies and ontologies have been used to manage the used terms. For instance, the Gene Ontology (GO) is one of the frameworks that are largely used.

Increasingly large amounts of valuable, but heterogeneous and sparse, biomolecular data and information are characterizing life sciences [1]. In particular, semantic controlled annotations of biomolecular entities, i.e. the associations between biomolecular entities (mainly genes and their protein products) and controlled terms that describe the biomolecular entity features or functions, are of great value.

Increasingly large amounts of valuable, but heterogeneous and sparse, biomolecular data and information are characterizing life sciences. In particular, semantic controlled annotations of biomolecular entities, i.e. the associations between biomolecular entities (mainly genes and their protein products) and controlled terms that describe the biomolecular entity features or functions, are of great value; they support scientists with several terminologies and ontologies describing structural, functional and phenotypic biological features of such entities (e.g. their sequence polymorphisms, expression in different tissues, or involvement in biological processes, biochemical pathways and genetic disorders).

Taking advantage of the previous GFINDer [2] system, we developed a knowledge based framework to create and maintain an updated and publicly available integrative data warehouse of genomic and proteomic semantic annotations. It adopts a modular and multilevel global schema that we propose for integrated data management. This data schema supports integration of data sources, possibly overlapping, which are fast evolving in data content, structure and number, and assures provenance tracking of all the integrated data.

Sensor network (WSN) [1, 2] is widely used in human's daily life. People use much kind of sensors to obtain various information from living environment and then this information can be transferred via wireless communication. WSN is exactly important for detecting the harsh environments which include precipitous mountain area, underwater environment, volcanic, battlefield and so on [3, 4]. WSN not only provides much information to people but also efficiently reduce the labor cost. The sensors havesome indispensable conditions such as they must have the ability to work long hours and provide enough sensing area. There are many advantages of WSN but still have a fatal weakness that the mentioned indispensable conditions are inversely proportional to the battery life. It means that WSN will become increasingly unreliable if there is a part of sensors that have run out their battery energy. Especially, the dead node is a relay node that the whole WSN will be crashed. To extend network lifetime of WSN, there have some researches proposed rest time control for solving this problem [5]. But sensors will still run out of energy someday.

2 Related Works

This section of the paper puts this work into the context of already existing relevant literature. Many studies were conducted to find and develop methods to create knowledge base for genetic disease diagnosis.

In [4] Agapito et al. developed Gene Ontology-based Weighted Association Rules Mining (GO-WAR), a novel data-mining approach able to extract weighted association rules starting from an annotated dataset of genes or gene products. This approach is initially calculate the information content for each GO term then, they extract weighted association rules by using a modified FP-Tree like algorithm able to deal with the dimension of classical biological datasets. In [6] Hemert and Baldock have used association rule mining to identify relationships among up and down regulated genes in gene expression studies. These studies do not make use of the GO and its hierarchical structure. Previous research applying association rule mining to the GO includes mining single level, multi-level and cross-ontology association rules. In [5] Carmona-Saez et al. developed an approach to mine single level associations between GO annotations and expressed genes from microarray data integrated with GO annotation information. The approach does not utilize the inherent information provided by the GO structure thereby limiting the knowledge discovered.

In [3] Davis et al. presented an objective framework for generating customized ontology slims for specific annotated datasets, exploiting information latent in the structure of the ontology graph and in the annotation data. This framework combines ontology engineering approaches, and a data-driven algorithm that draws on graph and information theory. Thus it provides deep explanation about the specific gene disease and annotated data for it. The limitation of above methods is that Classical association rules mining algorithms are not able to deal with different sources of production of GO annotations. Consequently, when used on annotated data they produce candidate rules with low Information Content and by which a large amount of information is usually missed. The second major drawback is that data is distributed and heterogeneous for which there is no Knowledge base which can maintain these data sources. So we proposed a system to create and maintain a Genomic and Proteomic Knowledge Base (GPKB), which integrates several of the most relevant sources which will assure quality and consistency of the data sources. Davis et al. [10], in his research article describe an approach for generalizing in the GO by calculating the information content of a node using both the ontology structure and the annotation dataset as a metric for generalization. They use a non-traditional definition of information content of a concept x as $Ix = Px - Ox$, where Px is the information gained by not generalizing concept x and Ox is the information lost if all the child terms of x are generalized to x . Px and Ox are calculated using information from the annotation dataset and the ontology structure. They use this approach to generate automatic slim sets from the GO, but it is unclear how this approach will work for mining associations from multiple ontologies.

Kate [11] in his paper a thorough investigation is done in the areas of Web mining and Semantic web, and the mixture of the techniques in these areas are used to simplify the complications in a specific domain. The domain that is focused here is of Molecular Biology (Lac Operon mechanism). Ontology mining is done, inorder to improvise the prevailing ontology functionally by the inclusion of DNA and RNA components, and also structurally by expanding the ontology in a different perspective. The analysis of these functional and structural modifications is done to overcome the present shortcomings in this ontology.

3 Proposed System

We have proposed a web based Genomic and Proteomic Knowledge Base system for detecting the genetic diseases. The genetic disease is detected by the Proteomic data (MF, CC, BP) using the cross ontology technique and Genomic data (Gene, miRNA, Transcription factors) byco-regulatory mechanism. In cross ontology the protein values are combined and compared to the nominal average values of the affiliated genes from the database, to find if the disease is intrinsic (below the average value) or extrinsic (above the average value) using collaborative filtering. DFS is used after Collaborative Filtering; this is done to filter results with respect to severity by considering protein values and affiliated genes. In Co-regulatory mechanism the diseases from each Genomic factor is integrated and the disease list is optimized by taking the common diseases from all the three genomic factors using Multiplicative Update Algorithm. By the given training dataset (Gene ID, MF, CC, and BP values) final results are displayed in the form of the Bayesian Rose Tree which includes symptoms and clinical recommendation. This can also be represented in textual format which can be stored in the cloud for remote access. The Architecture of proposed disease diagnosis framework is shown in Fig. 1. Figure 2 represents a few sample diseases and its miRNA values.

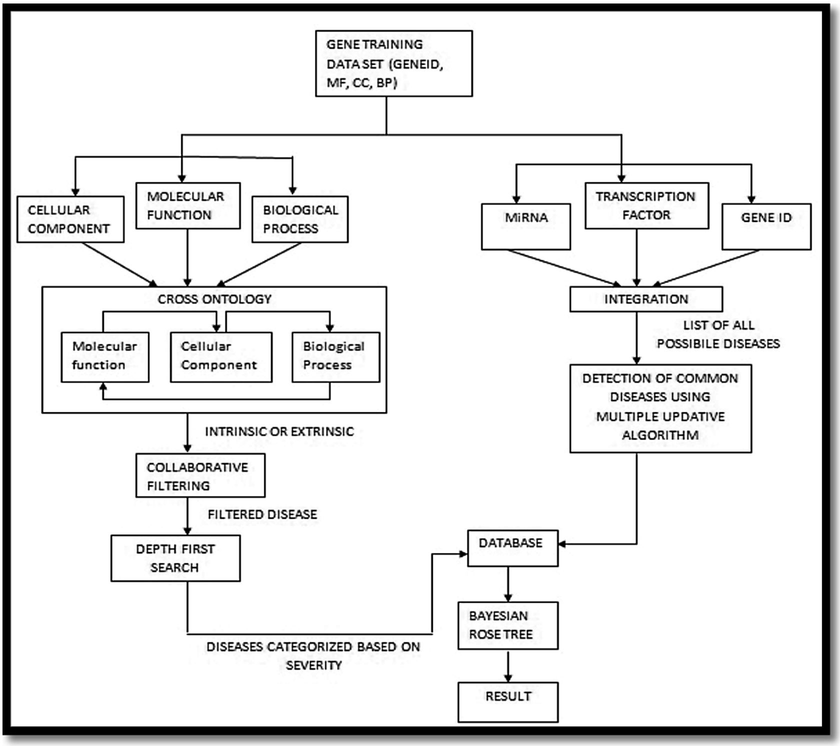


Fig. 1. System architecture of proposed framework

list	mirna
BONE & MUSCLE DISEASE	mir:1300
LIVER & KIDENEY DISEASE	mir:613812
BONE & MUSCLE DISEASE	mir:611490
OTHERS	mir:604273
BONE & MUSCLE DISEASE	mir:266150
LIVER & KIDENEY DISEASE	mir:222700
SKIN DISEASE	mir:12130
BRAIN DISEASE	mir:251290
BRAIN DISEASE	mir:230900
SKIN DISEASE	mir:20100
BONE & MUSCLE DISEASE	mir:233700
SKIN DISEASE	mir:276700
SKIN DISEASE	mir:607624
BONE & MUSCLE DISEASE	mir:614887
BONE & MUSCLE DISEASE	mir:610678
BRAIN DISEASE	mir:216360
BONE & MUSCLE DISEASE	mir:231005

Fig. 2. Few sample diseases and its miRNA values

3.1 Gene Ontology

The GO define concepts/classes used to express gene function, and associations between these concepts. It classifies functions along three aspects: **molecular function** molecular activities of gene products, **cellular component** where gene products are active, **biological process** pathways and larger processes made up of the activities of multiple gene products. In our proposed framework, we have created the gene ontology and maintained the entire gene and the associated disease details, user can register and login with the system to get his gene related details We are proposing cross ontology to manipulate the Protein values from three sub ontologies for identifying the gene attacked disease. Also our proposed system, focus on intrinsic and extrinsic. An example of the dataset is shown in Fig. 3 it contains the disease id, disease, gene-id affecting it and the disease type–intrinsic or extrinsic. Based on ***cellular component,*** **molecular** ***function*** and ***biological process*** values intrinsic and extrinsic calculation would be manipulated.

3.2 Collaborative Filtering

In our proposed work, we used semantic mining for logical analysis. User get the details from Ontology base with help of **Collaborative filtering,** also the gene disease and symptoms with the help of logical calculation for protein value of human and normal value for particular gene id, then cross ontology process we get the BP, CC&MF value for gene to identify the gene have Intrinsic or extrinsic. If the normal protein value of human is compare to lower than that of calculating cross ontology value (comparing BP&CC or MF&CC or MF&BP) is said to be Intrinsic. If the normal protein value of human is compare to higher than that of calculating cross ontology value (comparing BP&CC or MF&CC or MF&BP) is said to be extrinsic.

id	name	geneid	ie
OMIM:130650	BECKWITH-WIEDEMANN SYNDROME	NSD1 (64324), CDKN1C (1028), H19 (283120), KCNQ1OT1 (10984), H19-IC	Intrinsic
OMIM:613812	BILE ACID SYNTHESIS DEFECT, CONGENITAL, 3	CYP7B1 (9420)	extrinsic
OMIM:615085	OSTEOPETROSIS, AUTOSOMAL RECESSIVE 8	SNX10 (29887),IDS (3423),ITCH (83737),GNPTAB (79158),PIEZO1 (9780),	Intrinsic
OMIM:604273	ATPASE DEFICIENCY, NUCLEAR-ENCODED	ATPAF2 (91647),FUCA1 (2517),CYBB (1536),GNS (2799)	extrinsic
OMIM:266150	PYRUVATE CARBOXYLASE DEFICIENCY	PC (5091),HNF4A (3172),HMOX1 (3162),GNS (2799)	extrinsic
OMIM:222700	LYSINURIC PROTEIN INTOLERANCE	SLC7A7 (9056),PIEZO1 (9780),IDUA (3425),GNS (2799)	
OMIM:121300	COPROPORPHYRIA, HEREDITARY	CPOX (1371),PCCB (5096),BSCL2 (26580).	extrinsic
OMIM:251290	BAND-LIKE CALCIFICATION WITH SIMPLIFIED GYRATION AND POLYMICROGYRIA	OCLN (100506658),ABCA1 (19),IDUA (3425)	Intrinsic
OMIM:230900	GAUCHER DISEASE, TYPE II	GBA (2629),IDUA (3425),HNF4A (3172)	intrinsic
OMIM:201100	ACRODERMATITIS ENTEROPATHICA, ZINC-DEFICIENCY TYPE	SLC39A4 (55630)	extrinsic
OMIM:214500	CHEDIAK-HIGASHI SYNDROME	LYST (1130),IDUA (3425),CPT2 (1376),PEX26 (55670)	extrinsic
OMIM:230000	FUCOSIDOSIS	FUCA1 (2517),KCNQ1OT1 (10984),PCCB (5096),PHKB (5257),CPT2 (1376)	Intrinsic
OMIM:616278	BILE ACID SYNTHESIS DEFECT, CONGENITAL, 5	ABCD3 (5825),HNF4A (3172),BOLA3 (388962),IDUA (3425),CPT2 (1376)	Intrinsic
OMIM:610293	GLYCOSYLPHOSPHATIDYLINOSITOL DEFICIENCY	PIGM (93183),AGPAT2 (10555),PIEZO1 (9780),HGSNAT (138050)	Intrinsic
OMIM:212140	CARNITINE DEFICIENCY, SYSTEMIC PRIMARY	SLC22A5 (6584),SLC39A4 (55630),BSCL2 (26580),LIPA (3988).	extrinsic
OMIM:276700	TYROSINEMIA, TYPE I	FAH (2184),KCNQ1OT1 (10984),SLC30A10 (55532),CPT2 (1376)	Intrinsic

Fig. 3. Represents table contacting disease id, disease, gene-id affecting it and the disease type–intrinsic or extrinsic

MOAL (Multi Ontology data mining at All Levels) algorithm is developed for mining the cross ontology relationship between the ontologies. MOAL mines cross ontology an association rule [8] that involves different formulation of Support and Confidence adding to each rule a p-value threshold computed using the Chi-square test. The drawback is chi-square test does not give us much information about the strength of the relationship. The major disadvantage is the time complexity of the algorithm increases. This is because of the frequent access of database. This algorithm uses modified Apriori algorithm as their mining strategy and the items are non-weighted. A modified version of Apriori algorithm is used for mining rules [9] where the items are non-weighted. It uses either MF Ontology or multi Ontology. Here it mines the cross-ontology association rules, i.e. rules that involve GO terms present in the three sub-ontologies of GO. The mined associated gene list for a sample disease is shown in Fig. 4. By using collaborative filtering, user get the details about the gene id for cross ontology technique we have to compare the protein value and getting BP& MF value, or MF&CC value or CC&BP value getting the gene disease and symptoms for user requirements.

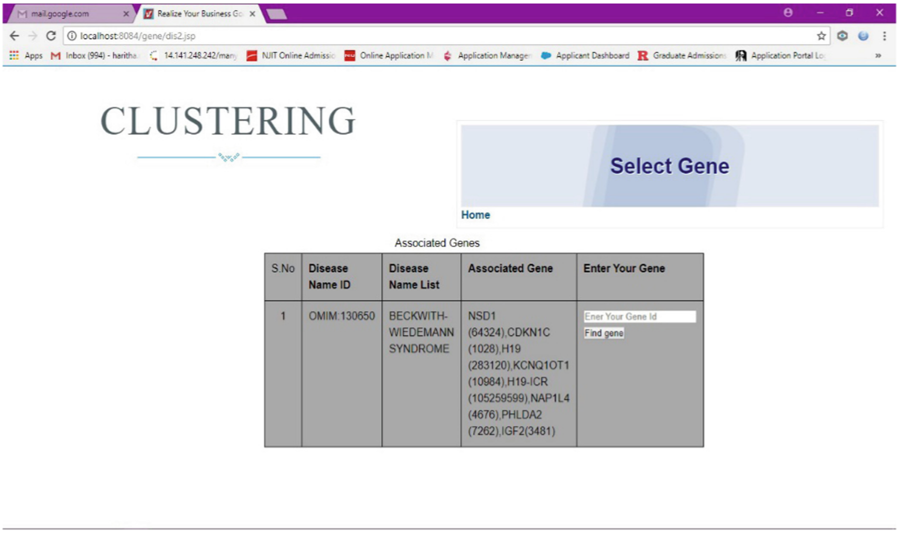


Fig. 4. Associated gene list is displayed for each disease.

3.3 Depth First Search

Depth first search in relation to specific domains such as searching for solutions in artificial intelligence. The graph to be traversed is often either too large to visit in its entirety or infinite. In this cases search is performed to a depth due to limited resources. DFS is used after Collaborative Filtering; this is done to filter results with respect to severity by considering protein values and affiliated genes.

When DF search is performed to a limited depth the time is still linear in terms to number of expanded vertices. Edges even if this number is not the same as the capacity of the entire graph because some vertices may be searched more than once and others not at all but the space complexity of this variant of DFS is only proportional to the depth limit. As a result is much smaller than the space needed for searching to the same depth using BFS. DF search also lends itself much better to heuristic methods for choosing a likely-looking branch.

3.4 Regulatory Modules

A large amount of cell's activity is controlled as a network of interacting modules. We present a probabilistic method for identifying regulatory modules from gene expression data. It identifies modules of co-regulated genes, their regulators and the circumstances under which regulation occurs, generating testable hypotheses in the form 'regulator X regulates module Y under conditions W'. We applied the method to a genetic disease "Saccharomyces cerevisiae" expression data set, showing its ability to identify functionally coherent modules and their correct regulators.

We propose an integrative framework that infers gene regulatory modules from the cell cycle of cancer cells by incorporating multiple sources of biological data, including gene expression profiles, gene ontology, and molecular interaction. We reconstructed regulatory modules to infer the underlying regulatory relationships. Four regulatory network motifs were identified from the interaction network. The association between each transcription factor and predicted target gene groups was examined by training a recurrent neural network. Finally we used a fusion technique to integrate both gene ontology and regulatory modules to improve the accuracy of genetic disease detection.

3.5 Multiplicative Update Algorithm

A novel approach to identify miRNAs and transcription factors co-regulatory modules (miRNA-TF-gene) is essential. To this end, an objective function is constructed by integrating the miRNA/TF/gene expression profiles, target site information (miRNA-gene and TF-gene regulations) as well as the protein-protein interactions. In order to obtain the optimal solution of the objective function, we solve the optimization model function effectively by iterative multiplicative updating algorithm.

Finally, Bayesian hierarchical clustering algorithm is used to produce trees with arbitrary branching structure at each node known as rose trees as in Fig. 5 and the textual format of the tree which can be stored in the local drive and also in the public cloud for remote access is shown in Fig. 6. Weget these trees as blend over partitions of a data set and use a computationally efficient greedy agglomerative algorithm to find the rose trees which have high marginal likelihood given the data.

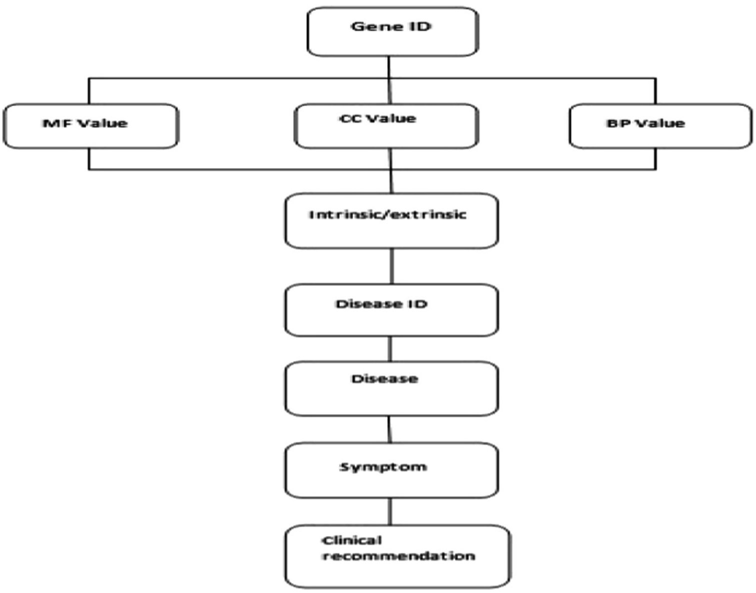
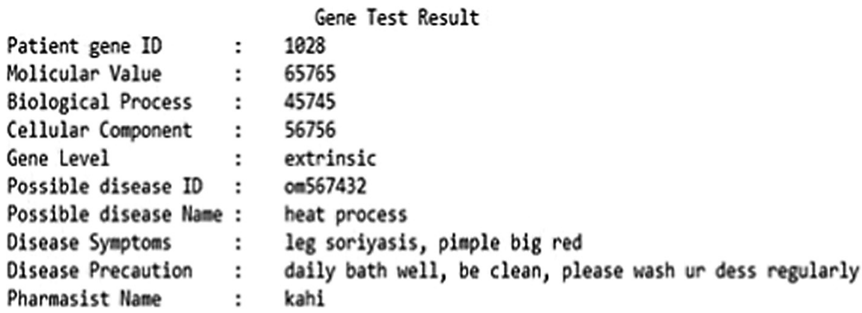


Fig. 5. Results are represented in Bayesian Rose Tree


Gene Test Result

Patient gene ID	:	1028
Molicular Value	:	65765
Biological Process	:	45745
Cellular Component	:	56756
Gene Level	:	extrinsic
Possible disease ID	:	om567432
Possible disease Name	:	heat process
Disease Symptoms	:	leg soriyasis, pimple big red
Disease Precaution	:	daily bath well, be clean, please wash ur dess regularly
Pharmasist Name	:	kahi

Fig. 6. Textual format of the tree which can be stored in the local drive and also in the public cloud for remote access

4 Experimental Results

The knowledge base is constructed from the various heterogeneous data sources [7]. Increasingly large amounts of valuable, but heterogeneous and sparse, biomolecular data and information are characterizing life sciences and thus there is no single homogeneous source. Thus from these sources the scores of each sub-ontologies protein values of each MF, CC, BP values are mined from different sources, similarly the TF, miRNA and the associated genes are mined from various sources along with the disease id (OMIM id).

Knowledge Base (KB) is technology that stores various complex unstructured and structured information. Our Knowledge base is constructed using the complex datasets like the protein and genomic values from various heterogeneous sources. And Fig. 7 displays the few Cellular Component sub ontologies, Gene ID, its score and the affiliated gene list. All these data are extracted from various different sources and are put together in our knowledge base, which is further used for detection and diagnosis of the genetic diseases through processing.

A web based framework is developed by creating the Genomic and Proteomic Knowledge Base (GPKB) which helps a common man in detecting the genetic diseases associated with his gene. A common man through his gene test may know the Genomic and Proteomic values. On considering the scientists they might know the disease name and would require information like list of those genes affected due to this disease, or might require the protein values to conduct his research. Our system aids the scientist society in listing the affiliated gene list, protein values, disease type (Intrinsic/ Extrinsic), symptoms and clinical recommendations for a single genetic disease. Lastly the doctors would know the disease name and would need information regarding its symptoms and clinical recommendation, our systems aids for such usage also.

The final results required by a common man are represented in a Bayesian rose tree format, which will represent the data in tree as well as in text format. Thus, when the same user returns the page instead of carrying out the entire process again the already existing results can be fetched and displayed. Figure 8 is the ER diagram representing the relational database schema. The Figs. 9 and 10 give the representation of the web application showing the disease category along with its count, the diseases under each category.

name	goid	score	affiliating genes
plasma membrane	GO:0005886	9.8	SLC3A1(6519),SLC3A2(6520),SLC7A2(6542),SLC7A5(8140)
extracellular exosome	GO:0070062	9.63	ASL(435),ASS1(445),SLC3A1(6519),SLC3A2(6520),SLC7A5
basolateral plasma membrane	GO:0016323	9.13	SLC7A6(9057),SLC7A7(9056),SLC7A8(23428)
integral component of plasma membrane	GO:0005887	9.1	SLC3A1(6519),SLC7A2(6542),SLC7A5(8140),SLC7A6(9057)
mitochondrial inner membrane	GO:0005743	9.26	ALAS2(212),CPOX(1371),FECH(2235),PPOX(5498)
mitochondrion	GO:0005739	9.17	ALAS1(211),ALAS2(212),CPOX(1371),FECH(2235),LIG3(39
bicellular tight junction	GO:0005923	8.62	JAM3(83700),OCLN(100506658)
lysosome	GO:0005764	9.16	GBA(2629),PSAP(5660)
lysosomal membrane	GO:0005765	8.96	GBA(2629),PSAP(5660)
lysosomal membrane	GO:0005765	8.96	GBA(2629),PSAP(5660)
late endosome	GO:0005770	8.62	SLC30A2(7780),SLC30A4(7782)
extracellular space	GO:0005615	9.76	CAT(847),CLEC11A(6320),CSF2(1437),CSF3(1440),IFNG(3
secretory granule	GO:0030141	9.43	CYBA(1535),IL1B(3553),MPO(4353)
phagolysosome	GO:0032010	9.13	NCF1(653361),NCF2(4688),NCF4(4689)
NADPH oxidase complex	GO:0043020	9.1	CYBA(1535),CYBB(1536),NCF1(653361),NCF2(4688),NCF4(
cytosol	GO:0005829	9.1	AFP(174),ALAD(210),CYCS(54205),FAH(2184),GSTZ1(2954
lysosome	GO:0005764	9.43	MYO5A(4644),RAB27A(5873),UNC13D(201294)

Fig. 7. Few Cellular Component sub ontologies, Gene ID, its score and the affiliated gene list

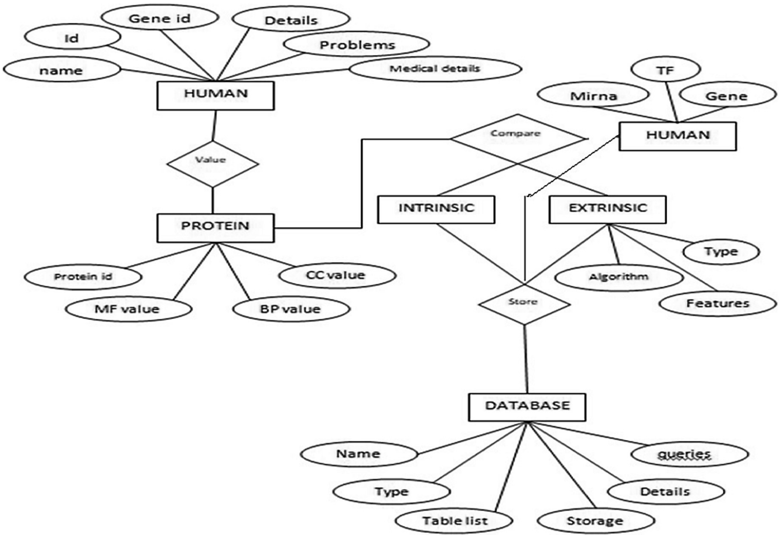


Fig. 8. The relational database schema of the proposed system using ER-diagram

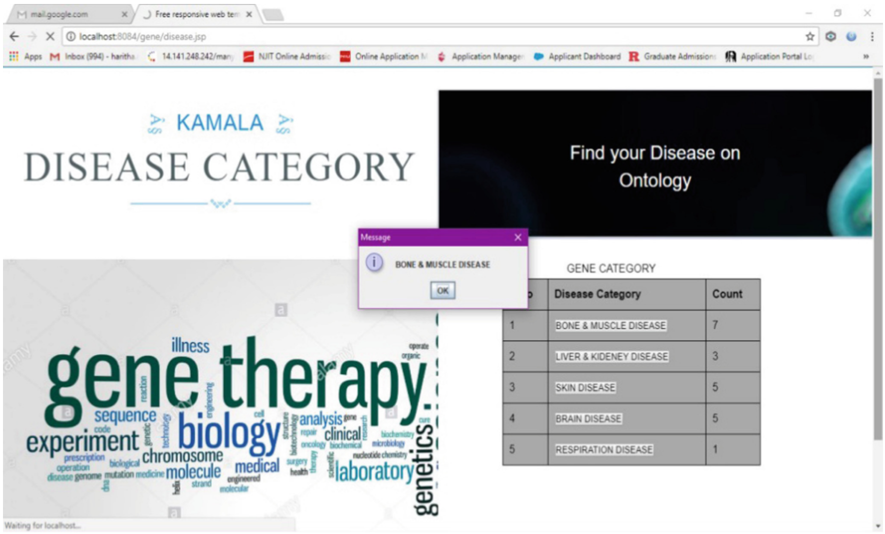


Fig. 9. Categories of diseases and its count

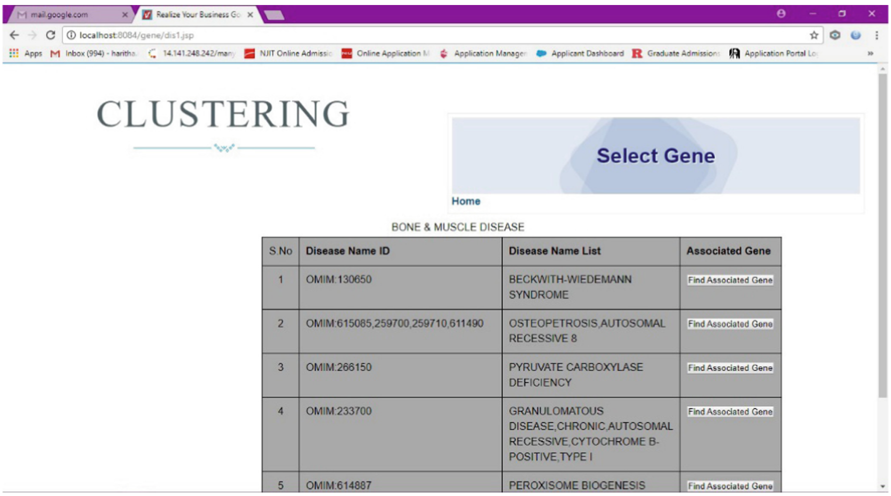


Fig. 10. List of diseases in the category Bone & Muscle disease

5 Conclusion

Relevant progresses in biotechnology and system biology are creating a remarkable amount of biomolecular data and semantic annotations; they increase in number and quality, but are dispersed and only partially connected. Integration and mining of these distributed and evolving data and information have the high potential of discovering hidden biomedical knowledge useful in understanding complex biological phenomena, normal or pathological, and ultimately of enhancing diagnosis, prognosis and treatment; but such integration poses huge challenges. Our work has tackled them by developing a novel and generalized way to define and easily maintain updated and extend an integration of many evolving and heterogeneous data sources. Our approach proved useful to extract biomedical knowledge about complex biological processes and diseases.

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Machine Learning Predictive Model for Industry 4.0

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Abstract. In an Industry 4.0 environment, the data generated by sensors networks requires machine learning and data analysis techniques. Thus, organizations face both new opportunities and challenges, one of them is predictive analysis using computer tools capable of detecting patterns in the analyzed data from the same rules that can be used to formulate predictions. The Heating, Ventilation and Air Conditioning Systems (HVAC) control in an important number of industries: indoor climate, air's temperature, humidity and pressure, creating an optimal production environment. In accordance, a case study is presented, in it a HVAC dataset was used to test the performance of the equipment and observe whether it maintains temperatures in an optimal range. The aim of this paper is making use of machine learning algorithms for the design of predictive models in the Industry 4.0 environment, using the previously mentioned dataset.

Keywords: Industry 4.0 · Internet of Things · Predictive maintenance
Sensors · Machine learning · Knowledge management processes
Dynamic knowledge integration

1 Introduction

Recent changes and important contribution in the fields of artificial intelligence, robotics and automation technologies are having a strong impact on knowledge management processes that form the basis for decision making in industrial, health, home, financial, business, social networks and many others, in order to create smart environments [8, 16, 24, 35, 38, 48]. In addition, many terms have been coined, Smart Manufacturing, Smart Production, Industrial Internet, i4.0, Connected Industry 4.0, to identify all that is encompassed by the paradigm of the fourth industrial revolution. These terms are representative of the changes in the industrial model know so far, by the irruption of the Internet of Things (IoT), Wireless Sensor Networks (WSN), cloud computing and Cyber physical systems (CPS) [17, 23, 33].

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These recent challenges of industry field require technologies that have been used previously for the construction of dynamic, intelligent, flexible and open applications, capable of working in a real time environment [13, 14, 27].

These emerging technologies have renewed the interest of researchers, universities, companies and governments in applying predictive analysis to the industrial environment. In this sub-discipline of data analysis, they found techniques and tools for the development of models capable of predicting future events, failures or behavior [34, 43]. Prediction models are created by leveraging statistical techniques, machine learning (ML) or data mining to extract behavioral patterns found in a dataset and when risks and opportunities are identified in these patterns [19, 32].

Several intelligent systems have been developed using sensors [46, 47, 52]. The incorporation of sensors in infrastructure, ambient intelligence, products, manufacturing equipment or production monitoring is an implicit component of the Industry 40 paradigm. Some authors insist that sensors networks still require development, although there are extensive proposals in the field of sensor networks, their use still presents many challenges in automatic data fusion, processing and the integration of large volumes of data generated by them [44, 45, 53].

In order to obtain useful information in the decision – making processes, such as prediction to anticipate failures, demands, production, sales volume, an overwhelming amount of data need to be processed, this still remains a challenge [5]. This paper is divided as follows: first section provides a brief background on Industry 4.0, predictive maintenance, the application of Machine Learning (ML) in the context of Industry 4.0 and prediction of failure. Then the conducted case study is described. Finally results showing the accuracy of applied Logistic Regression and Random Forest are outlined and the conclusion and future work are presented.

2 Industry 4.0

The concept of Industry 4.0 was born in Germany during the year 2011, when the government and the business sector, led by Bosch, formed a research group to find a common framework that would allow for the application of new technologies. They delivered their first report in 2012, it was presented in public at the Hannover Fair in 2013. This was the beginning of the paradigm that is now known as the fourth industrial revolution, different countries refer to it by different terms according the initiatives developed in those countries. It is applied within the industrial ecosystem both at the macro level at SMEs [33, 51].

In addition to the enablers such as IoT, CPS, Big Data, Cybersecurity, 3D printing, there is a large number of requirements for the implementation of Industry 4.0. This research addresses predictive maintenance from the perspective of the data generated by sensors. In this case temperature sensors on HVAC systems installed on 20 buildings. The aim is detecting failures in HVAC equipment that obtain an extreme temperature, through the data collected by the sensors.

2.1 Predictive Maintenance

The concept of predictive maintenance is not new. However, as an axis of development for the adoption of the industry 4.0 scheme, predictive maintenance is the subject of research. The aim is to obtain models that reduce uncertainty in diagnoses. Ballesteros in [2] lists basic conditions that must be satisfied in order to determine that an organization has a predictive maintenance scheme:

- When the operation of a piece of equipment is monitored and measured, it must be done in a non-intrusive way, under normal operating conditions.
- The variable that has to be measured in order to make the predictions, must fulfill conditions of: repeatability, analysis, parametrization and diagnosis.
- The results and the values of the measures can be expressed in physical units or correlated indexes.

There is a tendency to expand the research that allows applying predictive models in industrial environments presents the development of a predictive maintenance system for power equipment, other authors propose its application to wind turbines or the prediction of anomalies in triaxial machines [6, 25]. These works share common elements with: they are based on machine learning (ML) methods and pursue the development of ML algorithms that increase the accuracy of their predictions [34, 42].

2.2 Machine Learning for Prediction

There are important contributions on the field of artificial intelligence and its techniques such as Case Based Reasoning (CBR) [3, 9, 10, 13, 18] and machine learning algorithms, in order to make predictions, improve the results and to better generalize the dataset. Therefore, it is necessary construct models that facilitate prediction and analysis to take decision [12, 21, 22, 38].

In the last decades artificial intelligence and Machine Learning (ML) techniques have transcended into a great variety of areas such as neuroscience, social media [7, 38], scientific, health [28], industrial and economic activities, and a large number of scientific works have been published on this topic. This is indicative of its importance [1, 7, 29].

Thanks to Artificial Intelligence and Machine Learning (ML) algorithms, we not only develop solutions for processing of large data in the era of the Internet of Things and Big Data, in [36, 37] the authors using Bayesian Filters and other algorithms to processing and make prediction with sensor signals. On the basis of extracted features and patterns we can construct predictive models using data analysis and ML algorithms [40, 41].

In a current real environment, a dataset has to be obtained before ML techniques can be applied [11, 15, 49]. They will subsequently go through different phases, such as a pre-processing, data training and application of a learning model and finally an evaluation phase. From the description made in [54], a scheme of ML stages has been designed, in Fig. 1 they are described in the order in which they are performed. Data pre-processing is carried out in order to prepare raw data. At this stage data are unstructured, noisy, incomplete and inconsistent, and they are transformed to be used as inputs for the algorithms selected for training. Subsequently, test data will be used to train the developed model, also predictions that are extracted from the new set of test data will be obtained.

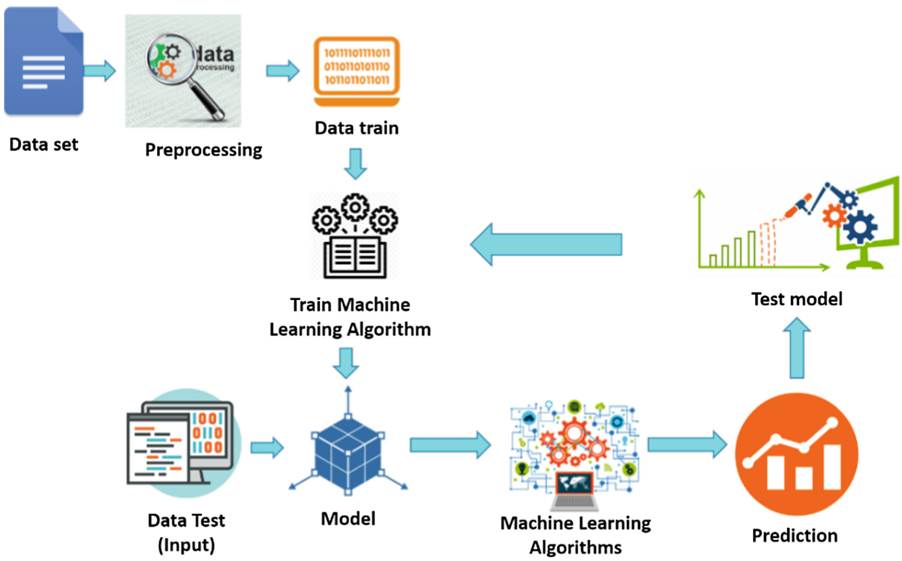

Fig. 1. Machine learning stages

To evaluate the model, error estimation data and the results of statistical tests are analyzed, these analyses are used to adjust the parameters of the applied algorithms and to determine if the use of other algorithms is necessary [32].

3 Industry 4.0 Environment Case Study

The Heating, Ventilation and Air Conditioning Systems (HVAC) control indoor climate, air's temperature, humidity and pressure, creating an optimal production environment on industrial buildings. These equipment are crucial for the operation of a factory in the context of Industry 4.0. However routine maintenance do not always identify their failures.

The aim of predictive maintenance in Industry 4.0 is extend equipment life using different tools and techniques to identify abnormal patterns such as: vibration, temperature or balance. In accordance with the importance of HVAC Systems, a case study is presented. Following section describes a free dataset from temperature sensors installed on Heating, Ventilation and Air Conditioning System (HVAC) in 20 buildings [30].

3.1 Dataset Description

In this case study, a dataset that is organized by columns was used. It contains the optimal temperature record and the real values measured by sensors in buildings. It was used to analyze the behavior of an HVAC air conditioning system [30] and determine if the equipment is failing to keep the indoor temperatures in an optimal range.

This dataset contains a total of 8000 (eight thousand) temperature records (TargetTemp) captured by a sensor network, installed in a set of buildings who were between 0 and 30 years old, their age corresponded to age of the HVAC systems, identified by the independent variable 'SystemAge'. Table 1 shows the structure of the dataset and its variables:

Table 1. Dataset

Column	Description
Date	Date of measurement
Time	Measurement time
TargetTemp	Temperature measured by the sensor
Actualtemp	Optimal temperature for the system
System	System model
SystemAge	Age of the HVAC system
BuildingID	Building identifier

3.2 Dataset Pre-processing

Several authors have used algorithms to perform feature selection and preprocessing data [20, 39]. The system established a range for the normal temperatures and two types of alarm that indicate extreme temperatures and therefore a possible failure. These are described in Table 2 as follows:

- Normal: within 5^{o} of the optimum temperature.
- Cold: 5^{o} colder than the optimum temperature. It is classified as extreme temperature and a sign of possible failure.
- Hot: 5^{o} hotter than the optimum temperature. Also it is classified as extreme temperature and a sign of possible failure.

Table 2. Normal and extreme temperature

Temperature	Description
Normal	IF(TargetTemp - Actualtemp) < 5
Alarm: extreme temperature – cold	IF(TargetTemp - Actualtemp) > 5
Alarm: extreme temperature – hot	IF(|TargetTemp - Actualtemp|) < −5

Two labels are added to the dataset 'Difference' and 'FilterDifference', in the first, the values obtained from the difference between 'TargetTemp' and 'Actualtemp' are stored. In 'FilterDifference' the binary conversion is carried out assigning *0* to the normal temperatures and *1* to the alarms for extreme temperature.

4 Results

Once the data were pre-processed, the extended dataset was used to divide the data into data train and data_test, the former was used to apply Machine Learning algorithms to obtain the prediction model. This model was then validated with the data_test. For the training of the data, two supervised learning algorithms will be used: Logistic Regression and Random Forest (RF) to evaluate the accuracy of each one in the prediction.

Logistic regression is a machine learning technique, statistical-inferential, which dates back to the 1960s, used in current scientific research. It is considered an extension of linear regression models, the difference is that is has a categorical variable capable of being binomial (0, 1) or multiple [32]. For the development of this research, the dataset was pre-processed so that the categorical variable (y) can be binomial. Applying the logistic regression analysis, we assume that $y = 1$, when the sensor sends an extreme temperature and $y = 0$ when the measured temperature ('TargetTemp') is within the normal range. Considering the above, the probability that the HVAC system is presenting a failure by recording extreme temperatures is given in Eq. 1:

$$P(y = 0) = 1 - P(y = 1) \tag{1}$$

$$Y = f(B_0 + B_1X_1 + B_2X_2 + \ldots + B_nX_n) + \mathrm{u} \tag{2}$$

Where u is the error term and f the logistic function:

$$f(z) = \frac{e^z}{1 + e^z} \tag{3}$$

So that:

$$E[Y] = P = P(Y = 1) = \frac{e^{B_0 + B_1X_1 + B_2X_2 + \ldots + B_nX_n}}{1 + e^{B_0 + B_1X_1 + B_2X_2 + \ldots + B_nX_n}} \tag{4}$$

$$ln\left(\frac{P}{1 - P}\right) = B_0X_0 + B_1X_1 + B_2X_2 + \ldots + B_nX_n \tag{5}$$

Where the set of independent variables is given by: $x_{1,}x_{2,}\ldots,x_{n,}$ where n is the total number. To predict the probability (P), we use the ***logit*** function of the binary logistic regression model represented in Eq. 5. It is indicated how by means of the logistic regression model, an accuracy of 0.651375 can be obtained in the prediction of values. For the purposes of this dataset, the SystemAge column was taken as a characteristic and, as a label, the FilterDifference column, the total data used was 8000 records.

The accuracy results presented by this prediction show a value of 0.65375. The values of X_train and X_test indicated that 5600 and 2400 values are taken respectively. After applying the logistic regression model and obtaining its percentage of precision, the random forest classification algorithm was applied to the dataset. In this regard, various authors [26, 31] confirm that the random forest classifier is an effective tool for the prediction processes.

This classifier is also considered as a nonparametric statistical method that allows to address regression and classification problems of two or more classes. The recent research of Scornet *et al.* [50] cited by [26] demonstrates the coherence of RF and its performance parameters is very low.

In [4] random forest is defined as follows: *"... a random forest is a classifier consisting if a collection of tree-structured classifiers {h* ($\boldsymbol{x}$,Θ_k), *k = 1,...} where the {*Θ_k*} are independent identically distributed random vectors and each tree casts a unit vote for the most popular class at input* **x**...*"*.

The values that were generated in the prediction show an accuracy of 0.6425 for a total of 5600 records used as training data and 2400 for the test data model. The difference in the effectiveness of each is 0.0125 with a more optimal result of the logistic regression model when 70% of the data was used for training and a 30% for the tests in each machine learning algortihm. A predecition of failure (1) was obtained, malfunctions tended to occur in equipment that was between 15 and 30 years old.

5 Conclusions and Future Work

The proposed prediction model still in its early stage of development. This allows for the implementation of other machine learning techniques and for the use of larger datasets obtained from sensors networks installed in order environment. The results for the dataset used in this case study, show that the precision of the logistic regression model is similar to that of random forest, in predicting malfunction in the HVAC system.

The modeling and integration of the large volumes of industrial data that are generated by machines and collected by sensors, is a clear problem that still needs to be addressed in future researches. Thus, testing with other machine learning methods for classification, training and prediction. These test will provide the grounds for the development of algorithms that generate predictive models adapted for organizations, in the context of Industry 4.0.

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Model of Integration of Business Intelligence and Knowledge Management

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Abstract. The correct integration between business intelligence (BI) and knowledge management (KM) allows organizations to make decisions in accordance with their strategic objectives, through accurate and timely information. The present article presents a model that uses emerging technologies to integrate both tools, considering also the technological and knowledge assets (which are key elements in decision making) in order to enable the cognitive download of company employees, innovation and operational excellence.

Keywords: Business intelligence · Knowledge management
Knowledge asset · Operational excellence

1 Introduction

At present, companies are subject to an environment that is changing, dynamic and difficult to predict. Therefore, in order to facilitate business tasks and meet the information requirements that the dynamism of the business claims, it is necessary to apply certain tools and develop a platform that integrates them.

As organizations must face a changing environment characterized by controllable and uncontrollable risks [1], top management is responsible for setting strategic objectives that allow companies to successfully face such environment. The traditional approach argues that the role of the CEO is to control and transform such strategic objectives based on progressive changes, and that their main function as a rational actor is to analyse the information in their power and influence emerging trends. All this in order to make efficient management and better determinations [2].

However, this approach creates two points of discussion: first, work takes more time to be done and does not respond in a timely manner to current needs, as there might exist delays and human failures in the information flows and the decision making process. Second, organizations are not encouraged to learn and automate knowledge. In consequence, companies' technological capacity and knowledge fundaments are not properly managed.

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https://doi.org/10.1007/978-3-319-95204-8_43

Once the need for assertiveness in decision making is identified, business intelligence is proposed as a viable solution given that, together with knowledge management, these tools concentrate organizations' most important resource: knowledge. In this way, it is possible to attain results that match organizations' objectives and evolution. Additionally, strategies like artificial intelligence, machine learning and knowledge automation must be integrated in order to implement computational algorithms in decision-making and in business intelligence. This will allow minimizing the errors caused by failures in human perception.

2 Background

2.1 Business Intelligence

Business intelligence, in its traditional connotation, was born in 1958 when H.P. Luhn, an employee of International Business Machines Corp. (IBM), published an article in the IBM Journal about "Business Intelligence System". The column was referring to a system that collects and accepts information, manages corporative documents and provides appropriate and timely data in the required places through efficient processing. As a result, such system facilitated communication and, therefore, interrelation [3]. The cycle proposed by IBM is shown in Fig. 1.

Business intelligence, in a later definition, refers to the compendium of techniques and tools that allow the transformation of large amounts of data coming from different sources into meaningful information, in order to make decisions that improve organizational performance [4].

Therefore, BI is supported in knowledge fundament and technological capacity, which results in a higher level of addressing, easier consultations and organizational flexibility. The effective use of business intelligence is considered an essential factor for companies' competitiveness, especially within changing markets [5].

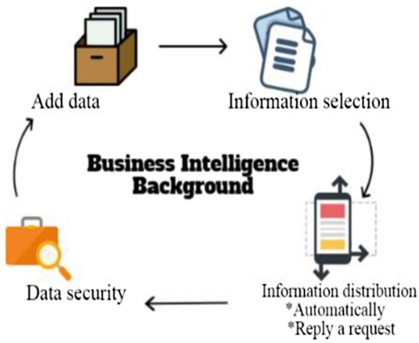

Fig. 1. Business intelligence background. Adapted: [6]. Own preparation

2.2 Knowledge Management

Knowledge management is based on the administration of resources that help organizations develop processes to acquire and share intellectual capital. It brings benefits such as quality improvement, cost reduction, increase and preservation of knowledge assets, streamlining of processes, and improvement of information flow and dissemination [7].

This tool is mainly characterized by its capacity to turn a company into a "learning organization", which consists of transforming the information that each individual has into functional knowledge for the company; that is to say, transferring knowledge from the place where it is generated to where it will be used [8].

Proper knowledge management allows the integration and implementation of a business management model that helps attaining better results, influences planning and assignment of responsibilities, as well as integrated policy, continuous improvement and information control [9]. Knowledge management must be oriented towards intangible management and total quality, meaning human, organizational and relational capital, which is a way to satisfy customers, shareholders, employees and the society [10] (Fig. 2).

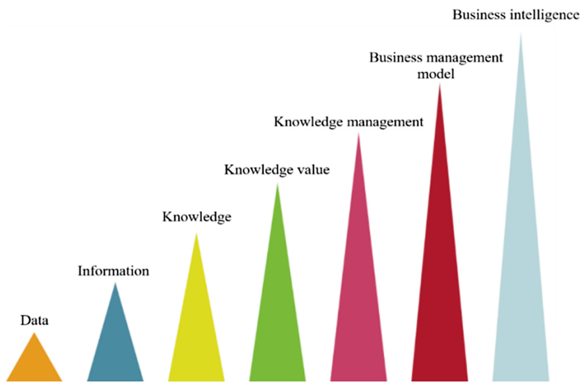

Fig. 2. Knowledge-based business intelligence process. Adapted: [11]. Own preparation

2.3 Technological Infrastructure

The technological component is distinctive in the creation of business intelligence. This is due to the evolution of systems and the fact that, given the needs of human beings, these have become necessary tools for knowledge workers and decision support [12]. Technological infrastructure is also relevant in the adoption of knowledge management principles when it comes to integrating and using organizations' valuable resources, which is done by the means of knowledge automation. This helps keeping the knowledge fundament up to date in order to close the gap between knowledge workers and the system.

McKinsey & Company, an organization focused on solving strategic management problems, has called automation of knowledge work to the use of computers to perform tasks that depend on complex analysis, judgments and creative problem solving [13]. The implementation of this tool implies the adoption of expert systems, which use artificial intelligence based upon intangible assets to predict the behaviour of the system [12] and decrease uncertainty about future events that will affect a company.

2.4 Knowledge Automation

Knowledge automation is directly linked to automatic learning, which is an important tool for wise personnel management. It is composed of five moments: (1) data collection, (2) pre-processing, (3) extraction of characteristics, (4) learner profile and (5) adaptation (recommendation). To some extent, knowledge automation allows the exploitation of users' knowledge through neural network models, for example, that allow predicting learners' behaviour while they use the systems. This makes it possible to form clusters, do research recommendations or create classifications according to the type of learning [14].

3 Relationship Between Business Intelligence and Knowledge Management

In the last decade, business intelligence has become an essential tool for organizations, as it provides a broad picture that supports decision making and improves organizational performance. However, the effectiveness of BI lies in the ability to present and use information in a timely manner [15]. Hence, BI should be merged with knowledge management, as this combination of tools allows the optimal use of data, and improves its availability, consistency and quality.

Recent studies of durability of organizations have highlighted the importance of knowledge management as a key element for companies' success, survival and extended lifespan [16]. Strategies that allow intelligent companies to undertake actions that grant hard-to-imitate advantages over competitors are based upon KM. Such advantages consist of aspects such as knowledge, resources and fixed and financial assets [11]. The first of these elements, knowledge, is the most difficult to reproduce, as shown in Fig. 3.

Fig. 3. Difficulty of imitation of organizational resources. Adapted: [11]. Own preparation

The implementation of knowledge management together with business intelligence guarantees the successful execution of organizations' strategies, as it handles different variables that converge in a company and successfully provides services and products in complex and dissimilar environments. Therefore, KM and BI grant a superior understanding of the unstable business context, so that better interpretation of results and decision making is achieved [17].

BI systems combine data collection, information storage and knowledge management with analytical tools to understand and interpret complex information. This interaction is shown in Fig. 4 [18].

Fig. 4. Combination of elements of business intelligence. Adapted: [18]. Own preparation

BI and KM have several aspects in common. For example, they use the same methodology to measure their performance, they both improve the daily performance of the business, need top management to be interested on increasing the quality of the processes, are receptive to leadership and organizational culture, and are founded on information [17] and emerging technologies. In addition, they both focus on people, who create, transmit, use properly managed knowledge, and also take responsibility for making and executing the right decisions based on BI [18]. This approach in people is supported by emerging technologies such as artificial intelligence, so that the human resource can engage in creative and inventive work [19].

4 Model of Integration of BI and KM

Integration of knowledge management and business intelligence tools is possible through the acquisition of structured and unstructured data, which are supported by artificial intelligence. After being stored and interpreted, such data will allow the successful implementation of knowledge automation.

Structured and unstructured data converge thanks to the interaction between the people involved, such as data scientists, domain experts and knowledge workers; and through technological alternatives such as internal communication networks, custom software, intranet and Balanced Scorecards. These tools will provide work team members with information and knowledge supported by data from internal and external sources, will increase speed and effectiveness in decision making, and will respond to the requirements, needs, opportunities and problems of the business. An initial approach to a model of integration of KM and BI is shown in Fig. 5.

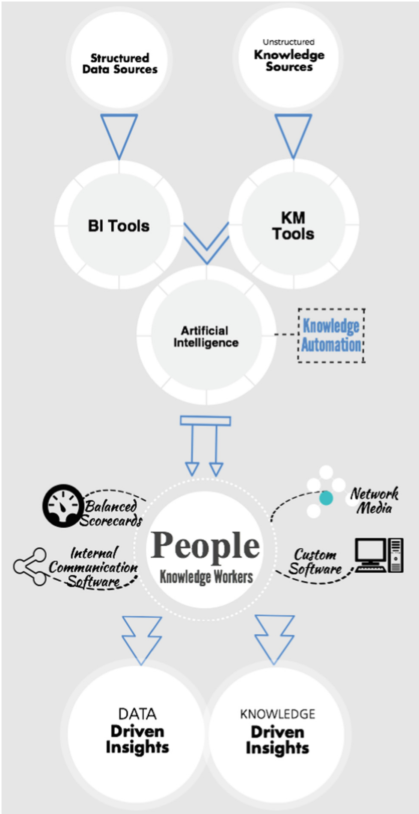

Fig. 5. Model of integration of KM & BI focused on people. Own preparation.

Bearing in mind that knowledge is the most important asset of a company and that it participates in all operations, its link to organizational planning and the definition of the strategic objective is essential. The model of integration hereby presented seeks the effectiveness of knowledge management and, therefore, the alignment of organizations' resources and processes in order to achieve the strategic objectives. This proposal transforms the traditional BI approach where decision makers were the business directors, and attributes this task to machines: intelligent agents capable of learning and programmed to follow the business process, which is structured by: creation, storage, transfer and application of knowledge.

In order to implement knowledge management, it is necessary to count on a company characterized by learning through the transfer of knowledge in terms of socialization (tacit to tacit), externalization (tacit to explicit), internalization (explicit to tacit) or combination (explicit to explicit), to turn such knowledge into functional knowledge. This contributes to the reinforcement of the knowledge asset, which creates value, is responsible for producing new and exchangeable knowledge and brings future benefits.

Knowledge assets should focus on meeting the needs, concerns and problems that arise in organizations, that is to say, they should support the planning process of strategic objectives, create strategic innovation and operational excellence. In order to meet business requirements, this model is based upon key elements of human and data knowledge, which together with artificial intelligence and their respective tools will manage knowledge and enable timely decision-making. The latter will be tracked through analysis results and indicators.

When knowledge management machines are considered to be capable of making decisive judgments, the risk of common human miscalculations is reduced, the decision-making process gains speed and decisions are executed in real time. In addition, the importance of this model lies on the opportunity to allow the cognitive download of employees, which implies eliminating the need to make mechanical decisions and ensuring that human knowledge focuses on creative and innovative work (Fig. 6).

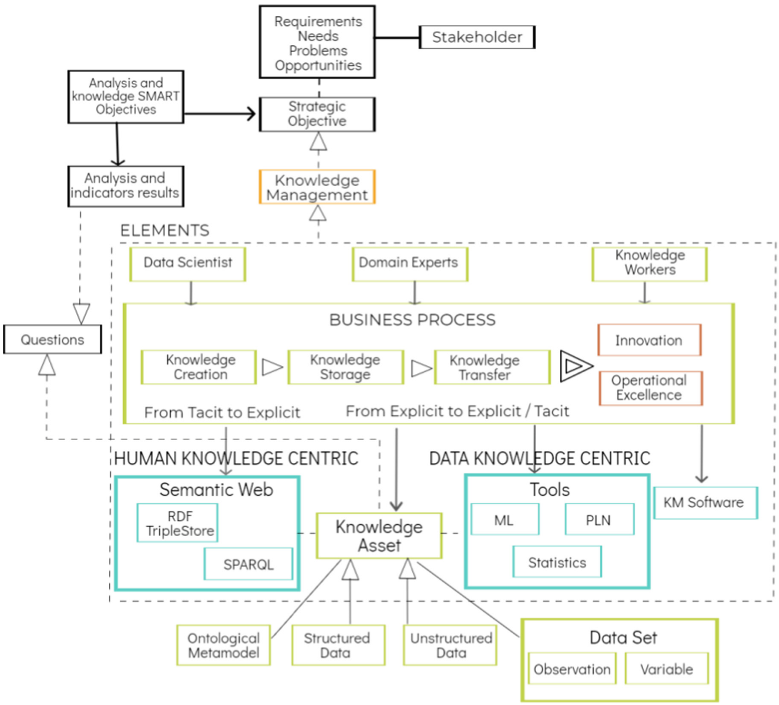

Fig. 6. Model of integration of business intelligence and knowledge management

5 Methodology and Validation

The model of integration was implemented in Azteca Telecomunicaciones Colombia, a company that belongs to the mexican group Grupo Salinas and provides connectivity services. By the end of 2016, the number of this company's active clients in Colombia exceeded 150,000, out of which more than 8000 were corporative, and included the main companies and carriers of the country. Moreover, the company has 500 direct and indirect employees and, through installation contractors and marketing channels, it generates 600 additional positions.

Azteca Telecomunicaciones Colombia works for the National Optical Fiber Project, which seeks to plan, design, install, put into commission, manage, operate and maintain the optical transport network in approximately 753 municipalities and 2000 public institutions, given that the incursion of this technology in most municipalities is less than 25%.

The first stage was information collection, for which the directives (CEO and technical director) and different knowledge workers (architects, infrastructure experts) were given a structured interview form. The municipal Police, the National Army, drones, sensors to measure tension and the inhabitants of the region also participated.

Data were structured and unstructured: (1) manuals and reports, and (2) photographs, videos and notes about, for example, optic fiber canals, state of the region, security of the area, fauna, flora and indigenous groups living there.

With the results, it was possible to identify the needs of rural areas, where the lack of technological resources and the difficulty in getting the optical fiber to these areas was evident. Also, a report on housing projects of the localities, customer data and devices to use was issued. The above mentioned process is shown in Fig. 7.

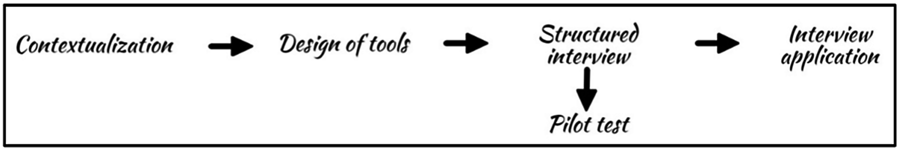

Fig. 7. Flowchart of interview application

The second stage consisted of a brainstorm, later analysed using a Ways to Grow Framework chart, which determined that the best idea was "to provide both connection service and rental service of computers or devices with Internet access for an affordable price". This strategy is appropriate because it matches the objectives of the organization, favours the state of the company and, given the social support to the areas and the generation of competitive advantage, it will cause a greater impact on the clients.

A Strategic Overview Knowledge Map was carried out posing the following questions:

- What is the knowledge necessary for each process that affects the strategic objective?

- What are the areas and who are the people that possess the knowledge?
- Is the knowledge tacit or explicit?
- What are the problems to be solved, or the decisions to be made with that knowledge?

The result of work sessions is shown in Table 1.

Table 1. Result of work sessions

Strategic objectives	Knowledge required	Location of the knowledge	Tacit or explicit	Problem addressed
To increase sales by 30% by 2017	• Client knowledge • Network availability • Coverage maps • Housing projects in each municipality • Level of service availability	• In information systems • Geographic information system • Marketing system • CRM • Network management systems	Explicit	Classification of knowledge
To increase participation of private and massive sector clients	• Network coverage • Socioeconomic level of the inhabitants • Presence of other operators • Cost of service installation	• Marketing systems • Geographic information systems • Electronic sheets • Marketing personnel	Explicit and tacit	Transformation of knowledge into explicit knowledge
To increase network availability	• Network coverage • Service operation reports • Infrastructure of municipalities • Electrical infrastructure • Network incidents • Vandalism information	• Trouble ticketing system • Geographic information system • Technicians	Explicit and tacit	Transformation of knowledge into explicit knowledge
To reduce client acquisition costs	• Network technology • Port availability • Coverage • Licencing • Negotiations with suppliers	• Marketing system • Network logical inventory system • Geographic information system • CMDB • SAP • Network and purchasing engineers	Explicit and tacit	Transformation of knowledge into explicit knowledge

Based on the above analysis, knowledge assets supporting the strategic objective: “to increase network availability” are going to be developed. For this purpose, more concrete and measurable goals were defined:

“The aims of this analysis are: to reduce network outages associated with natural disasters by 15% by the end of 2017; to reduce infrastructure unavailability caused by vandalism by 20% by 2018; to reduce service costs and to increase the accuracy of data for portfolios by 20%.”

Having stablished this strategic objective, and after the interviews and work sessions were carried out, everything related to the PORTFOLIOS was defined as knowledge asset, for which, as proposed in the metamodel, the ontology and the data set were developed. It was possible to answer questions such as:

- What variables does a contractor use to quote the making of a portfolio?
- How to determine the height of each of the poles by sector?
- How to determine the available access roads to the sector for the fiber installation?
- What is the urban growth rate of each of the municipalities (Areas m^2)?

The information was programmatically incorporated into a prototype for data analysis, considering additional aspects such as requirements, needs, personnel, resources, among others. *Protege* was also used as a facilitator of knowledge management through ontologies, by consulting information by meaning and not by textual content, with the collaboration of intelligent agents.

The described objective regarding network availability (design of optimal routes, possible inconveniences in the design stage and all the following stages, reduction of unavailability caused by infrastructure theft or vandalism, and increase of data accuracy) was accomplished by means of the knowledge asset.

6 Conclusions

In order for organizations to achieve competitive advantage and operational efficiency, the contemporary business world needs to change traditional paradigms. This can be accomplished through business intelligence and artificial intelligence, which endow machines with decision-making capacity within organizations, and allow the human resource to engage in creative and innovative work.

Adoption of expert systems that use artificial intelligence decreases uncertainty in decision making and allows to predict the behaviour of the system.

Business intelligence and knowledge management converge in the interaction of data scientists, domain experts and knowledge workers. These actors can relate through adaptable tools such as internal communication networks, custom software, intranet or Balanced Scorecards.

For the purpose of achieving the strategic objectives matching organizations’ needs, requirements and problems, the present model seeks to use artificial intelligence to manage business intelligence, and to merge the latter with knowledge management.

The application and validation of the model in Azteca Telecomunicaciones Colombia makes it possible to evidence the transformation of information into knowledge assets. It generated a basis ready for analysis, guaranteeing the availability of infrastructure, the correct design of the optical fiber network, the reduction of deployment costs thanks to the use of optimal routes and the identification of possible construction problems in the design stage and the following stages.

7 Future Work

1. Application of the described methodology within organizations in developing economies, in order to allow the operative and documentary download of employees and, in this way, improve management and generation of innovation.
2. Detailed review, in terms of human resources, of the impact that the implementation of artificial intelligence solutions-as facilitators of knowledge management - would cause in organizations. Implementation of intelligent agent tests for knowledge automation with non-conventional paradigms of organizational learning.
3. Models of artificial intelligence and knowledge automation focused on specific areas of knowledge, where emerging technology tools allow decision making and operational.

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Corporate Networks Traffic Analysis for Knowledge Management Based on Random Interactions Clustering Algorithm

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Abstract. Categorization of network traffic according to application is an element that determines important task in management network such as flow prioritization according; consist on the importance of the application to determine which flows get the most resources or which flows get resources first, traffic policing consists in drops traffic and diagnostic monitoring. In the other hand, categorize applications can be employed for resolve engineering problems such as workload categorization for identify the amount of work assigned or done by a client, capacity planning and route provisioning.

In this paper, we show the results of the research project "Implementation of the RAIN algorithm for the clustering of network users". It describes the problem, and mentions some related researches. Then, the selected gravitation algorithm is itemized; it also submits the tests analysis and results, and finally shows the reached conclusions from the research.

Keywords: Gravitation clustering · Clustering algorithm · Machine learning
Data mining · Network traffic

1 Introduction

The traffic qualification, is an item that sets important tasks in the network management, such as the flow prioritization, which [1] consists on determining the importance of the application depending on the resources attainment or use, the traffic control, the appliance characterization, the traffic volume rating, the capacity planning and the routing supply. The traditional focus to classify the network traffic is based on categorizing the port number or protocol, based on this parameters the network operator can allocate the bandwidth that fits for each user.

This method is viable since originally the apps P2P used static port numbers and protocols such as, HTTP and FTP, this way was distinguished the transferred file type or the app used. However, later P2P app versions came out, as BitTorrent, which offered quick downloads of big-sized files, through a protocol and static port; since this

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type of apps were restricted, the port masking came up hampering to block out on a direct way those ports known as out of the business focus.

Due to port masking and protocol, this detection technique of the network traffic started to be inefficient, and also to increase the computational and storage cost.

Previously are exposed the limitations that have motivated the use of the features of haulage layer to classify the traffic. For instance, in [1, 2], is shown that the cluster analysis is capable to classify the internet traffic using the gotten information.

In this paper, some projects related to the network traffic qualification and the obtained results on each case are described, in order to submit the references for the algorithm used selection. Afterwards, it describes the selected and deployed algorithm for the users clustering in accordance with the features of the haulage layer. Then, it sets the general design of a software that interfaced in this process, since the data collection to the users clustering. Likewise, it shows the stage of tests and results analysis in the research. Finally, we raises the conclusions of this research.

2 Problem

Due to internet growth and applications more robust consume in terms of bandwidth is escalating, instead of increasing the size of their WAN circuits; companies feel the need to properly manage their circuits to make a distribution more efficient.

For this reason, have been developed tools how load balancing network that employs an algorithm which for the simplicity and speed allows it to deliver very high performance, including both high throughput and low response time, in a wide range of useful client/server applications. The network performance load balancing can be measured in the next topics: CPU overhead, response time, throughput, switch occupancy. In this form, this tool provides an ideal, cost-effective solution for enhancing the scalability and high availability of these applications.

In spite of use tools mentioned lately, the companies offer to users the same bandwidth in a plan with the identical characteristics, however the traffic is not equivalent between users, such us it is described in algorithm load balancing network a distribution is necessary for a traffic efficient although this distribution is not visible to users, the main goal is select appropriate clusters according to consume of bandwidth by each user.

3 Related Projects

The network traffic classification can be tackled from multiple techniques. So, this paper mainly looks through those related to the problem raised domain, such as the algorithm: EM, K-Means and DBSCAN (Table 1), another related project are mentioned in [3–6].

Follows up, it's focused on the most important proposals for the studied case.

Table 1. Clustering algorithms

Algorithm	Technology	Process	Results
EM (Expectation Maximization) [7]	Machine learning	The initial step is defining the expected value constant, first, the probability density is assigned to the dataset, then in the maximization procedure the density values are estimated for each model parameters. These steps are repeated until getting a local maximum equal to an established global maximum	The performed tests to this algorithm show that it's suitable to classify information with the same general features, it separates the bundle's header and identifies a particular kind of traffic
K-Means [2]	Machine learning	The clusters are figured out by an established similarity, according to the Euclidian distance, whilst a great distance means being in a different cluster. K-Means at first, randomly picks objects into a dataset, the objects are divided in the closest clusters, K-Means iteratively calculates the new centers and then it divides them again, based on the new centers to converge	This algorithm is tested on apps based on the TCP protocol, regarding to the following features of static flow: bundles' total number, bundles average size, in other words the useful burden size excluding the headers, transferred bytes and average time among the bundles arrives, getting an accuracy above 79%
DBSCAN [2]	Machine learning	DBSCAN, is based on the density just as the EM algorithm exposed in [8]. Which in, the concept relies on two parameters épsilon (eps) and minPts, where eps is the distance around the object defining the neighborhood, and minPts is the minimum number to determine the object core. The cluster is made up of every plugged object density based on eps and minPts until committing each object into the dataset	This algorithm is tested on apps based on the TCP protocol, regarding to the following features of static flow: bundles total number, bundles average size, in other words the useful burden size excluding the headers, transferred bytes and average time among the bundles arrives, getting an accuracy above 72%
K-Means and statistic flow [9]	Statistic	The classification revolve around two steps: clustering, where the dataset is divided into separate clusters, according to similar or different flow; such procedure is made with K-Means, then this clusters use the available tags according to the flow and gets a cluster's mapping. This procedure focuses only on the TCP traffic classification	This focus is assessed in a dataset traces from a wide kind of apps, which provides an accuracy close to 94%

4 Gravitational Clustering Algorithm (GCA)

Gravitational Clustering Algorithm universal proposed on [10] automatically generates the number of clusters in a dataset. Every object is considered as an object in the future space and is moved using the universal gravitational force law and the second Newton's law. Based on the clustering techniques exposed on data mining, that according to [11], it's a procedure that allows to extract useful information from vast datasets, or according to [12–14] who state that data mining is a procedure which, on the basis dataset (often vast volume) and using statistic methods and machine learning, among others, it finds out implicit knowledge on data.

Each pattern found in the dataset is seen as an object in the future space and moved by the gravitational force and the Newton's second law. This proposal is based on the gravitational algorithm suggested by [15], the main advantage about the exposed techniques are: speed and robustness.

A data point exerts a higher force on a data point located in a different cluster, then, the data are moved in the cluster's center way; this technique will determine the clusters in the dataset. If a data does not belong to a cluster, it will not be assigned to the cluster, in this way, the noise in the classified dataset is removed.

Every data in the dataset is moved according to a simple version of the next Eq. 1.

$$x(t+1) = x(t) + \frac{\vec{d}G}{\left\|\vec{d}\right\|^3} \tag{1}$$

Where, $\vec{d} = \vec{y} - \vec{x}$ and the gravitational constant G, regards velocity in any space of time, v(t), such as the zero vector and $\Delta(t) = 1$. Distance between data points and the gravitational constant G is reduced, while the information points are moved to the pertaining clusters, depending on the defined value by constant G, as it's referenced in [10].

GCA create a dataset using a separation structure from the dataset and union-correlation, and distance between objects. The clustering algorithm based on random interactions, use an extra parameter (α) to determine the minimum of data points that a cluster should include to be considered as a truly cluster. Looking into the gotten algorithm's complexity is O(n), and it defines that the function' complexity is usually enclosed by O(#clusters) $\leq$ (N) equation, as exposed on [10].

5 Random Interactions Clustering Algorithm (RAIN)

RAIN, is a broadening of the Gravitational Clustering Algorithm, which implements different movement functions and automatically commits the gravitational constant [16].

Three elements are defined here:

(a) Maximum distance between close points, which is determined in Eq. 2 according to the three possible paths for an information's point.

$$\hat{d} = \frac{2 * \sqrt{n}}{\sqrt{3} * N^{1/n}} \tag{2}$$

(b) Movement functions, define the X data point's final position, interacting with another Y data point, Eq. 3.

$$x(t+1) = x(t) + G * \vec{d} * f\left(\frac{\left\|\vec{d}\right\|}{\hat{d}}\right) \tag{3}$$

(c) Allocation of initial gravitational constant G, in order to define the required clusters, such constant is reduced in a constant amount (ΔG).

A synthetic dataset is employed (from CLUTO[1]), submitted on [16], in the WEKA tool, in order to check out the EM [10] and DBSCAN [2] algorithms' efficacy.

The clusters number is summarized in Table 2, the amount of clusters in each point and the initial parameters defined for the results attainment, by each algorithm.

Table 2. Comparison between EM, DBScan and RAIN algorithms

Algorithm	Class	Record	Percentage	Parameters
EM	10	Class 0: 634 Class 1: 539 Class 2: 1536 Class 3: 995 Class 4: 361 Class 5: 738 Class 6: 1024 Class 7: 1020 Class 8: 663 Class 9: 490	Class 0: (8%) Class 1: (7%) Class 2: (9%) Class 3: (12%) Class 4: (5%) Class 5: (9%) Class 6: (13%) Class 7: (13%) Class 8: (8%) Class 9: (6%)	Iterations: 100 minStdDev: 1.0E−6 numClusters: −1 seed: 100 Instances: 8000
DBScan	6	Class 0: 1307 Class 1: 1021 Class 2: 1178 Class 3: 608 Class 4: 1641 Class 5: 908 Noise: 1337	Class 0: (20%) Class 1: (15%) Class 2: (18%) Class 3: (9%) Class 4: (25%) Class 5: (14%)	Eps: 0.1 minPoints: 390 instances: 8000
RAIN	8	Class 0: 1856 Class 1: 714 Class 2: 995 Class 3: 1023 Class 4: 698 Class 5: 666 Class 6: 713 Class 7: 945 Noise: 390	Class 0: (23%) Class 1: (9%) Class 2: (12%) Class 3: (13%) Class 4: (9%) Class 5: (8%) Class 6: (9%) Class 7: (12%)	Eps: 0.0001 Gravity: 1 dG: 0.001 Alpha: 0.03 Instances: 8000

[1] http://glaros.dtc.umn.edu/gkhome/cluto/cluto/overview.

6 Methodology

The method applied in the present project was the descriptive-exploratory scientific research with an experimental focus. According to the formal procedure of researching, the hypothetic-deductive method was used, where there is a stated assumption in, which, through a deductive reasoning led to prove it by empirical way. It was sought to set on basis on testing, a weighing mechanism for the gauges of algorithms' assessment, so that it is possible to test such mechanism for the dataset. The next stages were defined and involved:

(a) Tool selection

The traffic control provides the mechanisms for getting and passing datasets, (where traffic is the information flow passed through the channel) this is an important parameter that enables to ensure transmission quality [17].

It is to be noted that, although the traffic control allows the user to manage the flow, it does not replace the correct use of bandwidth; this is the reason why, the traffic analysis arises, in order to avoid overloading the link capacity [17], in other words, it prevents to reduce the network performance and provides the required tools to identifyin an accurate way the possible problems in a specific networks, so it allows to properly manage the bandwidth layout.

The traffic analysis is framed on three general classes: bundle analyzers, port and hardware scanning. The bundle analyzers allow to capture all of the processed information from the network card, the port scanning is designed to test other computers or network devices, and report the attained information, and the hardware scanning reports which devices are currently within the network; the difference between these analyzers relates to the scanned area and the identification of the device's purpose, concerning to the network's interaction.

(b) Parameters selection

According to the Project approach, it is required to select a parameters set, which allows to determine who is the network user and who is making use of the bandwidth; as a result, the next criterion were deduced: origin address, destination address, origin port, destination port, protocol, bandwidth, user and date.

Traffic analyzers. Regards to software tools to measure the network traffic, there is the next classification: Sniffer, SNMP o WMI, within the researching frame, different tools were tested for the purpose of reaching the stated cluster. Each one of these items is detailed to submit the information that lead to the bundle analyzers selection – wireshark.

(c) Dataset structuring

Two applications were built with the JAVA programming language, to process the collected data. The first one, built in order to take the data with the monitoring information and insert it in a database per day (the format of those files is previously turned from libcap to text), easing the consultation procedures required to order the data (protocol and address), and the second one has as aim to structure the information to shape the entries set suitable to the clustering algorithm to deploy.

Once the dataset was consolidated, the assessment of population mean was made up, in order to identify the prevailing range in the studied data; according to Eq. 4, where $\overline{X}$, is the sample mean, z_c represents the reliability (gicen by $\overline{X} + 1.96$), the standard deviation (σ), Eq. 5 and the square root of all the records ($\sqrt{n}$).

$$\overline{X} + z_c \frac{\sigma}{\sqrt{n}} \tag{4}$$

$$s = \sqrt{\sum\nolimits_{i=1}^{n} (x_i - \bar{x})^2 - (n - 1)} \tag{5}$$

7 Results

(a) Network traffic dataset

Dataset description. The dataset was taken from some users cluster's network traffic, monitored by the bundle analyzer wireshark. Due to this, the combinations were set, according to the raised clustering type at the first stage of this project.

The data structure was gotten from all of the stocked records in the database, where there are submitted the numbers placed in distant ranges. In this way, due to the set's heterogeneity (non-linear problems) it was possible to use statistical analysis' methods to calculate the settings of maximum distance already mentioned above (Eq. 4).

In order to reduce the set's heterogeneity, the Eq. 5 was used, for the determination of protocols with a dispersion range above zero, as a result, it was created a new structure with the protocol's information (total of 50) for each user's register, date and hour.

Initially layout. The tests are applied with the following layout: universal gravitational constant $G = 1$, $dG = 0.0001$, $eps = 0.04$, $\alpha = 30$, $adjust = 500000$, $M = 5\sqrt{N}$ and decreasing function $\frac{1}{X^3}$.

Result obtained using the network traffic data. The 1186 points' clustering was achieved, such points are discriminated in the clusters shown in Table 3.

The total of origin records was 1274, whereof points did not join any cluster. In this way, it was taken a records' sample, which had an outlier value (zero) and it was

Table 3. Network traffic results – protocols

Cluster id	Number of points per cluster
54	62
56	191
57	107
58	78
60	274
62	265
63	209

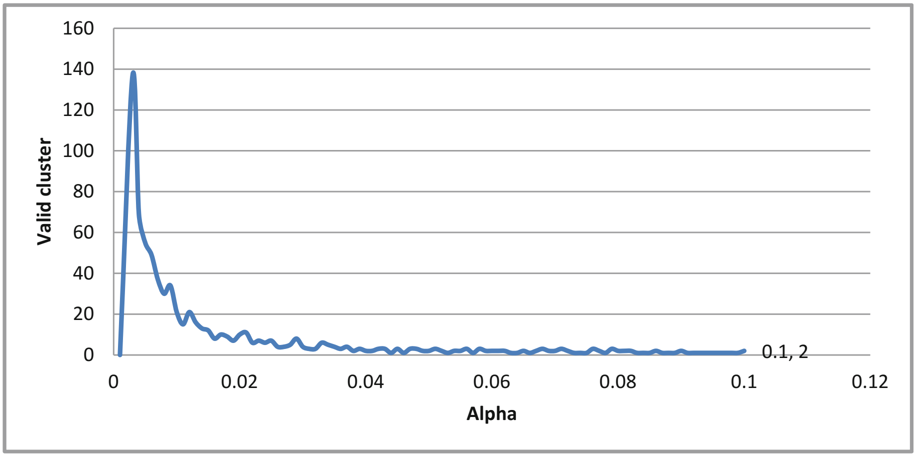

Fig. 1. Sensibility of α according to grouping points

verified if they actually belonged to any cluster, finding out they belonged to a cluster with not close to zero values.

Nevertheless, verifying the relation between the settled clusters' data, a proximity between the clustering values was detected; as there is no way to graphically represent the clustering in a Cartesian plane as it is a n-features set with n > 2, there is an alternative structure proposed in here, which is described in the next section.

Sensibility of setting variables. The algorithm's behavior is defined by the setting of the variables as a set. The most relevant parameters in this dataset are outlined below (Fig. 1):

- Sensibility constant α. The algorithm uses the parameter α to determine the number of points setting a valid cluster.
  The trending of the obtained clusters' amount is represented on Fig. 1, regarding to the parameter α variability.
- Gravitational sensibility's constant. According to the algorithm, this constant is determinant in clusters' creation, because, with the studied vector magnitude, it determines the points movement, it is an important value, as if the assigned value is huge, it leads to a single cluster, but on the other hand, if it is a small value it may quickly become zero (0) after the defined iterations' execution. According to the performed experiments, it is a fact that it is a relative parameter to the dataset.

In Fig. 2 the algorithm's sensibility according to the studied dataset is shown, as it is seen in the gravity's value according to other experiments, it turned out to be smaller; what proves that this value is determined based on the dataset.

- Sensibility's constant to the iterations' number. The iterations' amount is displayed in Fig. 3, wherein it is proved that the proposed method by [3], $5\sqrt{N}$ which, for this

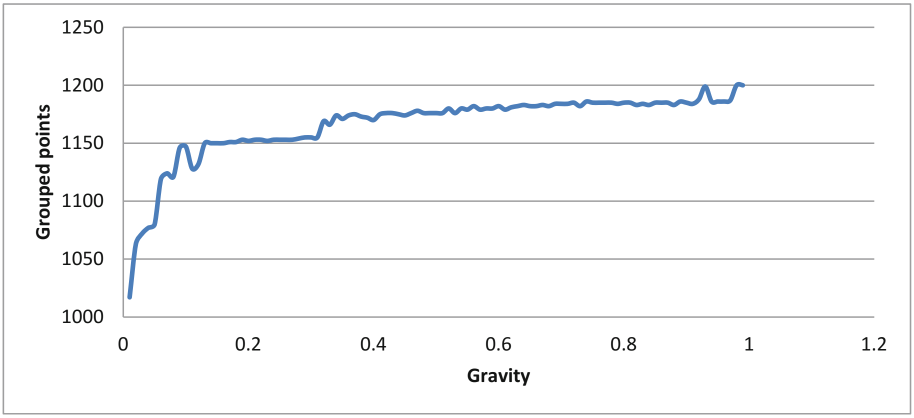

Fig. 2. Gravity's sensibility. Shows the trend of the number of grouped points, with respect to the variation of the parameter G.

case turns out to be 135, and it is a suitable value for the clusters' number that is considered as ideal for the exposed case.

- Sensibility's constant of the maximum distance's adjustment. The maximum distance's adjustment added as a parameter normalize data, is determined in a proper way, since, after the estimated value is 500000, it is noticed that it does not get a higher number of cluster points.

The trending of the amount of cluster points is represented in the Fig. 4, regarding to the change of the parameter maximum distance's adjustment.

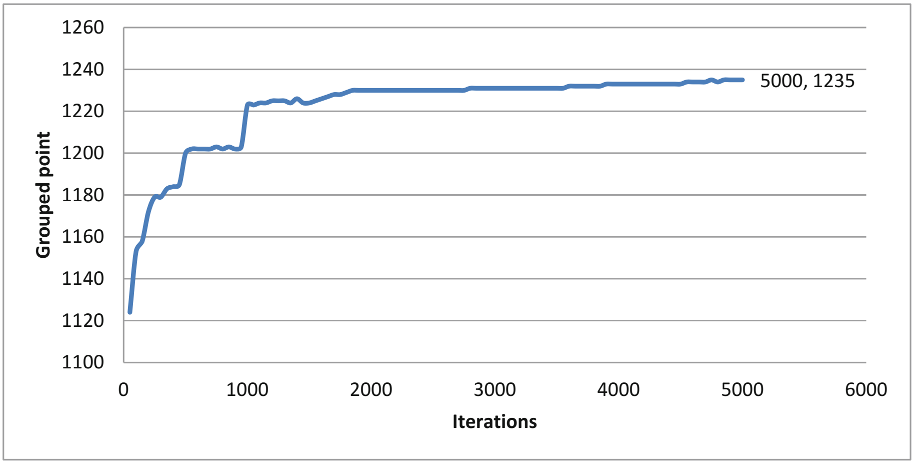

Fig. 3. Sensibility to iterations.

The clusters' formation is verified with a set of outlier records, which were not alike and therefore they had to be classified as noise, due to such records were gathered without any common feature, it was raised to resize the dataset, as next section shows.

(b) Adjustment relative to the network traffic dataset
Dataset's description. The used testing dataset was built from the case mentioned in the last section, in order to prove the clustering's applicability, the domain was resized, in this way the bandwidth consumption of each user per each data (user, date and hour) sum up, allocating to each protocol a percentage according to the total consumption of the bandwidth in that period of time.

Initial layout. As well as the last case, it is done the maximum distance's adjustment, considered as required to ensure the clustering, according to the mentioned data.

This adjustment is computed according to the Eq. 5, the tests are made up with the next layout: universal gravitation's constant G = 0.01, dG = 0.00001, eps = 0.0004, α = 50, adjustment = 0.0260729, M = 500 and decreasing function $\frac{1}{x^3}$.

Clustering's results with traffic data in the resized network. The 1160 points' clustering is achieved, as it is shown in the Table 4.

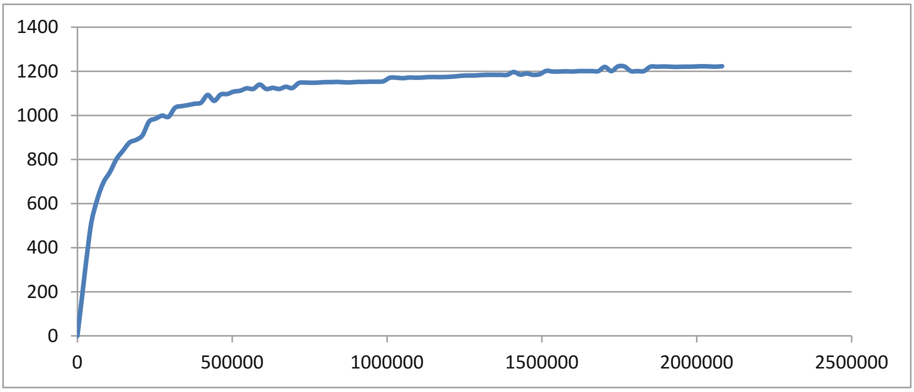

Fig. 4. Sensitivity to maximum distance adjustment

Table 4. Results network traffic of resized data - protocols

Cluster id	Number of points per cluster
67	175
70	154
72	253
75	299
76	279

Gathered points 1160 from 1274. The obtained clustering was assessed in the same way than the last case, in this checking the outlier users of zero consumption did not attach to any cluster, indicating an existing noise in the merge procedure. The obtained clustering in this case it led to identify the monitored users according to the use ratio of protocol per data (user, date and hour).

Layout sensibility. The representative parameters for the dataset are shown below.

- Sensibility's constant to alpha (α). Fig. 5 shows the clusters' number for different values of α.

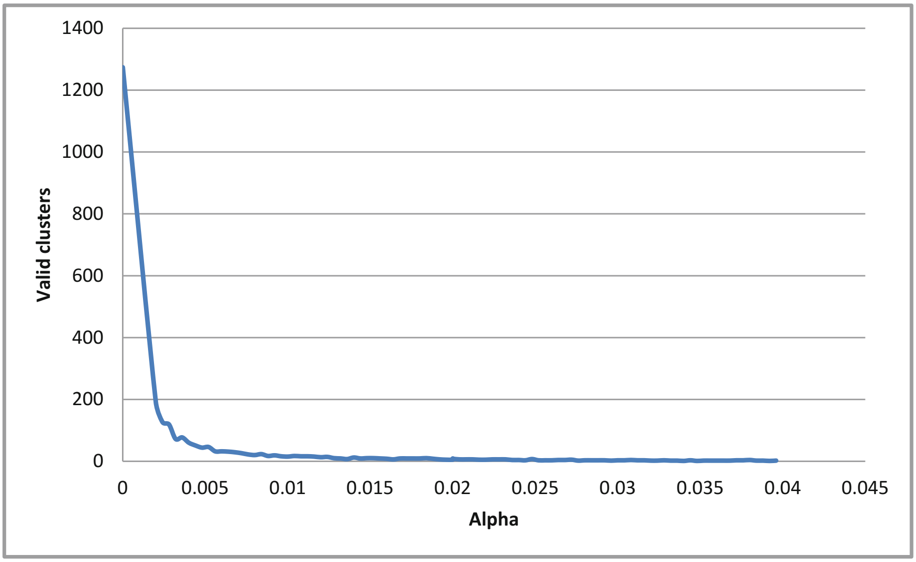

Fig. 5. Sensibility constant α

- Constant of sensitivity to constant of Gravitation. According to the performed experiments, it is established as a relative parameter to the dataset. In Fig. 6 it is seen the algorithm's sensibility according to the studied dataset, as it is presented, the gravity's value in relation to the other experiments, it turned out to be appreciably low, what proves that this value is attained based on the dataset.
- Sensibility's constant of the maximum distance's adjustment. Figure 7 shows the sensibility to gravity's decreasing for the studied case, according to the performed tests the most suitable value is 0.00001.

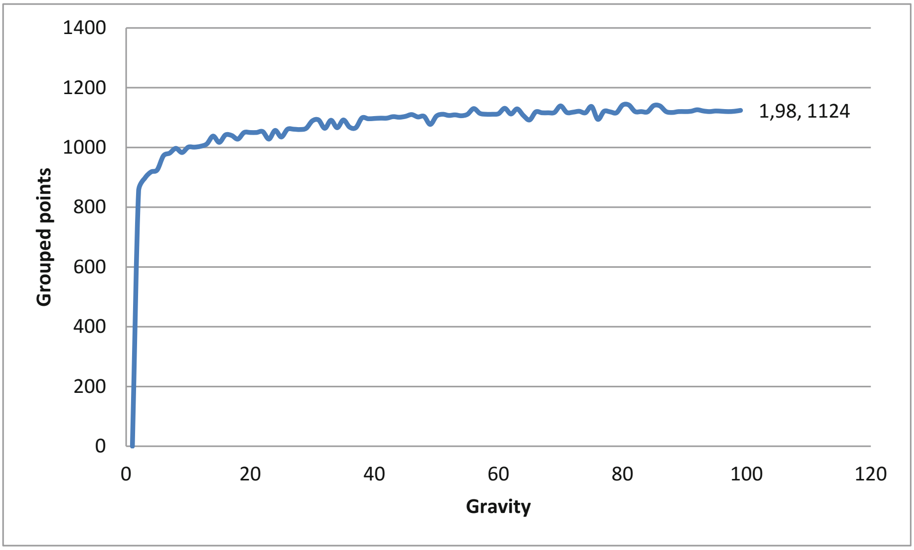

Fig. 6. Gravity's sensibility α

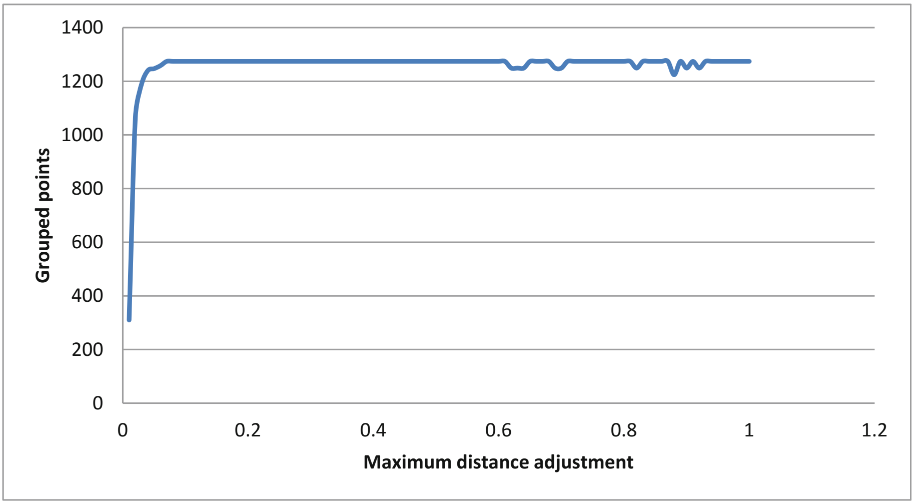

Fig. 7. Constant sensitivity to maximum distance adjustment

(c) Network traffic dataset including URL

Dataset description. As aim for the present Project, it was raised the user's clustering per consumed web applications; the origin's dataset for this case is based on the case presented above, in Sects. 1 and 2. The information about the ten most consumed sites attached to this cluster, derived per data (user, date, and hour).

This procedure is made up for the real data and resized to make an analysis of the behavior in the two cases.

Initial layout. The applied maximum distance's adjustment is calculated according to the Eq. 5, the tests are made up with the layouts shown in Table 5.

Table 5. Network traffic configuration including URL

Dataset	G	dG	Épsilon	α	M	Decreasing function	Adjustment
Protocols and real URLs	1	0.00001	0.04	0.02	500	$\frac{1}{x^3}$	1051319
Protocols and relative URLs	1	0.00001	0.04	0.02	500	$\frac{1}{x^3}$	500000

Results from clustering of real and resized network traffic data. The clustering from 1171 and 1109 is achieved.as it is shown in Table 6.

Table 6. Traffic network comparison results, including URLs

Dataset	Clusters	Grouped points
Real	6	1171
Relative	5	1109

8 Conclusions

It implemented and proved the RAIN algorithm's working, through a synthetic dataset. These data are able to validate the required parameters for the algorithm's execution, adapting to the maximum distance and cluster formation to improve clustering's result, these adjustments improved the algorithm's behavior regarding to the reference project.

From the defined structure, the entrance data is established for the algorithm, which are crucial for itself's behavior; as for the clusters checking.

To make the checking it is determined which data could get to be naturally gathered or part of the noise. From the results analysis, it deduces that data in a close range may have closer relations that permits the clustering.

The dimensions number of entrance data makes possible the results checking, based on the performance that can be made. In other words, for a dataset with a limited dimensions' number (up to 3) it is possible to graphically check the clusters formation.

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Semantic Analysis System for Industry 4.0

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Abstract. The sensorization of machines used in industries (Industry 4.0) and the ability to connect them to a data network, have changed the way companies maintain and optimize the performance of their machines. Each one is capable of generating large volumes of data daily, big data methodologies can now be applied to these data in order to extract knowledge, this was an impossible task not so long ago. However, in many cases sensorization and data analysis are not enough to detect faults or alarms and once they occur, an operator must fix them manually. The purpose of this paper is to use a semantic analyzer, based primarily on a case-based reasoning system which extracts information from the reports written by operators about the faults they resolved in machines. Thus, when a fault or alarm occurs and there are previous reports about this machine, the developed system independently proposes a solution and there is no need for an operator to identify the problem. To do this, a text analysis platform has been created, it applies case-based reasoning to report the causes of the problem. In the majority of cases, the proposed system can successfully resolve the problem and it is not necessary to revise the machine in order to detect a malfunction and also simplifies the repair process by providing the operator with a glossary of key terms based on the history of repair reports.

Keywords: Semantic analysis · Industry 4.0
Case-based reasoning system

1 Introduction

Data have gained great importance mainly due to advances in computing, which allow for the analysis of large volumes of information to extract new knowledge. In this regard, industries are the biggest beneficiaries due to the large amount of data that machines and sensors can generate during a day. Analysing such data can be of great benefit if this results in a machine increasing its productivity. For this purpose, information can be analysed in order to prevent the occurrence of malfunctions or alarms which would otherwise have a negative effect on production. Moreover, if a malfunction or alarm do occur the repair time may be

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reduced. In both cases, by implementing the developed system companies can achieve significant savings.

This paper focuses on the second possibility. Once the fault has occurred, the machine must be repaired quickly and efficiently so that production can resume as soon as possible. Traditionally, when a machine suffers a malfunction, an operator goes to check the machine for reasons that may have caused the malfunction and, once the problem is identified it can be repaired so that the machine can finally return to normal operation.

Therefore, the margin for improvement goes through the autonomous detection of the problem that has caused the breakdown and that the system itself provides the information to carry out the repair, so that the operator saves the time of analyzing the machine and can proceed to repair it directly. In case the system cannot determine the causes, the operator must inspect it in the same way as would be done without the system being presented.

When an operator inspects and checks a machine, they write a report on what they have done, including information about the machine itself, the anomaly and the repair procedure followed. These reports are usually collected in advocacy portions that allow for the inclusion of free text to describe these processes.

The designed system is based on the history of existing reports that had previously been made for each machine. To include these texts in the system, it is necessary to run an analysis of the text written by the operator and maintain a case memory, which will be the basis of the system. Thus, a Case-Based Reasoning (CBR) [9] system has been designed so that when it detects a new fault, it recovers similar situations from the past (stored in the memory of cases), along with its different causes and solutions. It analyzes the reasons why the fault may have occurred and presents the operator who must fix the incident the reasons for the fault along with the solution.

Thanks to the use of the system, the inspection period of the machine is eliminated by the operator who has to repair it and relevant information about the repair is provided, so that an experienced operator can resolve it directly on the basis of this information.

The rest of the article is structured as follows: the background details the types of maintenance that currently exist in the industry, technologies for text analysis and similar cases to which CBR systems have been applied [12,18]. Then, the proposed system is described. The results are described in Sect. 4 and finally, Sect. 5 presents the conclusions and future lines of work.

2 Background

For decades, machine maintenance has played a vital role in industry because of the enormous economic impact that alarms or malfunctions can have on a company. Today it is still vital for any industry, with four maintenance models that can be followed [17]:

Corrective Maintenance: This type of maintenance consists of troubleshooting existing faults or problems to make the system work properly again. This type of maintenance can be unplanned, in case it is solved randomly without intervention or planning to solve it, or planned if it is corrected intentionally because it was previously detected by predictive or preventive maintenance.

Preventive Maintenance: Try to reduce equipment failure by looking for solutions to different problems before they occur. This avoids unplanned corrective maintenance. Although this type of maintenance is focused on increasing reliability and reducing costs, this type of maintenance does not guarantee that future failures will not occur.

Predictive Maintenance: Emerges as a complement to corrective and preventive maintenance. In this type of maintenance, a series of parameters are monitored and analyzed to determine possible anomalies. The process refers essentially to the ability to generate estimates or assumptions about the status of a particular component. When well-defined processes are predicted, especially in control theory [16], it is possible to generate a mathematical model that reliably represents reality [13,19]. However, other types of processes require experimental techniques, such as classification algorithms [4] or Artificial Neural Networks (ANNs) [6]. This approach attempts to extract and model the system from historical data.

Proactive Maintenance: A strategy used to maintain the stability and performance of a machine. The service life of the equipment is extended while avoiding errors and breakdowns [11]. There are two types of repair [8]: perfect maintenance, when a machine returns to its ideal state (in this case the cost is usually high), and imperfect maintenance, where an affordable part of the repair quality is sacrificed to reduce the cost. Another point to bear in mind in this type of maintenance is the performance of the machine which, due to its natural deterioration over time, must receive periodic checks throughout its useful life. For this purpose, it is possible to carry out periodic maintenance where the performance of the machine is evaluated on a regular basis in spite of its correct condition. This latter solution is not optimal when the overhaul period is short and the machines operate in perfect conditions. An alternative is based on monitoring the condition of the machinery and evaluating different parameters. Combining these two options, a model is presented in [21], where performance loss is predicted from failure rate and performance degradation.

Although the new computer models have made the main studies focus on preventive maintenance mainly, the present work focuses on corrective maintenance. While it is true that optimum preventive maintenance would not cause any kind of breakdown, in practice the machines suffer breakdowns and still need to perform corrective maintenance.

Once the maintenance has been carried out, it is good practice for the operators in charge of carrying out the maintenance to describe the problem and the solution by filling in parts of incidents. Typically, these parts consist of, in addition to an area to include information about the machine, a free text area where they describe in their own way the problem and the process followed.

It is therefore necessary to include techniques that analyze the text written by the operator, which will not necessarily always be the same, so that the terms used and their form of writing are usually not unified. The use of text-mining techniques is therefore necessary. In text mining there are a number of techniques or tools that are very common and that greatly facilitate the extraction of information, making it more effective. Some of the most used techniques are the following:

Stop Words: There are many words in the language that, despite having a great weight or importance, contribute little or even make the tasks of text mining difficult. This is because they are very common words (articles, pronouns, prepositions, conjunctions, etc.) that have repercussions on similarity calculations. They do not bring nuances that are useful in mining to the semantics of a text. For example, if somebody wants to analyze the incidence text where it is specified that "the screw has been broken", the relevant words are the verb (has been broken) and the noun (screw), but the article does not provide useful information for the task we are trying to perform. These words are known as stop words.

Analyzers: Analyzers are filters that are applied to words in the pre-processing phase of data to maximize the quality of search results. Depending on the language processing when editing a text, different results will be achieved. One of the most commonly used analysers is the stemmer type [14], which performs lexical derivation-based language processing for use in information retrieval; specifically, it reduces words to their root. It is a language-dependent analyzer.

Metrics: There are several types of metrics related to text analysis. Some of them focus on assessing the quality of the task performed (precision, recall, fall-out, miss, etc.). On the other hand, there are other metrics based on methods of counting the most frequent words in texts that allow calculations of similarity between documents based on the number of words repeated in them. The Term Frequency - Inverse Document Frequency algorithm [3], better known as TF-IDF, obtains a metric that indicates the relevance of each word contained in a document within a set of corpus. Specifically, the frequency of occurrence of a word within a document is calculated and the frequency of each word in the document that is contained, taking into account the appearance in all documents. This solves the problem that a word is very common in all documents and therefore has less relevance. For example, in the case study, the words "error", "failure", "incidence", etc. will be very common in the dataset of technical reports. However, they do not provide useful information for troubleshooting errors, as they are incident reports and it is assumed that something has gone wrong.

There are also other types of metrics that categorize texts based on decision rules by discovering a pattern that identifies similar documents.

But text analysis must be combined with an expert system that is able to determine motives and solutions from the extracted information. As mentioned above, CBR systems are used for this purpose. CBR is a kind of reasoning, used in human thinking, which draws on past experiences to solve new problems [5]. Thus, if at one point in the past it has been decided to solve a problem using a particular solution (or group of solutions) and, once that solution has been applied, a certain result has been obtained, then it seems logical that if a new problem with characteristics similar to those previously solved in the past is presented, the experience gained from past experience should be used to solve the new problem. In this way, we know that we have in our memory the experience of solving a problem similar to the current one. If the result obtained after applying the solution in the past was good, then it seems logical to apply a similar solution now to solve the current problem. On the contrary, if the result obtained in the past was not good, then the logical option should be to modify the solution applied in the past in order to obtain a better result.

The operating model of a CBR system is known as the life cycle of a CBR system. The life cycle of a CBR system specifies the time-sorted and time-related steps by which information is extracted and learned to solve a specific problem. The life cycle of a CBR system is formed by four sequential processes [2]. These four processes are known as "Retrieve", "Reuse", "Revise" and "Retain" [7]. When a new problem is presented to a CBR system, past experience is used to obtain the most appropriate solution. Thus, the first thing the CBR system does is run the recovery phase. This is a phase in which cases with a problem description more similar to the current problem are searched in the memory. The adaptation phase is then executed, in which the system works with the solutions corresponding to the most similar cases recovered in the previous phase. The outcome of the adaptation phase is a solution to the current problem. The proposed solution is reviewed or evaluated, checking its validity. Finally, in the learning phase, the system stores the new experience and learns from it. As the reader can see, the possibilities for executing each phase of the CBR cycle can be multiple. For example, in the recovery of similar cases different similarity techniques and algorithms can be applied. Optionally, an expert knowledge review phase can be used.

3 Proposed System

The presentation of the proposed system is based on the explanation of its workflow in this section. As it is shown in Fig. 1, the system has two input data (the historical data set of the company's machines and their current data) and one output data (a matrix with the most frequent terms and their relevance). This workflow can be divided into two stages, the first of which, explained in Sect. 3.1, makes use of a CBR system, and the second one applies a text mining technique as presented in Sect. 3.2.

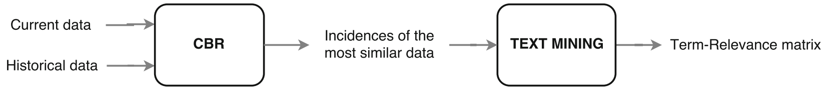

Fig. 1. System workflow

3.1 CBR System

The study of the variables measured by the sensors on the machines can report a possible state of failure in the industry. The recording of these data over time enables an analysis of their evolution. Most faults and problems in the different machines are repeated over time. If one industry is in a state of failure, by studying similar cases that have occurred in the past and the solution applied to them the problem can be easily solved. For this purpose, a CBR system is used in this system.

At this stage it is necessary to filter the data beforehand. Subsequently, a CBR system is applied in order to obtain the most similar records to the current data of industrial machines. After this data selection process, another filtering process is carried out to consider only the relevant information for the next stage. This process is explained in Fig. 2.

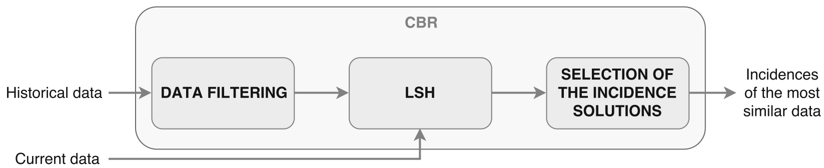

Fig. 2. Obtaining incidences of historical data most similar to current data

First of all, it is necessary to consider only the historical data records where incidences have occurred. This is a low percentage of the total records, since if there were too many incidences the industrial activity would not be profitable. This is why data is filtered by removing all records that do not have incidence data.

Finally, the data records most similar to the industry current data are filtered. The goal is to consider only the information that will be useful for the next stage. Therefore, the filtering process consists of selecting the incidence solutions of the data set obtained after the application of Locality Sensitive Hashing (LSH) techniques [15], dismissing the rest of the information.

LSH is a technique based on the generation of hashes which is commonly used for cases where you want to search for similar results, clustering or detection of outliers within a large set of data. The operation of this technique, unlike hashing, consists of associating similar records to the same hash. In this way, the most similar results are stored into the same bucket, as well as, those found in more distant buckets are the most different data. In this work an LSH based on Approximate Nearest Neighbor Search has been carried out [1].

As a result of this phase, a set of solutions to the incidences of the cases that are most similar to the current industry state is obtained. These solutions will be used as input data in the next system step.

3.2 Text Analysis

At this stage of the system workflow, a textual analysis of the incidences written by industry operators is performed. A process framed in the theory of text mining is applied to obtain a term-relevance relationship in the dataset. The different stages of this process are shown in Fig. 3.

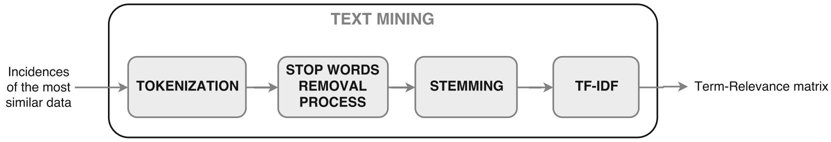

Fig. 3. Text mining process to obtain a term-relevance matrix

The solutions of the incidences obtained in the previous stage are considered in this process. In other words, the solutions for incidences of historical records most similar to the company's current ones are the starting point for this textual analysis process.

This textual analysis process is a sequential application of several techniques derived from the text mining field. First of all, each phrase of the incidences corpus is divided into a set words by a process called tokenization. Thereby, the analysis of word frequencies in the data corpus can be performed. Thus, the phrase "the screws broke" translates into a matrix in which each word is an element: ['the', 'screws', 'broke'].

A process of removing stop words follows. Continuing with the previous example and bearing in mind that the stop word would be the article "the" as we have already mentioned above, the result of this stage would be the following matrix: ['screws', 'broke'].

The next step is to reduce each word to its root through a lemmatization process. This is done using the well-known Porter Stemmer [20]. Thus, all the words derived from a given one are reduced to the same stem. In this way, the subsequent frequency analysis takes into account the meaning of the stem instead of considering the concrete meaning given by its morphemes. Applying the stemming on the above example gives us the following matrix: ['screw', 'brok']. Additionally, in order to keep a record of the original words, a list that relates each word to its stem is created.

Finally, a frequency analysis of the words in the data set under consideration takes place. The TF-IDF technique is applied to calculate the relevance of the words taking into account their appearance in each specific record and in the whole data corpus. As a result, a TF-IDF value is obtained for each word in each incidence. In order to generalize this information, a matrix containing all the words that appear in the incidences is constructed. Each one of these words is assigned a relevance ($Term\_Relevance$) which is the sum of its TF-IDF values in all incidences (N).

$$Term\_Relevance = \sum_{i=1}^{N} TF\_IDF(x_i)$$

After the application of the TF-IDF, the result obtained is a matrix that presents stems related to its relevance. To make this result easily understandable, the list that relates stems and their original words is used. Each stem is translated into its original word, giving rise to a matrix that relates terms (not stems) and their relevance in the data corpus.

In this way, by means of this text analysis, a matrix with the most relevant terms of the considered incidences and their relevance degree is obtained. The goal of the system is to assist the operator in the process of repairing the malfunction condition in the industry. For this purpose, the system analyzes the most similar failure cases to the current state of the industry's machines. It also provides a list with the most relevant terms for the solution process. As these studied cases are similar to the current fault state, the list provided will help the operator to fix the fault state in an easier way.

4 Results

This section presents the results obtained. The operating environment is initially described in the Sect. 4.1. Thereby, the data obtained by the sensors in the industry will be presented. Subsequently, the results obtained are described and validated in Sect. 4.2.

4.1 Experiment Setup

To validate the system, a corpus of data was obtained from a Spanish company. These data have been obtained from different sensors adapted to the different machines. In this way it was possible to take measurements such as temperature, different variables for accounting events and some timings. Textual data relating to incidents and system failures are also taken into account.

Every hour, a data record is obtained automatically. This data are filtered and pre-processed by a Supervisory Control And Data Acquisition (SCADA) system and an Extract, Transform and Load (ETL) process. In this way, the following types of data can be distinguished in the data corpus:

- **Machine identifiers:** There are some variables that act as the unique identifier of machines. In this case, because of the hierarchy established in this industry, these identifiers are the PLC, the station, the area, the element and its class.

- **Statistical variables and sensor measurements:** There are a series of statistical variables that will be useful to check if the system is in a fault state or not. Some of them can are the number of failures per hour of a machine, its efficiency per hour, the number of total starts or the total running time. There are also a number of other variables obtained directly from industry sensors, such as the temperature of a machine.
- **Incidences:** This data is only recorded when a machine has failed and the operator has registered it. If at the time of obtaining the record there was no system error, these fields are empty. This is textual data describing the problem, its cause and the solution applied.

Following the workflow proposed in Sect. 3, the application consists of considering all historical data and a new record with current industry data. This last record contains fault data for some of the machines in the industry. Firstly, data records where there have been no incidences (those that do not represent a case of failure in the industry) are dismissed. The statistical data and sensor measurements of the records are compared with those of the current data record, and the most similar cases occurred in the past are obtained. This information is filtered to consider only the solutions of the incidences. Subsequently, the solutions are tokenized, empty words are eliminated and a stemming algorithm is applied. Finally, by using the TF-IDF a term relevance matrix is obtained. The results will be discussed in the following section.

4.2 Evaluation

From the experiment described above, a matrix of terms is obtained. It specifies the term relevance in the dataset. The words are written in Spanish due to the geographical location of the industry where the experiment has been carried out. The 10 most relevant terms obtained are those shown in Table 1.

Table 1. Most relevant terms obtained in the experiment and their relevance

Term	Relevance
Gomas	107
Comprobando	102
Seguimiento	101
Paso	63
Estado	62
Comprueba	61
Manualmente	56
Separa	45
Desvío	38
Coloca	36

To facilitate the comprehension of these results, a visualization technique called Word-cloud [10] has been applied. The terms with greater relevance have a larger size to attract attention, and the less relevant terms appear with a smaller size. Thus, the presentation of these results helps to understand the relevance of the terms, and the interpretation of the results is quicker and easier for the operator (Fig. 4).

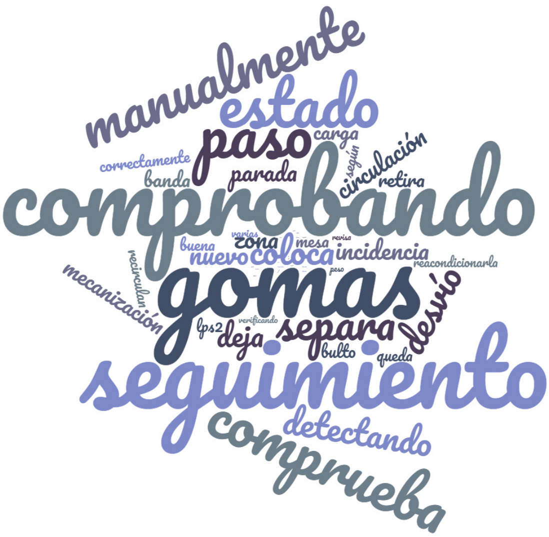

Fig. 4. Word cloud of the term-relevance matrix

The most relevant words obtained in this case study are "gomas" ("rubbers"), "comprobando" ("checking"), "seguimiento" ("tracking"), "paso" ("step") and "estado" ("status"). For troubleshooting the fault condition, in this case, checking the rubber status of the machines was essential. For this reason, it is concluded that the system was supportive in resolving the failure status of the industry. However, there are some words that do not provide much relevant information to troubleshooting. Some of these are "manualmente" ("manually"), "seguimiento" ("tracking") or "incidencia" ("incidence").

The proposed system reduces the solution time period for an industry failure state. This is due to the fact that the system performs an analysis based on historical data and proposes possible solutions. Thus, the operator will not waste time on overhauling all the machines in the industry and the error will be efficiently solved. In addition, by providing a visual representation of the results, their interpretation is much faster and easier for operators. This makes it even easier to troubleshoot the industry's failure status.

5 Conclusions and Future Work

The main objective of the work was to reduce the time spent by operators in resolving incidents and thanks to the system designed has been fulfilled. More specifically, it has been reduced due to the fact that the inspection procedure of the machine in search of the reasons for the breakdown is eliminated.

But it is not only possible to optimize the total repair time by eliminating the inspection phase of the machine. The analysis of historical information and the extraction of the most relevant information in the reports previously written by the operators, present sufficient evidence to the operators to identify not only the cause, but also identify how the incidence should be resolved. Therefore, the savings can be significant depending on the type of industry in which it is implemented.

In addition, the system reduces the training capacity required for operators, saving indirect costs such as training courses for new personnel.

At a technical level, the inclusion of techniques such as stemming means that the operator's way of expressing himself/herself when writing the reports is not relevant to the system's result.

As future work, it considers the use of the system in different industries (of different sectors) to carry out a study of how the use of a memory of cases common to all of them would affect the system. At the functional level, we are already working on the inclusion of novelties such as operators with experience in repairs can mark words so that they are not considered in future cases (adding to a blacklist of terms). Also, the inclusion of functionalities to quickly consult the history of apparitions in reports of each word. Similarly, the system will be evaluated from reports and industries in other countries, evaluating how writing language affects the results of the system.

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Business and Customer Relationship Management

Using the Concept of SoLoMo Marketing in Digital Environment to Increase Brand Awareness and Communication with Customers

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Abstract. In today's digital age, businesses are doing a lot of their activities online. The internet always brings new possibilities in every area and the area of integrated marketing communication is one of the most developing fields. An important role is played by social media with links to user geolocation and mobile devices, i.e. mobile marketing. These marketing techniques are based on attracting attention to the brand, product, or particular business. The aim of this paper is to examine and point out the effect of ads on Facebook's social network using mobile marketing tools. The data were obtained with the conducted survey and the internal documents of the selected company. The results confirmed the premise that using the latest marketing communications in the digital environment greatly increases brand awareness and geolocation. The target is therefore to create user-friendly content and get its attention. Such a way of integrated marketing communication represents the most popular way to attract customers in a simple and effective way with properly placed content and information. However, the principle of both-sided, active communication is a prerequisite for such functioning. Today's customers are very happy to in-form others about where they are, what they are doing, where they are shopping, and so on. This behavior helps companies actively monitor their activities and prepare an attractive offer for them. Since the issue of SoLoMo marketing is still relatively little explored in Slovakia, the paper points out mainly the theoretical knowledge of the given issue.

Keywords: Customer · Digital marketing · Facebook · Mobile Online marketing · SoLoMo

1 Introduction

In order to address the target group effectively, the classic marketing approach changes due to various factors, and the strongest reasons are clear competitive environment, new information technologies and market saturation [18]. Internet and technology are

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developing at a rapid pace, and as well as integrated marketing communication in the online environment along with user preferences, new services and information technologies [8]. Experts are constantly developing various models to track and investigate the effects of advertising on customers. However, their responses to a fragmented and diversified market still present unique challenges for traders to exploit new ways of efficient and effective persuasion [22]. The world's online marketing market is dominated by two major players - Google and Facebook. It can be said that they are in constant competition, with the pace of innovation of services and the offered advertising formats bringing news on almost a weekly basis. Keeping up with all the changes is really not easy [11]. At the core of the Internet activity monitoring center is primarily the company website. From a marketing point of view, emphasis is placed mainly on optimizing them for mobile devices, along with the use of available mobile applications [6]. Therefore, they are considered to be the main representation and the basis of corporate online activities and are given extraordinary importance [15].

From the above, it can be stated that in the area of digital marketing, the already mentioned areas of social networks and mobile devices will be used more and more frequently. At the same time, the location in which the customer stays, is at the center of the action, as some studies suggest [4, 10]. In practice, this system is referred to as "SoLoMo - social, local, mobile", so it consists of three principles that are currently influence online marketing: social networks, locality and mobile phones. When implementing these activities, it is important to integrate all three characteristics into the concept so that they are able to offer their visitors unique experiences. This trend was created with the growing popularity of mobile phones and the rapid expansion of mobile internet [6]. SoLoMo marketing has become an important tool for product promotion, brand development that stimulates direct purchases because it offers more interpersonal connectivity, intimacy and sociability that are used by mobile phone users [23]. It is strong due to its ability to disseminate product information to the virtual communities of users (i.e. classmates, family, friends and acquaintances) widely and quickly. Friends on social networks (such as Facebook) can respond to the ad by pressing a similar button, sharing personal experiences, and reviewing and recommending the brand in the ad [19]. Subsequently, advertisers can use geographic information in real-time and word-of-mouth power and socialization in mobile marketing efforts to increase the specificity and effectiveness of ads [25]. It helps the companies to increase bi-directional dialogue with consumers, allowing traders to quickly understand consumers' feelings, their campaign or product ratings. They can then flexibly respond to market changes and reach potential consumers through bidirectional communication [1].

1.1 Social Networks

Social networks that, combine local and social characteristics, are gaining more space. For businesses, they represent the most used information channel by providing them with valuable information about consumers, their hobbies, habits and interests [5]. Within the monitored system, this is a platform that is used to spread the marketing message and engage customers in communication with the company brand [2]. The company, as a message disseminator, engages social networks to promote their brand

and engage target groups in communication [21]. Content shared across social networks strengthens brand visibility in the online environment, and transparent communication through social networks strengthens its authenticity, supporting long-term connecting or merging of potential and existing brand customers [24]. Their primary activities can be summarized as follows in the Table 1.

Table 1. Basic marketing activities of the company on the social networks

Role	Activity
Information about the company (brand)	Brand awareness and awareness building
Pre-sales support for product/service	Getting acquainted with the features and value offered
Convincing about the benefits of the product/service	Purchase arguments
After-sales support	Communication and problem solving
Community building	Long-term communication and its support
Problem solving and communication	Crisis communication to solve problem

An important part of implementing a social media strategy is to create and share high-quality content and move it towards the audience. To create high-quality content on social networks, you need to specify content targeting, content type, content update frequency, and calendar update [24]. Here, it is important to note that, according to the authors who deal with the topic, the latest trends in social networks will shift away from the quantity (e.g. five Facebook posts each day) back to quality (only a few posts per month but those that have stirred up) [22].

Subsequently, companies will try to push new technologies and will not be able to predict how they will work. With massive deployment of data-driven campaign optimization techniques, it will finally evaluate its profitability [12]. However, the creation of quality content remains the most important element. If businesses want to continue to pursue good-quality marketing activities on social networks, they have to try to realize the following activities:

- maximum differentiation from competition,
- creating a “wow” effect,
- be up to date,
- solving customers’ problems [13].

At the same time, it is possible to expect that this growth will be further enhanced by the growth and diversification of websites and social media in the future. Ultimately, this involves incorporating a wider concept of online marketing and specifically customized website design [10].

The following Fig. 1. points to the most visited social networks in Slovakia compared to the world for 2017.

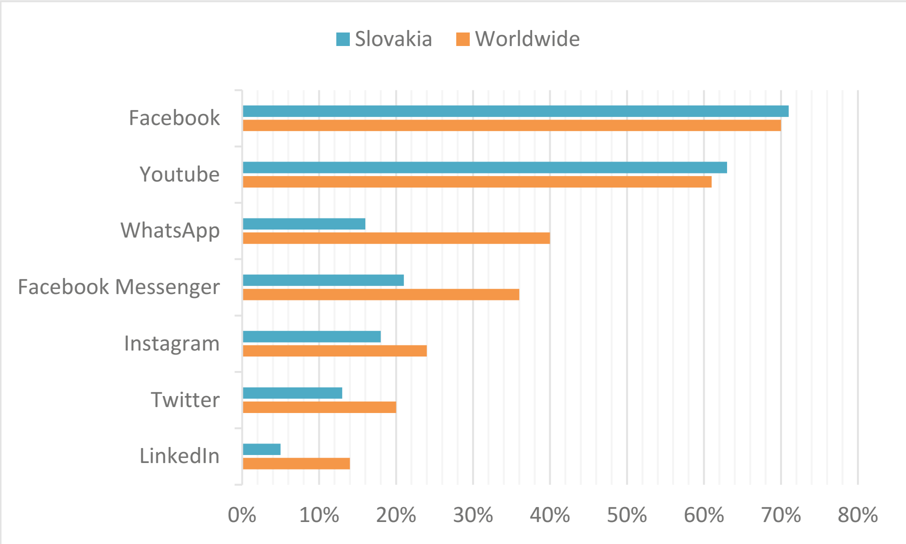

Fig. 1. The most popular global social networks sites worldwide and in the Slovakia

1.2 Local

Businesses enter the local level when a customer's or client's location is known, which is now easily detected by the mobile phone, respectively smartphone [19]. Companies can offer more personalized services on the basis of their clients' movements, thereby providing them with information about the territory they are in [3]. The already mentioned social networks have created an environment in which consumers expect from the brand its online presence, transparency, accessibility, and ability to create an affinity with the customer [25]. It is just locality that makes it easier for consumers to find the kind of business that best solve their problem or the need [17].

The most frequently used locally based techniques and facilities that businesses can use are:

- GPS
- radiofrequency identifiers
- Wi-Fi
- Bluetooth
- Beacon technologies work with location services in smartphones. They utilize a bluetooth signal that can tell you when you are close to Beacon devices, such as at the cash register in the store.

Each of these techniques helps you get a lot of data including address, industry of business, description, business hours, and other information related to the brand. The most important of these data is so-called geographic code [14]. With navigation systems, however, geographic codes can have a significant error rate. This means that if the customer plans to visit a specific location, the geographic code must be accurate enough to get him there. It could be in the street or in the car park. With reference to interaction with places on mobile phones, geographic codes have to offer the exact markings [16]. The reason of the growth of these services can be summarized as one main purpose: they provide consumers information resulting from their physical location [23] (Fig. 2).

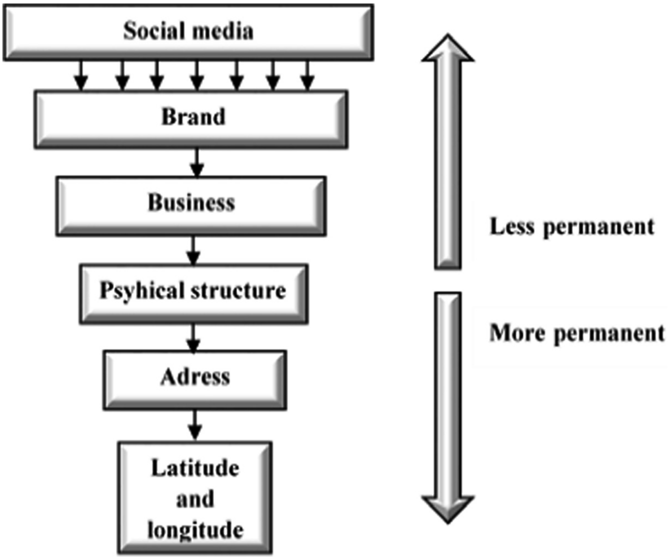

Fig. 2. Process of company geolocation

1.3 Mobile (Smartphone)

The fact that most of the population is online every day on their smartphones is not new, whereby the use of smartphones is directly related to mobile optimization and mobile online communications. Smartphones have become the primary channel for creating, collecting and sharing information about identity [19], friends, our lives, to access social networks for sharing the user's location with friends [2].

Primary activities of marketing communications within a SoLoMO are based on user engagement into communication by applications of the third parties such as local search, tagging photos at specific locations, typing tips and location-specific reviews, tweeting, or accepting geolocation ads and offers [25]. Opportunities for interacting with customers are varied, and the opportunities by which they are addressed opened new ways of communication. In the past, it has already been proven that the trust of the provider and the content of mobile communication is a key factor for customers [7]. The use of smartphone options is directly related to mobile optimization and mobile online communications. Mobile advertising and optimization have been discussed for a long time and mobile strategy is a priority for businesses. Statistical indicators say that as many as 54% of smartphone users are experiencing different problems on websites and 23% prefer to go to a site that works better [19].

It is therefore possible to talk about a certain "SEO content strategy" for mobile phones. That is, the connection between the technical factor (what the search engine likes) and what the customers like [9]. To summarize this part, it's a combination of optimization for search engines with content marketing, paid ads, email marketing, social networking strategies, and a thorough analysis of obtained data.

2 Materials and Methods

In connection with the theme of the paper, the authors focused on the effect of ads on the Facebook social network during the reporting period. A newly established enterprise belonging to SME's in the area of accommodation and catering services sector was selected as the object of the survey. The tracking process consisted of four detailed steps. For the purposes of identifying marketing activities on the social network, the profile of the selected business was created. It started its business activities in May 2017 and did not use marketing communication on social networks until that time. The subject of interest was to find out how to change the customer's perception of the company after the Facebook campaign. As we mentioned in the theoretical background of the study, marketing communication on social networks is currently important. The study looked at a selected time period in which a campaign on accommodation options, services offered, and other opportunities in a nearby location was carried out. The goal of the campaign's "Summer Events" in the period 08/2017 was mainly to raise awareness of the brand of the company about the offered accommodation and catering services. Another objective was to make the geolocation of the monitored enterprise more visible, along with an additional offer of services in its portfolio. The results from customer behavior analysis were helpful in optimizing SEO sites for smartphones and tablets (Fig. 3).

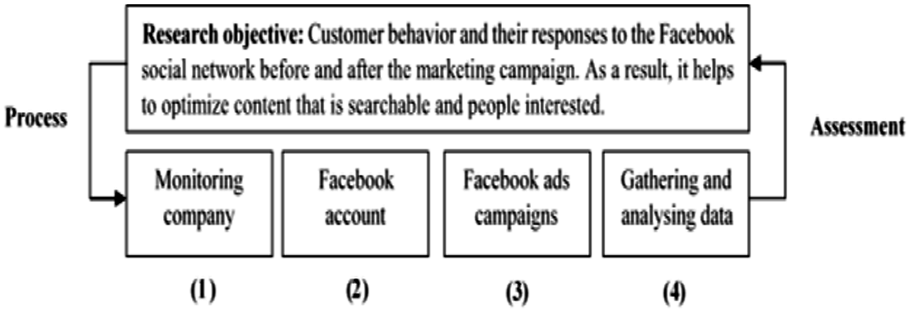

Fig. 3. Process of the survey

The following steps have been followed during the survey:

1. As part of the monitoring of the selected business, its market activities in the online environment were monitored.
2. Logged up account in June 2017 on Facebook social network and the beginning of its marketing activities.
3. Implementation of advertising campaigns in August 2017 aimed at making the company known, and informing about the services offered and community building.
4. The obtained data was analyzed to confirm that the brand awareness of the business and its geolocation had increased after the Facebook promotion.

3 Results and Discussion

The results obtained are presented in graphical form and their interpretation is presented in the form of text. The synthesis of these views allowed us to sum up some conclusions for future scientific and practical discussion.

Figure 4 summarizes demographic data about people who "likes" the profile of the selected business on the Facebook social network. Data were obtained based on the age and gender information they reported in their user profiles.

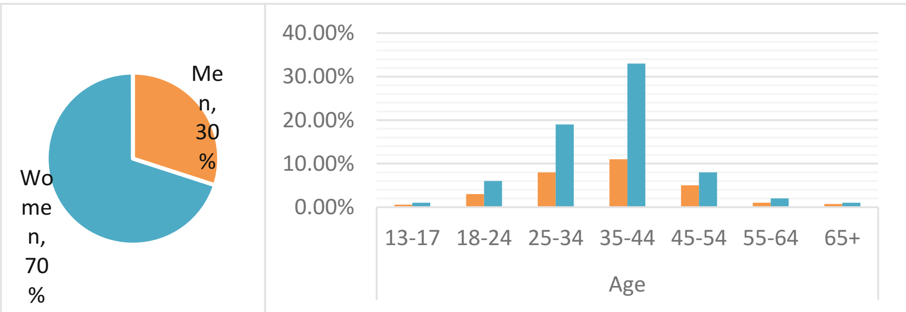

Fig. 4. Demographic data about the followers on Facebook

Facebook brings new opportunities for effective marketing communications, with accurate targeting and high interference. It represents a very powerful channel, which is one of the main pillars of every good marketing strategy (Fig. 5). In the first step of the survey, we defined the target audience and the target of the campaign. From these two attributes, the next steps were taken (identifying the target group size we know the target campaign, selecting appropriate ad formats, and planning the overall strategy). Immediately after launching the campaign, we began the process of ongoing evaluation and optimization on the basis of which adjustments were made (in our case, targeting). Gradual optimization helped achieve the primary goal of the campaign. The fact, that the successful campaign is ultimately a satisfied client, we have seen from the reactions of the target group, especially the number of "likes" and comments. The implemented campaign brought benefits to the client in the form of a significant increase in the number of customers in a short period of time (Fig. 6). For success, we consider the high quality content, that was suitable for potential customers. In conjunction with targeted audience posts corresponding to the content of each post, this collaboration brings excellent results. The results point to a simple example of how to implement such a campaign.

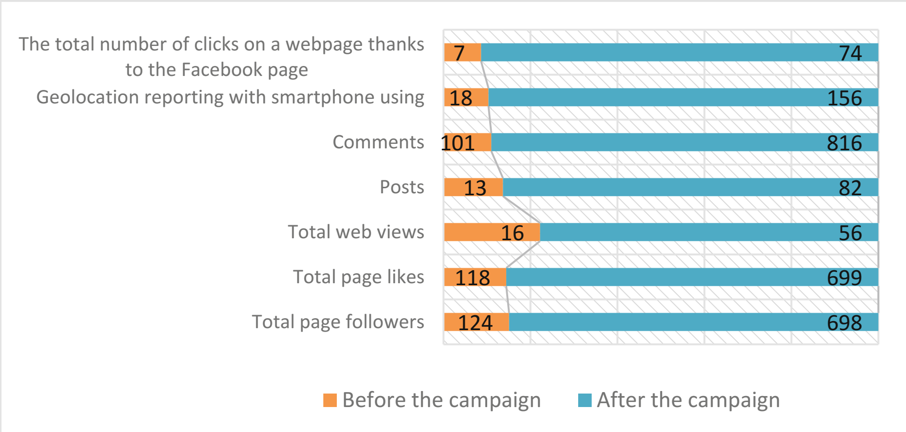

Fig. 5. View of key indicators about customers before and after the campaign

From the presented results, it is possible to see significant differences between the monitored indicators and the visit rate of the Facebook social network account prior to the realization of the advertising campaign. This has confirmed its high efficiency. The

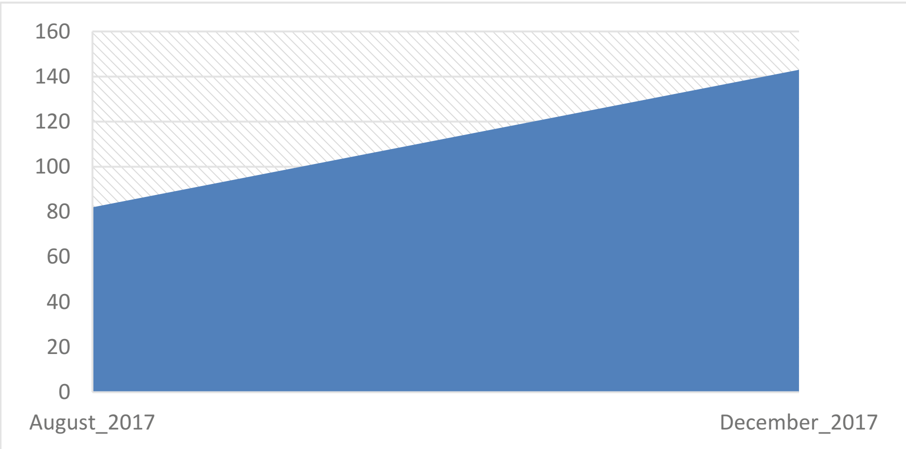

Fig. 6. Number of customers who found accommodation during the reference period

positive thing is that website visitors and information sharing ones have been using the geolocation reporting option to a high degree. As it has already been mentioned, the digital environment is being changed, based on the way how the brands address their followers. Social networks help define the personality of the brand very well, capturing the behavior of the customer who is interested in it.

From the data obtained, it was further possible to find out that most users were looking for social networking recommendations when deciding how to use their services. They were interested in how the business communicates with its customers and what they think about its services. This was confirmed by the highly positive campaign evaluation and helpful communication with users. Such behavior finally resulted in a high impact for the owner, as the number of service orders and their booking for the next time period increased.

Of course, there are a number of possibilities to improve the platform. Targeting and message is rare in advertising so general that it can be targeted at all, regardless of age, gender, interests, or family situation. Therefore, it is really important to determine who your customers are. Facebook offers 11 goals to choose from. It's important to choose one that leads exactly to what action your campaign can achieve. In the case of a better understanding of your customers, it is possible to use A/B testing to help reduce the amount of time invested, lower cost of clicks and a higher number of shares. Facebook is also coming up with new ad campaign formats. It's important that you check your effectiveness regularly when you run your ad. It allows you to track the number of pointers that make it easy to see if your ad is doing well or is inefficient.

4 Conclusion

All integrated marketing activities of companies want the customers to engage actively in on-site shopping. This is the most valuable type of social engagement of the target customer group. Effectiveness of their placement must be optimized for mobile devices engagement in the same way as the websites are optimized for searching. This is the way, how customers using SoLoMo are engaged in build branding in a real environment. Therefore, it is essential that these pages are considered to be the property of company brand, where the details and experience with the brand are accurate, comprehensive and consistent. The resulting strategy is designed to make the business visible to customers, to bring them to the web where they finally become its followers. The more people start going on the web, the more errors which are to be corrected are found. Not only technical but also procedural, such as incomprehensible menus, poorly defined call to action, conversion rate, etc. All these are follow-up activities that are part of a fully-fledged online strategy, which is a fundamental step in implementing SoLoMo marketing strategy.

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Evaluation of the Most Frequented Forms of Customer Feedback Acquisition and Analysis

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Abstract. Knowing and analyzing customer requirements is a constant challenge in quality management. Organizations can use various forms to identify and analyze these requirements. The most commonly used tools include complaint analysis, observation of customer behavior, like/dislike questions, questions about feelings, general questionnaires, external and internal focus groups, attributive satisfaction measurement and statistical analysis. This paper aims to explore the extent to which these techniques are associated with the organization's resultant success. The results are based on a survey and the data are processed by standard statistical procedures. Individual analyzes pointed out to the fact that in terms of the market situation there are four groups of organizations. One of them, named as "innovators", uses mostly semi-open forms of customer feedback acquisition and analysis. The success of the organization is a relatively broad concept, and the generalization of its predictors is not entirely possible. The submitted paper provides an objective view of forms of customer feedback analysis as an opportunity for organizational competitiveness.

Keywords: Customer feedback · Forms · Techniques · Competitiveness Quality management

1 Introduction

1.1 Customer Requirements

Customer requirements play a key role in business. Most often we meet the "management" of requirements in the field of quality management, but current studies show that this is a cross-cutting topic [10, 11]. Requirements are the needs or expectations of a customer towards the particular object – it can be a product, service, process, system, or whole organization [17]. Most often the product is associated with the requirements.

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The extent to which the product meets the customer's requirements is resulting quality. Quality is a precondition for the organization competitiveness [1, 2, 8, 17].

In quality management, customer unmodified requirements occur in two stages. The first is the identification of requirements and the second one is the measurement of requirements achievement – i.e. customer feedback [6]. Several forms, methods and techniques from simple to sophisticated ones can be used [9].

1.2 Forms of Customer Requirements Acquisition and Analysis

Two forms of techniques are used to identify customer requirements. One of them is Voice of customer. It is a direct survey of customer expectations and needs with his/her active participation [5]. Such methods may include questions about feelings, like/dislike questions, attributive satisfaction measurement, external focus groups or general questionnaires [3]. The second group is quality attributes development. Such methods don't require direct customer engagement, and they are concerned with the logical deduction of experts to "reveal" customer requirements. This group can include observations of customer behavior, complaint analysis, internal focus groups, or statistical analysis [4, 13].

In addition to these forms and methods, there are a number of other techniques that work with customer requirements such as critical incident technique [7], Kano model [16], analytical hierarchic process [15], or conjoint analysis [14]. These are, however, relatively sophisticated methods, the use of which is rather scientific, and their practical application in comparison to the others is smaller [10].

While it is possible to find the opinions that the purpose of these techniques is different, the prevailing opinion is that they all serve a generic purpose – to identify the customer requirements [5, 10, 13].

1.3 Research Gap

The above-mentioned methods are common tools for product development and validation. If information concerning customer requirements "are not lost" during the design, manufacture and delivery of the product, it is assumed that the product and, ultimately, the organization can be successful on the market. Empirically-oriented research into this problem has confirmed this assumption [12]. Until now, however, the impact of individual forms of acquisition and analysis of customer requirements on the final success has not been examined. In some studies, an evidence of implicit reference to relationship between these two factors can be found, but it is still open questions [11]. The aim of this study is therefore to examine empirically the impact of different forms of customer feedback on the success and competitiveness of the organization.

With reference to this aim, several questions could be mentioned that could help to understand the assumption that customer feedback is one of the sources of success:

1. What is the rate of use of different forms of feedback from the customer?
2. What are the relationships between utilization of different forms of measurement of customer feedback?

3. Is there a relationship between the forms of feedback measurement and the organization size?
4. Which forms of feedback measurement have the greatest impact on success?

Answers to these research questions are in the Sects. 3.1, 3.2, 3.3 and 3.4. To achieve them the procedures listed in the following chapter – materials and methods – were used.

2 Materials and Methods

This study is empirical. The basis to get the answers to the research questions were the data obtained from the survey. For the realization of the survey a questionnaire was created and it consisted of four attributes: predictors, forms, situational factors and organization type. These four attributes were then divided into 17 questions – each question representing one variable. Variables with "scale" measures were quantified in values from 0 to 100. The variables overview is found in Table 1.

Table 1. Basic data structure

Attribute	Variable	Measure
Predictors	P1: Usefulness of information from customer feedback measurement	Scale
	P2: Importance of customer feedback measurement	Scale
Forms	F1: Complaint analysis	Scale
	F2: Observation of customer behavior	Scale
	F3: Like/dislike questions	Scale
	F4: Questions about feelings	Scale
	F5: General questionnaires	Scale
	F6: External focus groups	Scale
	F7: Internal focus groups	Scale
	F8: Attributive satisfaction measurement	Scale
	F9: Statistical analysis	Scale
Situational factors	S1: Success of organization	Scale
	S2: Market position	Scale
	S3: Attractiveness of market	Scale
	S4: Easy of market entry	Scale
Type	T1: Number of employees	Ordinal
	T2: Sector	Nominal

The data were processed in the SPSS Statistics and Minitab software. Several procedures have been used for processing. Bivariate correlation analysis was used to explore relations between variables. Testing of subsets variance was performed by ANOVA. Reduction of the variables (in relevant cases) was performed by the factor analysis using the principal component algorithm. The most intense relationship between variables was in more detail analyzed by regression analysis. Groups of similar organizations were identified by K-means clustering procedure. The results are represented mainly in a graphical and tabular form and are supplemented by a text part containing interpretative comments.

3 Results

The survey was carried out in the Slovak Republic in 2017 and had an electronic form. Altogether, more than 70,000 organizations from all economic sectors were addressed. Random sampling procedure was used in this survey. After excluding incomplete or incorrectly answered questionnaires, totally 435 valid questionnaires were included in the analysis. Representation of individual organizations by size and sector can be seen in Fig. 1.

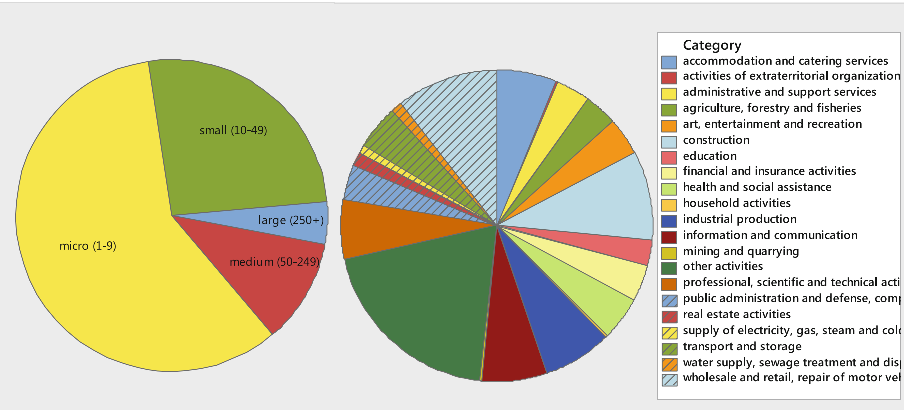

Fig. 1. Organizations by size (left pie chart) and by sector (right pie chart)

To validate the consistency of the questionnaire, the reliability analysis with the Cronbach alpha indicator was used. This metric is often used in psychology to measure scale reliability. It is therefore also appropriate in surveys assessment. The set of all numerical variables was on the value 0.851. Since it is more than 0.7 as recommended in the literature, the data set can be considered consistent.

3.1 Rate of Use of Customer Feedback Forms

In total, the survey included 9 forms of the acquisition and analysis of customer feedback. On the scale 0–100 the respondents were asked to indicate to what extent this form was used in their organization. The results are in Table 2.

The extent of use of these forms is very different – from the least frequently used forms such as statistical analysis (11%) to the most frequently used ones as observation (64%). More important, however, is that all variables have a relatively high variability

(35–40). In sociological surveys, variability usually oscillates around the level of 20%. This may evoke that the data is “mixed” from too many different groups. This suspicion was confirmed by a quick normality data test, which had negative results in all nine variables, so the data do not have a normal distribution.

In this case, two solutions are desirable – either the data are stratified into groups with lower variability (in our case by a sector) or a factor analysis is performed. Since the number of sectors is high, stratification would make the results unclear. Therefore, the data were subjected to the factor analysis procedure.

Table 2. Selected descriptive statistics of particular variables.

Variable	Mean	StDev	1st quartile	Median	3rd quartile	Mode
Complaint	49.68	37.90	10	50	90	0
Observation	64.37	37.02	40	80	100	100
Like/dislike	58.49	36.99	30	68	95	100
Feelings	52.10	38.15	10	50	90	0
QuestGen	31.40	40.08	0	0	70	0
ExtFG	23.96	32.60	0	0	50	0
IntFG	27.22	33.06	0	10	50	0
AttribSat	41.92	38.80	0	50	80	0
Stat	11.34	23.58	0	0	10	0

3.2 Relationship Between Customer Feedback Forms

The factor analysis was based on the principal component analysis method. Nine variables entered the process. The Kaiser-Meyer-Olkin measure has reached the value of 0.825 and the values of communalities for all variables exceeded 0.60 (the minimum requirement is 0.20). Thus, both assumptions for the correct factor analysis were met. Altogether, nine rotational iterations were performed and three factors were identified to account for up to 67% of the variability of all nine variables. The representation of these factors is in Table 3. For reasons of clarity, values below 0.300 were suppressed.

Table 3. Results of factor analysis (principal component method) – rotated component matrix.

Variable	Factor 1 (simple forms)	Factor 2 (semi-open forms)	Factor 3 (Analytical forms)
Feelings	0.838		
Like/dislike	0.828		
Observations	0.789		
Complaint	0.611		0.462
ExtFG		0.783	
IntFG		0.741	
AttribSat	0.549	0.572	
QuestGen			0.847
Stat		0.455	0.662

By factor analysis we managed to reduce the original 9 variables to three uncorrelated factors. The first is characterized by the strong influence of variables: feelings, like/dislike, observations and complaint. With regard to the character of these customer feedback forms, we could refer to this factor as "simple forms". The second factor is mainly represented by variables: external and internal focus groups and attributive satisfaction measurement. That's why we called it "semi-open forms". The latest third factor consists mainly of: general questionnaires and statistical analysis. Therefore, it has been named as "analytical forms". For other analytical purposes, the factor scores of all three factors were stored in each case. This score represents an "affiliation" of the case (respondent) to individual factors.

3.3 Relationship Between Customer Feedback Forms and Size of Organization

We could assume that the bigger is the size of the organization the higher is the sophistication of approaches to the customer feedback forms. The results were tested by a simple stratification according to the size of the organization. The monitored indicator being the individual factor scores of three identified factors. The results are found in Table 4.

Table 4. Means of factor scores by size of organization

Size of organization		Factor 1	Factor 2	Factor 3
Micro (1–9)	Mean	0.043	−0.092	−0.317
	StDev	0.996	0.962	0.791
Small (10–49)	Mean	0.007	−0.023	0.158
	StDev	1.029	0.940	0.940
Medium (50–249)	Mean	−0.090	0.322	0.768
	StDev	0.990	1.170	1.218
Large (250+)	Mean	−0.369	0.494	1.178
	StDev	0.874	1.132	1.054

Factor scores were standardized by Z-score. As a result, the average factor score of each factor is 0 and its standard deviation is 1. If, therefore, the values in lines "mean" are close to 0 and in lines "StDev" (standard deviation) are close to 1, that means, that in these types of organizations the use of selected customer feedback forms is average (after inclusion of all organizations). The table shows lower utilization of simple forms (factor 1) and larger utilization of analytical forms (factor 3) by large organizations. This is also confirmed by the analysis of variance carried out subsequently – Table 5.

Based on the results it can be seen that the size of the organization is a good distinguishing feature not only in analytical forms but also in semi-open forms. Simple forms have proven to be the universal methods for acquiring and analyzing customer feedback, which are used by both small and larger organizations.

Table 5. Selected descriptive statistics of particular variables.

Factor		Sum of squares	df	Mean square	F	Sig.
Factor 1: simple forms * Size	Between groups	3.427	3	1.142	1.144	0.331
	Within groups	412.573	413	0.999		
	Total	416.000	416			
Factor 2: semi-open forms * Size	Between groups	11.582	3	3.861	3.943	0.009
	Within groups	404.418	413	0.979		
	Total	416.000	416			
Factor 3: analytical forms * Size	Between groups	80.909	3	26.970	33.240	0.000
	Within groups	335.091	413	0.811		
	Total	416.000	416			

3.4 Customer Feedback Forms Impact on Success of Organization

From the previous chapter, it can be seen that the growth of the size of the organization increases the sophistication of customer feedback forms. The view of the use of forms is interesting, but more important for competitiveness improvement is their effect. In the survey, the effect was monitored using the variables “S1: Success of Organization” and “S2: Market Position”, supplemented by two other variables “S3: Attractiveness of Market” and “S4: Easy of market entry”. In order to investigate the effect, a bivariate correlation analysis was carried out involving 7 variables: four aforementioned situational variables and three factors (forms F1, F2 and F3) identified earlier. The results of this analysis can be found in Table 6.

Table 6. Results of bivariate correlation analysis. ** ($p < 0.01$)

Variables	F1	F2	F3	S1	S3	S3	S4
F1	1	0.000	0.000	0.391**	0.252**	0.320**	0.065
F2		1	0.000	0.082	0.127**	0.077	0.054
F3			1	0.154**	0.224**	0.201**	−0.007
S1				1	0.510**	0.429**	0.132**
S2					1	0.486**	0.131**
S3						1	0.164**
S4							1

The highest correlation coefficient for S1variable (success of organization) was identified in the simple forms of customer feedback (F1) and reached 0.391. In order to understand the intensity of the relationship better, it can be further explored by a regression analysis. A linear regression model with residual analysis was used. Its results are in Fig. 2.

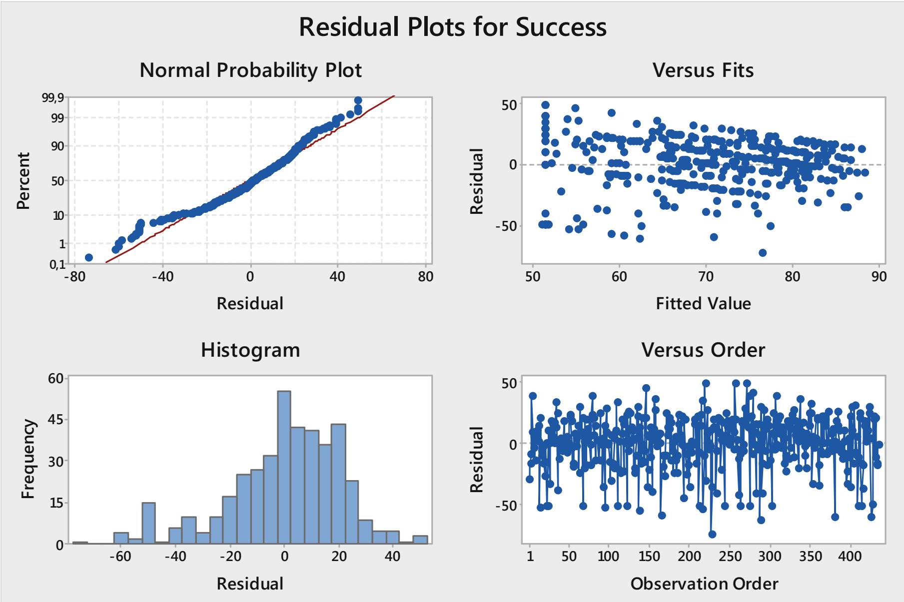

Fig. 2. Results of regression analysis

Confirming this relationship on the basis of regression is quite risky from the methodological point of view. Especially if there is a risk of collinearity between some situational variables (S1, S2 and S3).

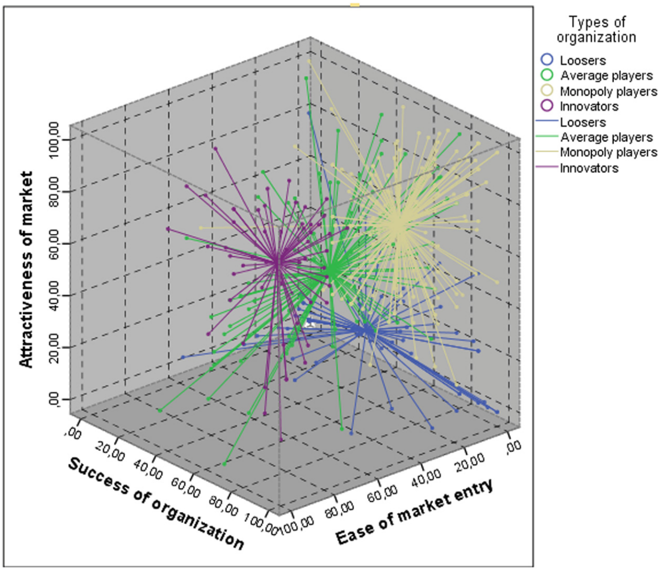

Fig. 3. Clustering of cases by K-means cluster

Another risk is the relatively low R-squared value – only 14.3% of the explained variance. In such cases, it is recommended to stratify according to those variables in which the collinearity assumption is assumed. In our case, these are situational variables S1 to S4. According to these variables, individual cases were grouped using the K-means cluster algorithm. It identified four groups that varied in their character. The groups were named "losers", "average players", "monopoly players" and "innovators" – Fig. 3.

These four groups varied according to their average values in each situational variable – success, position, market attractiveness and easy entry. While monopoly players are characterized by strong market power and difficult market entry, innovators achieve excellent results also in a simpler market entry and therefore in stronger competition as well – Fig. 4.

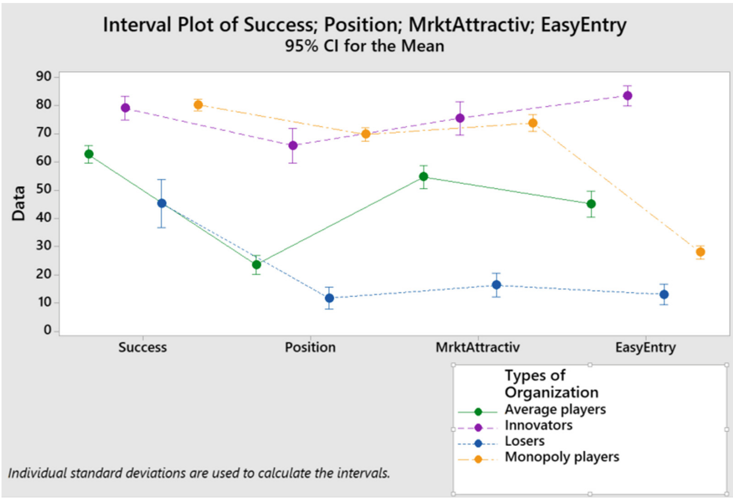

Fig. 4. Main characteristics of clusters

Clustering procedure identified four groups of organizations and created a new nominal variable. According to this variable, we subsequently stratified the results of the use of individual customer feedback forms – Fig. 5.

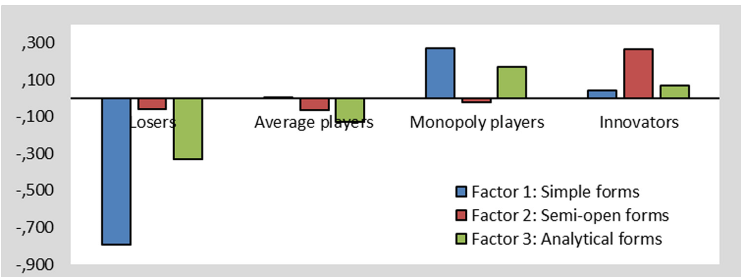

Fig. 5. Use of customer feedback forms by types of organization

The results of Fig. 5 can be characterized by the fact that unsuccessful organizations (losers) do not use almost any customer feedback form, the most successful organizations use especially semi-open forms. These forms consist of external and internal focus groups and attributive satisfaction measurement (see Table 3). Thus, it may be thought that strongly analytical tools do not play such a big role in a company success as (well-known) good knowledge of customer needs and expectations – this knowledge could be at most acquired by semi-open forms.

4 Discussion

Better knowledge of customer requirements is still an actual topic in efforts to increase the competitiveness of the organization. The aim of this study was to examine empirically the impact of different forms of customer feedback on the success and competitiveness of the organization. The results suggest that in a highly competitive environment, semi-open forms which enable better understanding of the needs and expectations of the customer are more efficient. On the contrary, for organizations that are close to the monopolistic market model or average players, simple forms of customer feedback are enough to succeed. In some cases, analytical forms may also be useful.

However, it is necessary to discuss to what extent these forms are used to improve market position and to what extent they are used with the aim to meet legislative requirements formally (e.g. the ISO 9000 standard). The brief results related to the customer feedback forms suggest that the second option also comes into play – Fig. 6.

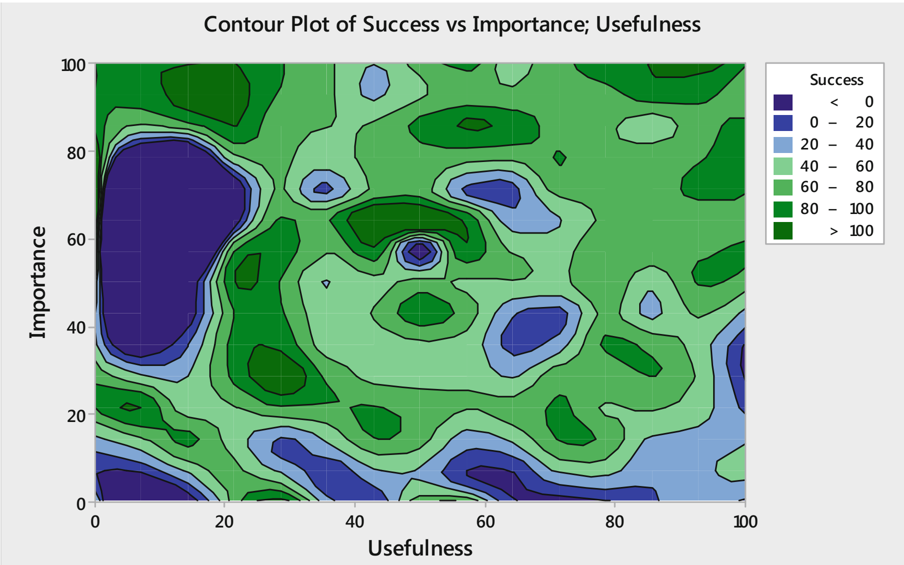

Fig. 6. Relationship between success, importance and usefulness of customer feedback acquisition and analysis

It can be seen from this figure that there is a distinct blue area on the left. It means the existence of organizations that are quite unsuccessful, but they consider customer feedback to be important (apparently under external influence), but they feel it is useless (apparently under internal influence). This result deserves separate attention and remains therefore as an open question of this presented research. Thus, it may be thought that strongly analytical tools do not play such a big role in a company success as (well-known) good knowledge of customer needs and expectations – this knowledge could be at most acquired by semi-open forms.

The results of this study are partly supported by the authors' claims about the need for customer feedback acquisition and analysis [5, 6, 12]. At the same time, they can present an objective source of information for discussion on quality management and increasing the competitiveness of organizations.

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Decision Support for Digital Marketing Through Virtual Organizations - Influencers on Twitter

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Abstract. Social networks have become a great communication channel where users express their opinions and sentiments freely. Companies have seen in these platforms an unbeatable opportunity to launch their promotional and commercial messages. The biggest challenge they face is the management and analysis of the huge amounts of data published on them and the location of influential individuals who may be prescriptors of such messages. Virtual Organizations become an unbeatable solution for the collection, filtering and analysis of all this information. The present work makes a proposal for an architecture that allows the management of data on Twitter to help make business decisions in the field of digital marketing. The results show not only the suitability of the architecture but also interesting conclusions about the elements of a tweet that determine the social influence of the individual or organization that publishes them.

Keywords: Virtual Organization · Twitter · Influencers · Decision making

1 Introduction

Online social networks are configured as a medium where many millions of users express their sentiments, their interests and their desires and share a multitude of contents that they themselves create or that they collect from others. Almost 2,800 million people are active users of social networks [15] and this figure is expected to increase to 2,950 million in 2020 [35]. Currently, social networks generate huge amounts of messages, photos and videos, this leads to a collapse when accessing to quality information [40]. In addition, the extraction of automatic information becomes a challenge [17] and more if this amount is such that it can not be managed in a simple way by a user [26], so that they are usually evaluated by methods computational [18]. These difficulties are being solved thanks to research and works that recover and organize this information in social networks [7, 21, 22, 40]. Although these platforms were conceived for playful use, social and entertainment, they have evolved and become consolidated as a clear alternative for bidirectional company-customer

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communication. Therefore, organizations are one of the agents with greater interest in the collection and management of a large amount of quality information in social networks, hence the Virtual Organizations are presented as an excellent option to help them in this task.

The objective of this work is the creation of an architecture of Virtual Organization (VO) that facilitates the collection, management and analysis of information obtained from social networks that facilitates decision-making for any type of organization [16]. For this, a case study is presented in which the tweets are analyzed in relation to two automotive companies (Nissan and Toyota). This proposal analyses the elements that determine the greater relevance of some tweets about others in terms of social influence and the most influential individuals are identified in the network of these two brands, which undoubtedly represents an excellent opportunity to improve the communication of the brands on Twitter. First, thanks to this proposal, individuals who can be prescribers of our brands or companies are located and the key elements so that our messages on the Twitter microblogging network are more effective and influential in the recipients of them are identified. The results point in the first place to the potential of the presented tool, secondly, they present a structure for writing tweets that any company can use to improve the impacts of their messages and, finally, it allows the unambiguous localization of influential users around a selected brand or word.

Subsequently, the theoretical framework of this work is presented first, secondly, the proposed a Virtual Organization architecture, followed by a section in which a case of real study will be reflected in the social network Twitter and finally the conclusions of our work.

2 Decisions in Digital Marketing and Virtual Organizations

Twitter is a social network of microblogging that was born in March 2006. Messages posted by users can be commented, indicated as favorites or shared with other users. Twitter users can follow other users and this relationship may or may not be reciprocal. Tweets can easily be integrated into topics through the use of hashtags (#) and can even name or address directly one or more people through the use of mentions (@). The relationships can be based on a family bond, friendship, work or a common interest.

As noted in the first section of this paper, the users therefore find their profile saturated with short messages that are being replaced by others, so the processing of the information becomes extremely complex [24, 25]. The messages that are sent can go unnoticed. It is for this reason that it is vitally important for any company that wants to have a relevant impact with its content on Twitter that, on the one hand, finds users whose messages have relevance and influence on others, and on the other hand, what does that a message increases the influence of the social profile from which it has been published. One of the most relevant theories to answer some of the questions posed is the heuristic-systematic model of information processing (HSM) [5] that can be used to explain how individuals decipher and process the large quantity of messages, and from there understand why certain messages are more attractive than others. There are already numerous researches that have used this model in the field of social networks [19, 41].

In the proposed model, individuals activate mechanisms in an unconscious way that allow them to detect heuristic clues that help them simplify the enormous amount of information they need to process. In the case of tweets can be elements such as hashtags, mentions or links. As we have been pointing out, another relevant factor is the influence that some users have over others. The analysis of interactions between individuals on Twitter facilitates the understanding of information flows and the location of users that have an influential position in the network [29].

Influence relationships between individuals have been a recurring theme of study in the offline environment. Social networks are conceived as a relationship between nodes (individual) that are linked through relationships. This conception is based on the classic and more than studied Graphs Theory [12] and that is fundamental base of the Theory of the Social Influence. This theory is based on the process by which some individuals influence the sentiments, attitudes, thoughts and actions of others [23]. The influence in the online environment is mainly due to the action of two mechanisms such as deindividualization and concurrence [27]. In the context of Twitter, these mechanisms are accentuated, the number of relationships of the individual is greater and the pressure of the group, which can cause a greater impact on the possible behavior of an individual [8]. Of course, not all individuals within the network will react in the same way, the so-called influencers, opinion leaders or digital evangelists, individuals who have the power to affect the decisions of others similar by their authority, knowledge, position or relationships [3] are the individuals that can make the difference, the challenge at the moment is the location of such influencers by the organizations [1].

To collect and synthesize all this tangle of information that occurs in a network like Twitter is not unreasonable to raise the use of intelligent agents integrated into a system. These agents have autonomy, ability to react to the environment, adaptability, communication, initiative and temporal continuity [10, 31, 34, 39] which makes them an essential element to manage the problem we have raised previously. And, they allow human agents to communicate with the intelligent agent through queries [36–38]. One way to model these systems with heterogeneous intelligent agents is the Virtual Organization [11, 13, 32, 33], based on the Theory of Human Organizations [9], allowing the description of the structure, behavior and dynamics of the organization [2]. Virtual organizations can be considered as a set of component grouped that need to coordinate resources and services across institutional boundaries [13, 30]. This approach allows the development of dynamic systems that adapt to the changes in their environment [6, 28]. In this proposed architecture to solve the problem of compiling, processing and analyzing the information of Twitter, each agent or agents have an individual objective or objectives and cooperate with other agents to achieve the objective of the organization [4]. The choice of Twitter is not casual. On the one hand, this platform allows the public extraction of messages and the content of individuals because these data are presented publicly. In addition, this network is the channel par excellence for interacting with influencers [1]. Finally, because taking into account the immense amount of content generated in it every second, it is ideal to prove that the proposal presented works and that it also does it in conditions of great demand in terms of the collection and storage of data.

3 Architecture Proposed

The proposed architecture is based on organizational aspects, which is why it is necessary to identify the organizational structure to be used. To do so, the first step involves identifying the components of potential users of the system. Based on this analysis, the roles of the agents that participate in the system and how they communicate are developed. It's a prototype based on a previous tool developed by the BISITE Research Group [21, 22].

The architecture is composed of different types of agents that are organized in three layers that will be described below (Fig. 1):

Layer 1: Raw data acquisition and processing. In this organization, the agents, upon request of the human agents in charge of making the decisions, collect the Twitter information and store it in a database that is subsequently filtered and processed to facilitate data to the organization of business analysis.

– Search agent: It communicates with the human agent who needs information to make a decision and then communicates with Twitter requesting information about users and tweets in relation to a keyword that the human has requested.
– Store management agent retrieves the tweets and data of the user who has published them according to the parameters that the previous agent has requested to Twitter and stores them in the database in the cloud. It will also be responsible for extracting them when required by another agent.
– Filtering agents: They are responsible for filtering the data you have obtained from the database thanks to the previous agent. Also discards the data that does not work.
– Low level processing agents: will be responsible for transforming raw data to codes and data that can be used in later phases by the next layer of our system (for example, determine the polarity of the sentiment [20, 32] of the tweets or estimate the influence score of each user on Twitter.

Layer 2: Business analysis. This second organization communicates with the agents of low level processing to request the extracted data that will be processed again for the realization of the analyses and calculations required by the human agents in charge of the decisions.

– Upper level processing agents: they are in charge of communicating with the coding and data extraction agents to obtain the necessary data to carry out the analyzes that have been required by the decision-making human agent.
– Coding and filtering agents: will be responsible for reviewing and filtering the previous data. They will eliminate tweets or user information that does not meet the criteria that have been indicated by the human agent. In addition, it will encode each of the data to adapt to the requirements of the analyzes that will be carried out at a later stage.
– Analysis, calculation and data extraction agents: perform the calculations and analyzes that have been required by the human agent and present the results in an interface adapting to what has been required.

Layer 3: Decision making. The latter organization is made up of human agents who will be responsible for making decisions in the company taking into account the results previously requested from the business analysis organization. Depending on the results obtained, they will be communicated again with the previous organization to give feedback on the adequacy of the information extracted so that this layer can learn and obtain optimal results adapted to the needs of the company. In addition, you will be contacted again with the first organization described above if you find it necessary to collect additional Twitter data.

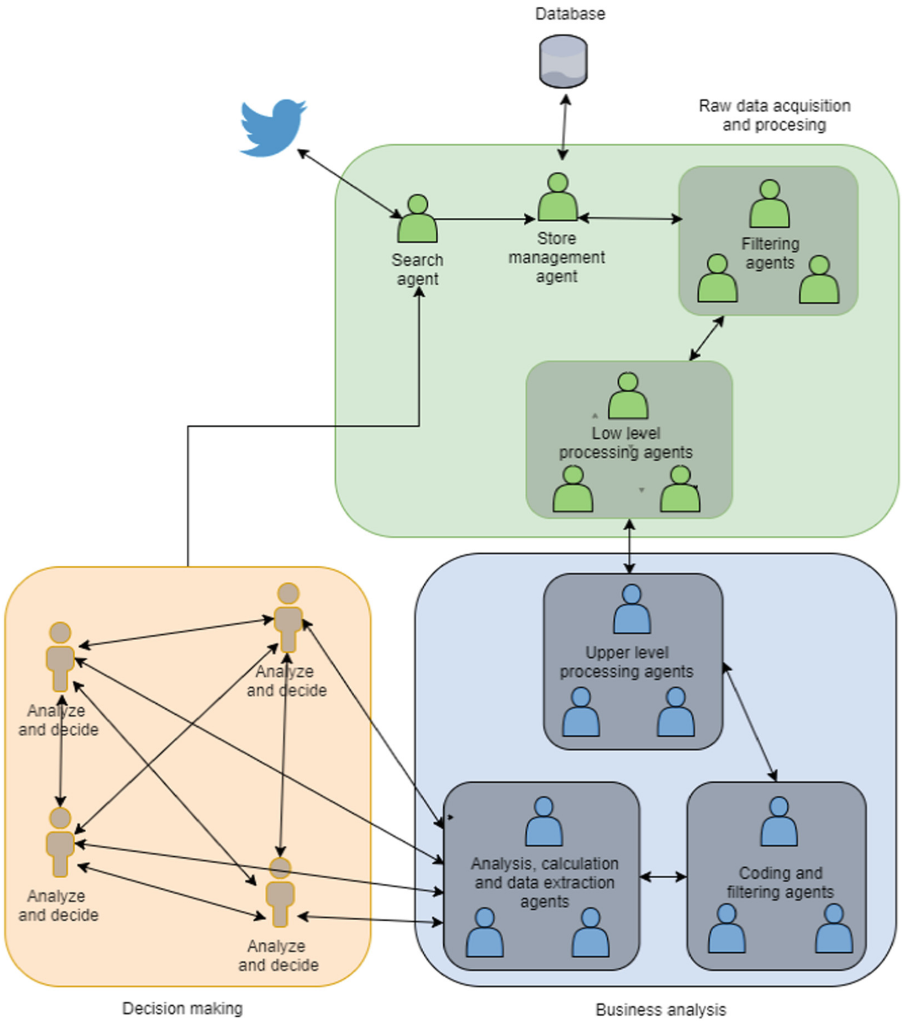

Fig. 1. Virtual Organization proposed, where three organizations are shown that will be responsible for the storage and first processing of Twitter data, the analysis of such data for the subsequent decision making by human agents of the company.

It consists of only one type of agent, in this case human agents. The number of agents will depend on the organization itself and the complexity and importance of the decision to be made. These agents will consult the results and analyzes obtained by the last agent of the previous layer and will make the decision that they consider most appropriate based on them.

They can also consider that the data is insufficient, requiring new data from the system and commenting on another new process of extracting data from Twitter for decision making.

4 Case Study: Social Influence and Digital Marketing Decisions

The objective of the case study proposed in this research is to know the elements that determine the influence of tweets published on Twitter and detect the most influential individuals in relation to the Toyota and Nissan brands. To achieve this objective, the previously presented Virtual Organization has been used. At present, the huge amount of information that flows through social networks prevents the processing of content by individuals. This is one of the reasons why commercial content does not always generate the desired impacts by companies or organizations. In addition, individuals tend to reject certain promotional, advertising or institutional content in our leisure spaces, especially if they come directly from the company. These are the two main reasons why many organizations use the influence of individuals in social networks so that they are the ones that provide this type of content to their followers' networks. An influencer in a network such as Twitter can help a business content prevail over other content. Therefore, our Virtual Organization must provide the decision-making human agent with the appropriate calculations to select the most influential users in the Twitter network of the two previously selected brands and also provide relevant information on their characteristics to determine which aspects determine the social influence in the context of study. Thus, and depending on the results obtained, it will adopt social or other actions to enhance the brand in the complicated environment of the largest microblogging network, opting for example by a marketing strategy of influencers or by a generation strategy. Content with certain characteristics, thus improving the company's impacts from the point of view of online positioning. The case study of this work has been carried out in the manner described below.

A scenario has been proposed in which a human agent selects two brands from the Japanese automotive sector (Toyota and Nissan) to collect information about the tweets generated on these brands in a period of 12 days. These brands are selected for several reasons listed below: because they are internationally renowned brands, because they belong to the country with the most weight in the automotive industry (Japan) and because the name of these brands does not have a double meaning such as the case of the Honda brand (which had to be excluded from the study due to problems of meaning in the Latin world).

The selected brands, as well as the language of the messages that are to be collected will be introduced in our data acquisition system, each brand is understood as a label that will be located in the messages (tweets) generated in Twitter in the chosen language. From the moment the system is launched, it will communicate with the Twitter API so that these messages and their structure, as well as information about the individual who published them, can be collected and stored in real time by the system. The raw data is stored in a database in the cloud which can be accessed at any time through an interface that shows the data already recoded.

Concluded the days of data collection, in our study case twelve days. These are turned over to the information management system in which the calculations required by the human agent in charge of decision making will be carried out. In this part of the process, various agents intervene to ensure that the data is cleaned, eliminating those tweets or data from individuals who are not complete, or who for several reasons have not been classified correctly.

Subsequently, the data that is required by the human agent is encoded and filtered for the decision-making process needed, in our case to locate the most influential users in the social network and from that classification, determine which are the characteristics that determine that effectively the contents that they publish have been of greater acceptance. Characteristics that are grouped into those of the individual and their social ties (number of followings and lexical variety of the individual as a proxy of the variety of topics that he is able to talk about in the social network) and those derived from the format of the tweets published (length of the tweet, sentiment or inclusion of additional elements to the tweet such as mentions, hashtags or links).

In this way, the system is based on the data calculated in the previous layer and applies the calculation model proposed by the decision maker, in the case of the present study a regression analysis has been proposed to help us understand why individuals that have been most influential of all those analyzed in the data acquisition layer have come to be based on their characteristics, those of their network and their way of writing the tweets. The equation proposed is the following:

$$\mathrm{I_i} = \beta_0 + \beta_1 \mathrm{LD_i} + \beta_2 \mathrm{F_i} + \beta_3 \mathrm{MC_i} + \beta_4 \mathrm{PS_i} + \beta_5 NS_{\mathrm{i}} + \beta_6 H_{\mathrm{i}} + \beta_7 \mathrm{M_i} + \beta_8 \mathrm{L_i} + \mathrm{e_i}$$

Where:

- I: is the influence on the social network Twitter (takes a value between 0 and 100).
- LD: lexical diversity captures the ratio between the unique words a user posts on a tweet divided by the total number of words written in a period. Ranking from 0 to 1.
- F: number of followings on Twitter of a individual.
- MC: average of characters of the tweets that the individual writes during the period of data collection.
- PS and NS: variables that reflect the polarity of the sentiment of the tweets depending on whether they are positive or negative.
- H: variable that indicates whether the tweet uses hashtags or not.

- M: variable that indicates if the tweet uses or not mentions.
- L: variable that collects whether the tweet has links or not.
- H, M and L are binary variables to test if these elements are present (value 0 or 1).

4.1 Case Study Results

The results obtained by the system allow to select those individuals who had been most influential in the analysis period in relation to the two previously selected brands and locate them unequivocally if so is wished thanks to the interface of the data acquisition layer. Table 1 presents an extract of the data with the most influential individuals, as well as its identification code. In addition, the variables that have determined this influence can be known, and these conclusions can be used to design more effective content on Twitter. The variables that were significant were the number of followings, the use of a positive sentiment in the published tweets, and the use of hashtags, mentions and links, the latter in a negative way. Figure 2 shown an example of a tweet that reflects the ideal characteristics of writing a message and that belongs to an influential individual in the community of the word Toyota. The tweet says: “What do you think? #WithMaryRabago #HighlanderHybrid #Let’sGoTogether thanks @Toyota friends” and it was published on April 15, 2015. The user that published it has a high influence score.

Table 1. Abstract from the database with the most influential users. A fragment of the database obtained for the case study is presented in which the ID and social influence value of the most influential individuals in the sample can be seen, which can take a value from 0 to 100.

User_id	Influence
878962471	52,155996
315384777	52,145197
87093734	52,135920
21927881	52,109531
85652658	52,049977
85652658	52,034173
270196028	51,988023
86013416	51,980018
291741396	51,962357
60099662	51,941394
233338836	51,941394
772189669	51,913833
…	…

Fig. 2. Tweet example (influencer user). The example shows a tweet with the ideal structure to achieve a great impact on Twitter and that has been published by a very influential individual from the database obtained.

5 Conclusions

As we have pointed out throughout our work, social networks and especially Twitter have become a space in which individuals share their sentiments, needs and interests on a daily basis. This information flows in excessive amounts making an analysis and extraction of quality information impossible to perform manually. Therefore, there is a need to use tools that facilitate and optimize this work.

Our proposal is a Virtual Organization that performs the processes of data acquisition and subsequent analysis in a simple, fast and providing the human agent responsible for the analysis of the information for subsequent decision making an unbeatable solution to the problem that we have indicated previously.

Through the case study, we have observed that the proposed system is functional and that it provides numerous advantages to human agents and organizations. The proposed structure can not only be implemented in other social networks or online spaces in a simple way, but also can be adapted to different decision-making processes of a company. We simply must request or modify the analysis required for the system so that it estimates the results and presents them to us through the interface prepared for this purpose. This platform, therefore, saves time and money in the management of information in organizations of any type and size, making it a powerful tool for business decision making.

In the case we have raised, these decisions are oriented to the management [14] of commercial and promotional content on Twitter. Thus, and thanks to the raised system, a company can locate the most influential individuals in a community around a specific brand, company or topic and consider, for example, using this type of user as prescribers of said organization. Even analyze the profile of these individuals to know how to focus their commercial or promotional messages so that they have a greater impact in the community to which they are directed, since as we have seen, our system has allowed us to also obtain valuable information about the variables that determine the greatest impact of the published tweets in relation to a certain label. These analyzes open a door to the efficient management of content on Twitter and allow optimizing marketing efforts in social networks, assuming a saving of time and money.

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Big Data and IOT

Towards the Automatic Identification and Monitoring of Radicalization Activities in Twitter

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Abstract. In the recent years, several terrorist groups have started to make an intensive use of the Internet and various online social networks to spread their message and radicalize vulnerable individuals. In this context, security forces are in charge of detecting and monitoring ongoing radicalization processes, which often take place publicly, in social networks such as Twitter. Unfortunately, effective countermeasures can only be adopted through early detection, which is not always possible through manual analysis due to the growing amount of information to be analyzed. We propose a novel framework to enable the automatic detection and monitoring of radicalization processes that occur in Twitter. In particular, our system performs two different tasks: (1) Detects influential users with a radicalization agenda, suggesting relevant profiles to human supervisors; and (2) Monitors the interactions of confirmed radical users, estimating the risk of radicalization for vulnerable users that interact with them. Finally, we present a case study on the monitoring of "Hogar Social Madrid", a far-right extremist group that operates in Spain and makes an intensive use of social networks. In this case study, we show how our platform enabled us to identify several profiles immersed in a process of radicalization, which corresponded to young individuals that recently adopted the radical messages and ideas of "Hogar Social Madrid".

Keywords: Social network monitoring · Radicalization detection
Sentiment analysis

1 Introduction

In the recent years, several terrorist groups have started to make an intensive use of the Internet and various online social networks to spread their message and radicalize vulnerable individuals [4]. Their goal involves encouraging others, especially young people, to support their terrorist organizations, to take part in the conflicts of Middle East and even to commit acts of violence in occident when traveling is not possible. For this reason, terrorist propaganda targets young western individuals and adopts their channels of communication and language. In this context, security forces are in charge of detecting and monitoring ongoing radicalization processes, which often take place publicly, in social networks such as Twitter. Unfortunately, effective countermeasures

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can only be taken through early detection, which is not always possible due to the growing amount of information to be analyzed [8, 14, 16].

We propose a novel framework to enable the automatic detection and monitoring of radicalization processes that occur in Twitter. In particular, our system performs two different tasks: (1) Detects influential users with a radicalization agenda, suggesting relevant profiles to human supervisors; and (2) Monitors the interactions of confirmed radical users, estimating the risk of radicalization for vulnerable users that interact with them.

The rest of this paper is structured as follows. Section 2 provides an overview of applications of social network and sentiment analysis for radicalization detection in the literature. Section 3 describes the architecture and workflow of the proposed framework. In Sect. 4, we present a case study where the proposed system is used to identify users in risk of radicalization by a far-right extremist group. Finally, Sect. 5 comprises the conclusions and proposes some promising future research lines.

2 Related Work

With the emergence of the online-radicalization phenomenon, several researchers have turned their attention to this problem, trying to increase our knowledge about how terrorists use social networks and how security forces can prevent and detect the online radicalization of vulnerable users.

In [7], the authors identified a group of radical Youtube users manually and used social network analysis techniques to extract their comments and analyze them. In particular, the authors used sentiment analysis to study gender differences in the messages spread by this group of radical users. This work revealed some interesting features of radical user networks. For instance, their results suggest that users with a higher status within the group where less likely to provide information about their gender. Also, in their case study about jihadism, women manifested a higher degree of sympathy towards political violence actors.

In [26], the authors propose a framework to build a social network based on the contents of different weblogs, the relationships between bloggers and the implicit relationships found in the semantics of the published messages. Once this network has been built, the framework provides numerous visualization techniques with different levels of abstraction to ease the exploration of the network and the extraction of knowledge. For instance, the platform is able to generate concept network visualizations and graph visualizations of users communities.

Regarding the social network Twitter, most works focus on the massive extraction of tweets to monitor the social reaction to terrorist attacks or other real-word events [9], rather than identifying concrete user profiles at risk of radicalization. Other authors have tried to identify radical users by analyzing the content of individual tweets, neglecting the information present in the following relationships and other user interactions [1]. Aside from terrorist propaganda detection and analysis, many works have focused on mining the information provided by users in social networks mostly with purposes related to sociological studies and marketing campaign impact assessment [20]. One remarkable example is the use of social mining techniques and natural language processing methods to assist the detection of drug-related adverse events in the real world by analyzing Twitter messages [3].

In addition, it has been shown that users in social networks interact in a homophilic manner; that is, they tend to maintain relationships with people who are similar to themselves, as characterized by age, race, gender, religion, ideology, or profession. For instance, in [16] the authors analyzed different community detection techniques to cluster users according to their political preferences. In particular, their case study about the political situation in Spain showed that analyzing one-directional following relationships in twitter leads to a more fine-grained community detection result with the Louvain algorithm. Conversely, analyzing bi-directional following relations leaded to a more coarse grained detection in their experiments (i.e., communities were merged together resulting in less detected groups). Our proposed approach relies on this tendency of users to interact with similar others while using social networks to automatically detect users in risk of radicalization by analyzing their interactions with confirmed radical profiles.

3 Proposed Approach

Our approach can help human experts in identifying this kind of profiles. Figure 1 shows an overview of the workflow of the proposed platform. The proposed workflow starts from the retrieval of useful information from the social network. This is achieved by filtering among all the published tweets. A collection of dictionaries which contain words and communication patterns used by radical users in different topics is used for the identification of radical users. This corpus is designed earlier by experts during the process.

From this corpus different search patterns can be built. These are represented as collections of words unified by different sets of basic logic operators (AND, OR). The resulting combinatorial tree is used by the platform to retrieve only the useful information from the network according to this schema. In this way, our tool analyses the stream of tweets published worldwide in real-time. Users whose tweets match the dictionary are registered and their digital footprint is further investigated by the platform. Potentially radical profiles are then presented to a human expert to verify whether they actually correspond to individuals with a radicalization profile or not.

The second stage of the platform is to monitor the sub-networks conformed by the profiles selected by the human expert. This way, the platform can detect how the radical ideology of these users spread across the network and which users might be at risk of being radicalized. To this end the platform estimates: (1) the overall potential and ability of a radical user to radicalize other users and (2) the risk and overall vulnerability of being radicalized. This section details the different algorithms and procedures applied by the proposed platform to partially automatize the detection and monitoring of radical users in Twitter.

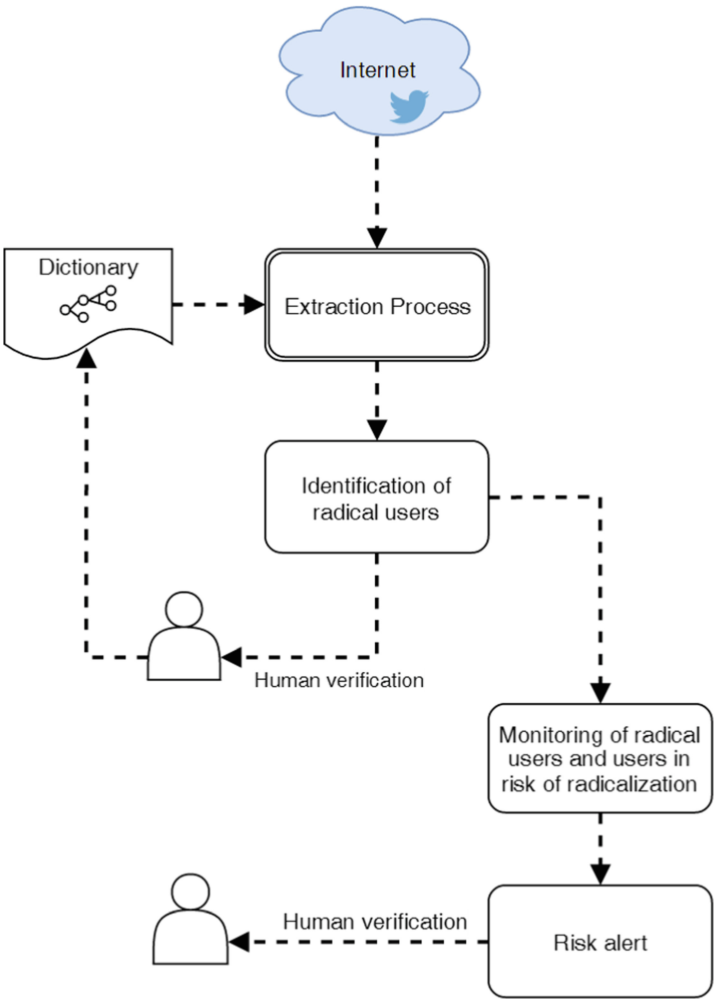

Fig. 1. Platform workflow schema

3.1 Identification of Radical Users from the Global Stream of Tweets

Essentially, our system uses several dictionaries that contain common patterns and keywords used by radical users in different domains. These dictionaries may be created by human experts, capturing in this manner their expert knowledge. By doing so, the dictionaries provide a flexible preliminary filter to radical user detection. In addition, as more insight is acquired on the communication habits of a certain group of radical individuals, the set of relevant patterns and keywords can be refined.

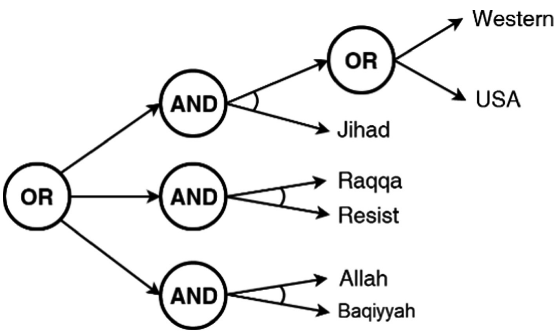

Fig. 2. Example AND/OR tree for ISIS propaganda identification

Our proposed approach to radical user identification involves the following steps:

- The human expert selects a dictionary according to the target radical ideology. The pattern dictionaries can be represented as a AND/OR tree, whose leaves indicate the presence of a specific word in the tweet (see Fig. 2).
- Our platform starts to download every tweet matching the pattern defined by the dictionary. The users that publish those tweets are identified and stored.
- The most relevant users, according a set of metrics (follower's number, retweet…) are selected as possible radical users that must be monitored.
- The selected users are shown to the human expert, who determines whether the suggested profiles truly correspond to radical users.
- Once a set of radical users has been identified by the human expert, the system enables a continuous monitoring and radicalization prevention process. The techniques proposed to solve this problem are described in the next section.

Once a set of radical users has been identified by the human expert, the system enables a continuous monitoring and radicalization prevention process. The techniques proposed to solve this problem are described in the next section.

3.2 Monitoring of Radical User Networks

As described in previous sections, the purpose of this surveillance is the detection and prevention of vulnerable users being radicalized. Initially, the monitored network consist of radical users identified either by expert knowledge or with the aid of the techniques described in Sect. 3.1. More specifically, we have a set of radical users and a quantitative measure of their radicalization-influence level:

$$U = \{(u_1, r_1), (u_2, r_2)\ldots, (u_n, r_n)\} \tag{1}$$

Where u_i is a radical user and $r_i \in [0, 1]$ a measure of its radicalization-influence. This influence can be assigned manually or estimated as a function of the number of followers, retweets and favourites. In particular, we propose calculating the radicalization influence of a given user u_i as follows:

$$r_i = \min\left(1, \frac{RTcount + FavCount}{tweetsCount}\right) \tag{2}$$

The twitter-following relations play a key role in the radicalization process. It has been shown that online social networks as Twitter exhibit a significant level of homophily 161820. For this reason, we can analyze the topology of a sub-network to measure the risk of radicalization of surrounding users.

Once the monitoring process begins, all the previously published tweets of monitored users are downloaded and analyzed. The goal here is to find interactions (e.g. mentions and retweets) between radical users and potentially vulnerable users of the social network. To this extend, the following information is considered:

- The list of all mentions published by the monitored users: $M = \{M_1, \ldots, M_m\}$
- All retweets done by the monitored users: $RT = \{RT_1, \ldots, RT_r\}$

Every user that has interacted with any of the monitored radical profiles is analysed and its risk of radicalization is estimated. The risk of a given user u being radicalized is computed as follows:

$$\begin{aligned} Risk(u) = & \sum_{i=1}^{n} r_i \cdot follows(u, \boldsymbol{u_i}) + \sum_{i=1}^{n} r_i \cdot follows(\boldsymbol{u_i}, u) \\ & + \sum_{i=1}^{r} RT_i.to(u) + \sum_{i=1}^{m} M_i.to(u) \cdot |sentiment(M_i)| \end{aligned} \tag{3}$$

where $|sentiment(M_i)| \in [0, 1]$ is the automatically estimated absolute value of sentiment 14 of the mention's original text. Currently, our prototype is capable of estimating the sentiment of tweets in Spanish, English, French, German, Russian and Arabic 20. This term was introduced in our formula after the observation that tweets or mentions with a strong emotional load might be more relevant to predict radicalization risks. For example, in Fig. 3 our method predicts a high radicalization risk because the user follows and is followed by a very influential radical user and received a mention with a strong emotional load from another radical user.

As interactions in social networks occur dynamically, our prototype platform performs the monitoring task described above in real time, periodically re-calculating the risk of radicalization.

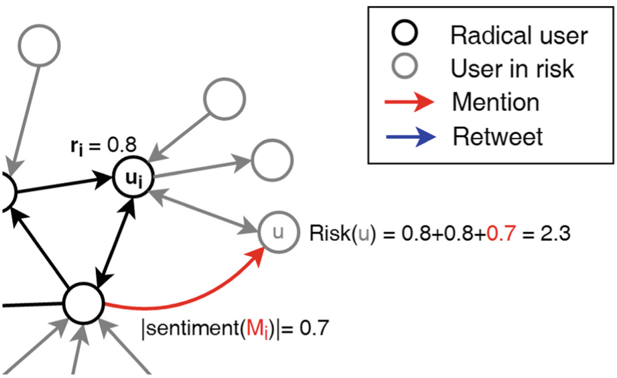

Fig. 3. Example of radicalization risk estimation

4 Case Study: Monitoring an Spanish Far-Right Extremist Group

In this section, a small study case is presented to illustrate the effectiveness of the proposed radicalization monitoring methods. Although the proposed system was designed to track Islamic terrorist supporters, it can be applied to other domains and radical ideologies. Specifically, we monitored the activity of four profiles related to a far-right extremist group that operates in the city of Madrid. This association, "Hogar social Madrid" (HSM), is well known by security forces for the spreading of xenophobic ideas and its relation with European neo-fascist groups (e.g. Golden Dawn). In this study case, we selected four social network profiles directly associated to this association. Then, the algorithm described in the previous section was executed to identify a number of users in risk of radicalization. Figure 4 shows the four selected radical users, the top-2 most vulnerable user as predicted by our algorithm and their "following" relations in the social network (names have been blurred to protect their privacy).

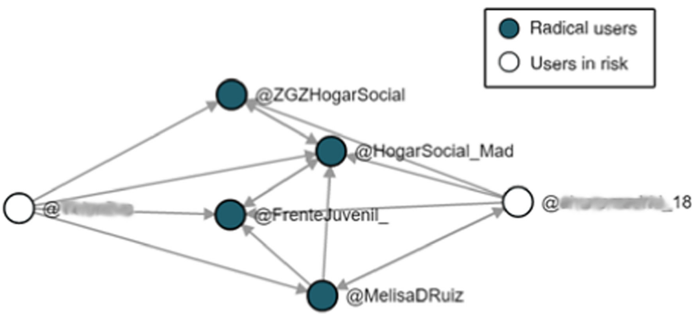

Fig. 4. Far-right radicalization network example (the names of the users in risk of radicalization have been omitted to protect their privacy)

A manual analysis of the users in risk confirms that these users have a strong ideological alignment with the extremist ideas of HSM and confirm the ties between this association and the neo-fascist political party Golden Dawn (see Fig. 5). From the profile image of the second user in risk, we can see that he is probably under 25 years of age, thus being the perfect target for radicalization [6].

Fig. 5. Two sample vulnerable users immersed in a radicalization process by the far-right extremist group HSM as detected by our platform

We can also visualize the activity in the social network of some monitored users over a specific period of time (see Fig. 6). This can be useful to find temporal correlations, which might indicate that two different profiles are managed by the same person.

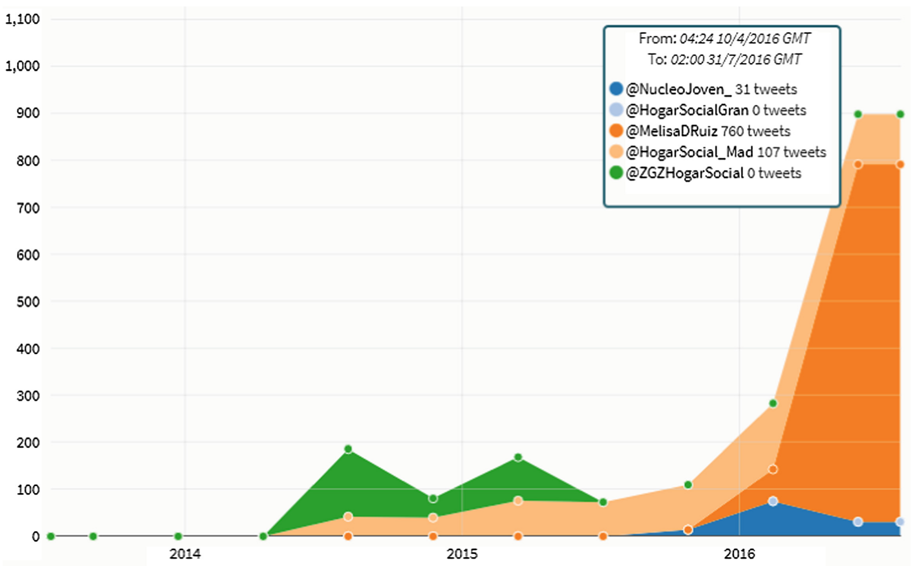

Fig. 6. Stacked chart with the activity of different monitored users

5 Conclusions and Future Work

In this document, we have described an automated framework for radical user identification and monitoring. Our prototype is designed to minimize the degree of human intervention needed to operate the software, making sure that all the repetitive, mechanic tasks have been automatized.

As compared to previous terrorism-centered social network analysis frameworks present in the literature [1, 9], the proposed framework enables investigators to detect users at risk of radicalization by analyzing their interactions with confirmed radical users. This is achieved by mining both the textual content of tweets by means of sentiment analysis techniques and the topology of the network of social interactions.

We have also presented a small study case where we identified a couple of users immersed in a process of radicalization by far-right groups. The early-stage radicalization detection enabled by our framework might help deploy effective countermeasures. However, further work is required to evaluate the tool in real-world scenarios, with additional and more exhaustive case studies. In particular, the analysis conducted in this paper is mostly qualitative. In the future, we intend to evaluate our framework on real-word datasets, assessing the precession and recall of our system and studying the effectiveness of our framework with different radical ideology groups.

In addition, the applicability of more sophisticated techniques (e.g. fuzzy logic [21] and neural networks [17, 23]) at various stages of the framework shall be explored. These techniques combined with natural language processing algorithms may be used to automatize the creation and maintenance of the dictionaries of radical users' communication patterns. Moreover, the over-time refinement of the dictionaries could be handled by applying a CBR methodology [18]. Finally, implementing the proposed framework in the context of a multi-agent system [11–13, 19, 24] could enable a more flexible way of processing information [2] by taking into consideration different agents, permissions [15], privacy constraints [10, 25] and load balancing strategies [5, 22].

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A Proposal for Application Discovery in the Context of IoT

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Abstract. In this paper we discuss some drawbacks of IoT in relation to reuse of applications. The studied approaches do not propose a repository for cataloguing applications or tools for discovering IoT applications for reuse. The purpose of this research is twofold: *(i)* propose a repository model to catalogue IoT applications, and *(ii)* present a tool for discovering IoT applications for reuse. The goal is to enable the search and reuse of existing solutions to avoid rework and to facilitate the development of applications for IoT. Based on the proposed approach, a proof of concept was implemented by means of a prototype. For the discovery process, a version of a *k*-NN (*k*-Nearest Neighbor) algorithm was adapted to use both Euclidean and Levenshtein distances. This was necessary due to descriptor types required to identify the applications. The prototype was applied to a case study with promising results, pointing out the usefulness of this proposal.

Keywords: IoT · Application discovery · Software reuse

1 Introduction

The changes incorporated to Web 3.0 brought improvements in the organization and systematization of information with the semantic web concept [14]. Web content became more than machine-readable and allowed computers and search engines to behave intelligently without the need for human intervention. Mobility and ubiquity are added to this evolution to mark the birth of Web 4.0, facilitating the use and interpretation of available information to support decision-making [6]. Internet of Things (IoT) is the key technology to unleash these advances.

IoT subsidizes solutions for Industry 4.0, a major paradigm shift in the way factories operate today, in the sense that it requires intense information digitization and direct communication between systems, machines, products and people [17]. In order to make Industry 4.0 a reality, it will be necessary to adopt a set of emerging IT and industrial automation technologies and the formation of a physical-cybernetic

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production system. Other current changes in the digital economy such as smart cities, smart homes and buildings, smart grid, agrobusiness sector, health, well-being, among others, will largely depend on IoT technologies [5].

IoT benefits from the advances of Internet, sensor network technologies and wireless actuators, which are part of a network of devices and objects massively connected. The convergence of these technologies is leading to the possibility of a structure that allows direct machine-to-machine communication through the Internet.

Kelvin Ashton coined the term Internet of Things in 1999. At that time he applied the term IoT as the title of a talk he gave at Procter & Gamble to link the new idea of RFID in the chain of supplies. Ten years later, Ashton [1] argued that he was right choosing the title of the lecture. His intention was to show that computers, and therefore the Internet, are strongly dependent on the limited capacity of humans to gather information. In his words, it is necessary to empower computers with their capability of gathering information. In a sense, computers could see, hear and smell the world by themselves.

The IoT paradigm has emerged with the widespread use of the Internet and recent technological advances such as Wireless Sensor Network (WSN), mobile communication and ubiquitous computing. Figure 1 shows the key concepts, technologies and standards involved in the creation of IoT. It is clear that the IoT paradigm resulted from the convergence of Internet, Things and Semantics [2].

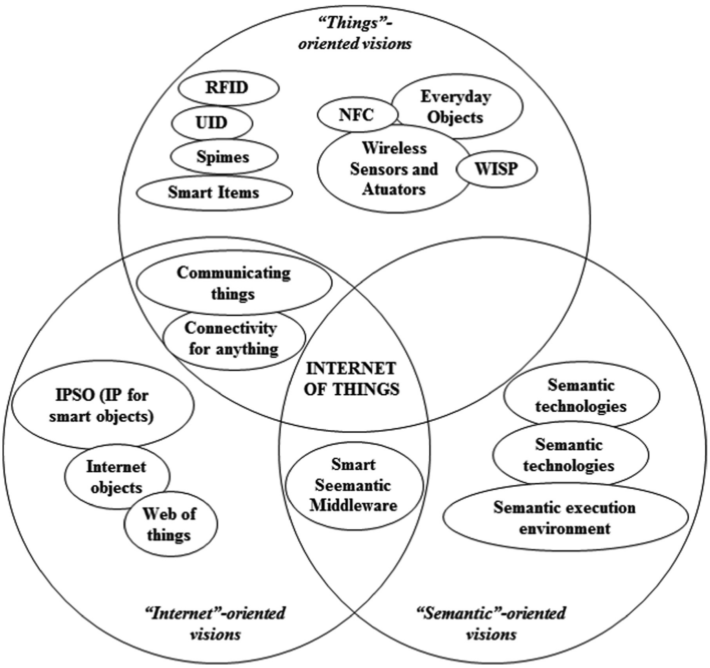

Fig. 1. IoT paradigm as a result of the convergence of different visions [2].

The “Things” oriented view is related to the identification of simple things with single addressing. It uses technologies such as RFID and NFC (Near Field Communication). The Internet-oriented view is closely linked to the protocols and their adaptations in order to allow the exchange of data between things and the Internet. The Internet 4.0 involves a large amount of data due to the exponential growth in the number of objects to be identified in IoT. This new context justifies the creation of things models for obtaining and processing data from IoT [3]. This is important for the development of decision-making systems.

Considering the accelerated expansion of IoT, it could be expected that this will also occur in relation to the number of applications to be developed in this platform. In this scenario, we present an approach based on Artificial Intelligence (AI) for discovering and reusing applications in the context of IoT. The results presented in this paper can be used to the discovery of IoT applications developed for smart cities, education institutions, healthcare companies, among other organizations.

2 Research Problems in IoT

IoT technologies present several research challenges that are approached both in the academy and in consortiums of companies interested in this subject. An approach to assess the limitations of the current IoT scenario and identify possible gaps could be to pay attention to the main actors in the IoT ecosystem, including vendors, application developers, platform providers or related services and final users.

Mineraud et al. [12] present a gap analysis of the context of IoT in order to identify relevant research problems:

- **Lack of integration between sensor technologies:** Demand improvements in the connection of heterogeneous restricted sensing and actuation devices with different restrictions and capacities, as well as the definition of passive device connectivity (RFID enablers).
- **Lack of models for data management:** IoT devices generate a huge amount of data that needs to be managed and analyzed. A management model and data ownership is a major concern for IoT platforms.
- **No dedicated catalogs:** Relevant data streams should be findable; they could be listed in dedicated catalogs where context information supports efficient discovery mechanisms.
- **Lack of adequate support for interoperability:** IoT platforms provide public application programming interfaces (APIs) based on the principles of the Representational State Transfer (REST) architecture to access the services provided. However, platforms use non-uniform REST API templates that complicate mashing up across platforms.
- **No dedicated IoT marketplaces:** Software application marketplaces seek to facilitate the discovery, purchase and distribution of applications. These marketplaces are a kind of centrally controlled solution like Apple App Store and Google Play. The author states that current stores have limitations on IoT applications. None of the current stores support the delivery of software purchased for connected devices, excepting the mobile terminals supported by the platform.

IoT focus is on the devices (sensors and actuators) and the communication technologies used to access them [18]. It is expected that IoT vendors will reach U$ 263 billion by 2020, with most of that amount coming from services [7]. Web technologies are already being applied to IoT and will be expanded to assist IoT and move beyond product silos in open web ecosystems based on open standards. To enable this, it will be necessary to create standards for identification, discovering and interoperating services from different platforms and suppliers. This will involve the need for precise descriptions and shared data models [18].

Mazhelis and Tyrvainen [10] analyzed several IoT platforms and identified a lack of facilities to discover or purchase of applications. In fact, none of the platforms offer a catalog of applications or services, that is, an app store for IoT to distribute devices and applications. In addition, there are no mechanisms for discovering IoT applications and services.

This paper focusses on the following research question: "How to make possible the search and reuse of IoT applications?"

There are many research results published on IoT and its wide universe of possible applications, but there are only a few scientific studies and reports on the discovery of applications for IoT and their relevance.

Mazhelis and Tyrvainen [10] investigated the main features of twelve IoT platforms. These features focused more on supporting the design and implementation of applications and services than on their functionalities. Apparently, the least supported activity is the discovery and purchase of applications. In fact, none of the platforms currently offer a catalog where applications or services can be found. One of the platforms, more specifically Arkessa, has committed to make this support available in the future.

Table 1 presents the main characteristics of IoT platforms analyzed, where the Purchasing column refers to the discovery and purchase of IoT applications.

Table 1. Characteristics of cloud IoT platforms [10]

Platform	Design and implementation				Operations			
	Device	Gateway	Web	User interface	Fulfillment		Assurance	Billing
					Purchasing	Provided		
Arkessa	+	−	+	+	(+)	+	+	−
Axeda	+	+	+	+	−	+	+	+
Etherios	+	+	+	+	−	+	+	−
NanoService	+	+	+	+	−	+	+	−
Nimbits	+	−	+	+	−		−	−
Ninja Blocks	+	+	+	+	−	+	+	−
OnePlatform	+	+	+	+	−	+	−	−
RealTime.io	+	+	+	+	−	+	−	−
SensorCloud	+	+	+	+	−	−	−	−
TempoDB	+	−	+	+	−	−	−	−
Thingworx	+	−	+	+	−	+	+	−
Xively	+	+	+	+	−	+	+	+

The main stakeholders that will benefit from the proposed model are the IoT application developers as well as users and business analysts. Developers can benefit from checking already existing solutions to the problem they want to solve and by reusing them to avoid rework. Users and business analysts will be able to benefit from the possibility of finding an IoT application that is already running, so that it might be applied within its context.

3 IoT Architectures and Applications

Things in IoT can be any objects in the physical world or the information world (virtual things) that are capable of being identified and integrated into communication networks [9]. IoT is a paradigm where intelligent objects collaborate actively with other physical and virtual objects available in the Internet. The IoT environments are characterized by the high degree of heterogeneity of devices and network protocols [16].

Borgia [5] emphasizes that intelligent objects are the building blocks of IoT. By including intelligence into everyday objects, they are transformed into objects capable of not only collecting information from the environment and interacting/controlling the physical world, but also exchanging data and information, since they are interconnected over the Internet.

In the context of IoT, beyond the concept of things, the concept of device plays an important role. A device can be a sensor, a label or an actuator. In general, it is an integral part of a thing. Thus, a thing is any object that has utility for humans, which can interact and communicate with other things via the Internet by being coupled to some computational device with both processing and communication capability [19].

IoT is a global infrastructure for the information society, enabling advanced services through the interconnection (physical and virtual) of things based on Information and Communication Technologies (ICTs). By exploring capabilities for identification, data capture, processing and communication, IoT makes full use of things to offer services to all types of applications, while ensuring that security and privacy requirements are met [9].

IoT paradigm combines aspects and technologies from different approaches [5]. Ubiquitous computing, Internet protocol, detection and communication technologies, and embedded devices are brought together to form a system where the real and digital worlds meet and are continually in symbiotic interaction. Figure 2 presents a macro view of the hierarchy of concepts involved in the IoT paradigm, which were developed due to lack of *(i)* standardization in network protocols and middleware platforms and *(ii)* heterogeneity of IoT devices. These concepts are: Reference model; Other elements; Reference architecture; Instantiated architecture; and System.

The Reference model is an abstract representation that presents a set of common concepts and relationships within a specific domain. Therefore, it is independent of standards, technologies, implementations or other more concrete details, and can be represented through conceptual models, taxonomies or ontologies [13].

Other elements specifies, in a unified and unambiguous manner, business rules, architectural styles or patterns, architectural decisions, good development practices, and hardware and/or software elements needed to build concrete architectures, which

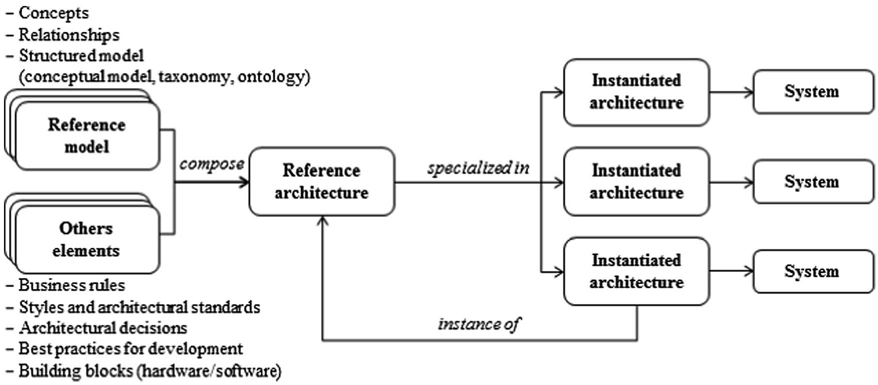

Fig. 2. Relationships between reference models, reference architectures and concrete architectures [16]

belong to the systems themselves [16]. The building blocks provide higher levels of business functionality within the context of the enterprise. They facilitate the architecture understanding, diminishing the learning curve and the effort for designing businesses rules.

The Reference architecture is based on one or more reference models. In the context of IoT, they are used to guide and facilitate the construction of concrete systems, considering the high heterogeneity and the lack of standardization in devices, protocols and middleware platforms. The research findings on reference architectures in IoT are recent. The most widespread IoT architecture proposals [2, 4, 8] can be organized in four layers as shown in Fig. 3.

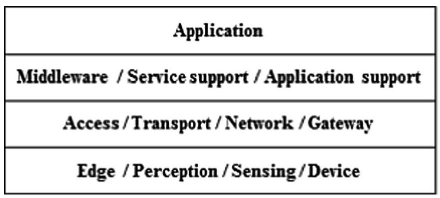

Fig. 3. Layered architecture of IoT

These layers can be described as follows:

- **Application Layer:** presents the features offered by the system and allows performances in the devices involved. Applications run on mobile applications and Internet sites.
- **Middleware layer:** Zarghami [20] specifies its main functionalities: *(i)* interface with access layer protocols; *(ii)* device abstraction; and *(iii)* acting on the data context and offering abstraction for the application. In the first feature, the middleware layer defines the information exchange protocols with the lower layers. In

the second, the layer acts on the data context, that is, it collects the information offered by the devices and selects the information that has an impact on the decision making process. In the third, the layer uses a RESTful interface to facilitate the interaction between client and devices. Thus, procedures do not need knowledge about implementations using the GET, DELETE, PUT, and POST primitives.
- **Access Layer:** is responsible for the first processing of received data and performs communication with the Internet, usually using Wi-Fi or cellular data technologies.
- **Acquisition Layer:** performs basic functions of obtaining physical data and communication. Sensors, actuators, embedded systems and RFID tags are in this layer. This hardware is responsible for providing identification, collecting physical information from the environment where they are located (sensors), acting mechanically in the medium (actuators) and allowing the sending/receiving of information.

Instantiated architectures are specializations of the Reference architecture over which the systems are built. The mechanisms work in two abstraction levels: *(i)* on the architectural level, abstracting the complexity of infrastructure generic services and *(ii)* on the IoT system detailed design level, providing means to facilitate the communication, data storage and retrieval.

According to Borgia [5], IoT has enormous potential for the development of new intelligent applications in almost all fields. This is mainly due to its dual ability to perform localized sensing and to offer customizable services. Regardless of the application field, it aims to improve the quality of daily life and have a profound impact on the economy and society. Figure 4 shows the subdivision of related domains and provides a non-exhaustive list of IoT applications for each one. Not all IoT applications have the same level of maturity. Some of them are already part of daily's people routine; others are still in the experimental phase, and others are more futurists and are in the initial phase.

An application repository supports the development of IoT applications and makes this knowledge available by means of a centralized location where IoT actors can find applications and information about them. This kind of repository is naturally connected to the concept of marketplaces. However, traditional app stores seem to have limitations with respect to IoT applications. None of the current application stores support the delivery of purchased software to the connected devices, except the mobile terminals supported by the platform.

From a short run perspective, the provision of a basic IoT marketplace could generate the following benefits: *(i)* data fusion and sharing; *(ii)* developer support; *(iii)* ecosystem training; and *(iv)* e-commerce and billing. From the long-term perspective, the marketplace could contribute to the uniformity of REST APIs and the standardization of communication protocols. IoT device manufacturers would be encouraged to use these open standards to improve their visibility in the marketplace.

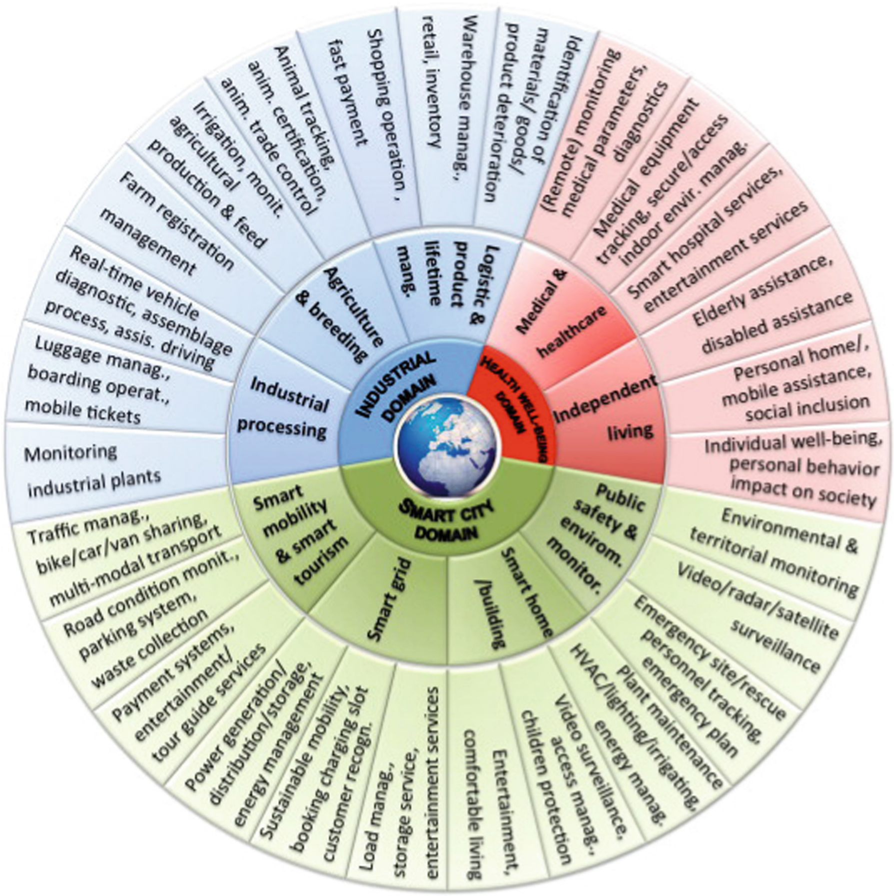

Fig. 4. Applications for IoT [5]

4 Proposed Approach

This proposal consists of a framework for representation, indexing and persistence of IoT applications. It includes an algorithm for comparing the requirements of new applications against the repository of already existing ones. The main objective is to enable search and reuse of IoT applications.

4.1 Descriptors

The starting point for the catalog construction was the classification of the applications as shown in Fig. 4. The figure provides an overview of possible IoT application solutions at three levels: domains, categories and specific solutions for each category. At the first level, Borgia [5] defined three domains: Industrial, Smart City and Health Well-Being. At the second level, Categories were thus nominated within each domain: *(i)* Industrial (logistics & product lifetime management, agriculture & breeding, and industrial processing); *(ii)* Smart City (smart mobility & smart tourism, smart grid, smart home/building, public safety & environment monitoring); and *(iii)* Health Well-Being (medical healthcare and independent living). The third level includes specific kinds of applications. The *category* level was chosen as descriptor in the present approach since it represents a mid-term commitment between the other categories. Therefore, the search algorithm uses the nine intermediate-level values as one of the descriptors.

In addition to the application descriptor *category* the following complementary descriptors were adopted:

- **Entity**: name of the corporation or the company owning the application;
- **Functionality:** free text stating the application functionality;
- **Year:** stands for year of the application creation;
- **SOA:** kind of SOA in which the application was developed;
- **Protocol:** kind of protocol used in the application layer.

4.2 Proposed Model

The model comprises three components: *(i)* User, which provides the graphical interfaces for the manipulation of IoT Apps; *(ii)* Repository, where the Apps and their descriptors are stored; and *(iii)* an algorithm that searches for and returns the most similar IoT Apps desired. Figure 5 shows the main containers of the proposed model, showing a macro view of all activities related to the search and possible reuse of IoT applications.

The User container specifies in high level the main activities performed by the actors that use the system. The Catalog Existing Apps activity allows interested companies or stakeholders to catalog their IoT applications in the Repository for reuse, composition, or customization. New applications developed or adapted are also cataloged in the repository. Before developing a new application, the user informs the descriptors and the system returns the most similar ones that are cataloged, with their respective specifications. A bus-like carrier gathers all information generated in the User container and drives them to the Store APPS activity that manages the information repository.

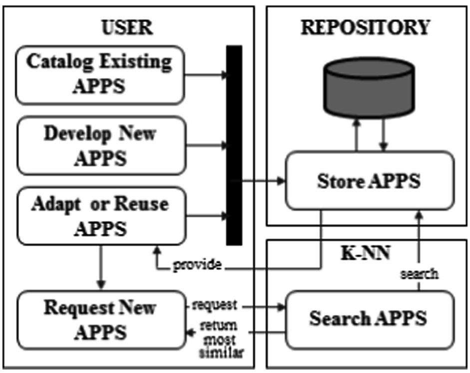

Fig. 5. Containers and activities of the proposed model

The K-NN container represents the *k*-NN algorithm (NN stands for Nearest Neighbor), a data mining algorithm that works with supervised learning to perform classifications. The algorithm receives a data vector that describes a new application, searches the Repository container, and returns a *k* amount of IoT applications or services that can meet user requirements.

The similarity is defined on the basis of the Euclidean distance between the data vector with respect to each member of the repository. However, textual features require an adaptation in *k*-NN that was carried out by using Levenshtein [11] distance. This technique evaluates the distance between two characters strings on the basis of the minimum number of operations required to transform one string in the other. The possible operations are insertion, deletion and substitution. All distances are normalized to reduce them to same basis.

From the search result, the user decides whether the returned IoT applications meet their expectations and, if so, initiate the procedures for reuse or adaptation of the applications.

5 Proof of Concept

The features used to describe the applications are: Category, Organization, Functionality, Year, Kind of SOA and Protocol. A data vector was defined considering this set of descriptors. The idea is to check to what degree the search engine is able to retrieve the desired application based on available applications. This data vector was submitted to the search algorithm that calculated the distances between the vector and each application described in the repository.

The search in the available application base was simulated for the vector (Logistics, Federal District Government, "Stock control", 2010, Restful, CoAP). Notice that all descriptors are standardized (have a defined domain), except Functionality, which is written in free text. This is the reason for the adaptation of the original *k*-NN algorithm in order to cope with Levenshtein distance. The search was simulated by means of a base of IoT application descriptors and a data vector representing the specification of a desired application.

The search mechanism requires the user to inform the number *k* that limits the amount of results closest to the search vector that should be shown. In this example $k = 4$. The algorithm calculates the distance of each available application to the search vector and selects the four closest. Part of the results is shown in Table 2. The distances are shown in the last column and the final results with the closest four applications are in shadow.

It can be observed that the first application matches almost completely with the search vector, representing a good candidate to reuse. In the lack of good candidates, a new application could be developed and included in the repository.

Table 2. Excerpt of the available application cases with the distance from the search vector

#	Category	Entity	Functionality	Year	SOA	Protocol	Distance
1	Logistics	Federal District Government	Inventory control of the Fed. District	2010	RESTful	CoAP	6.25
2	Logistics	CARREFOUR	Inventory control of IT products	2008	RESTful	XMPP	7.21
3	Logistics	Amazon	Working with minimum inventory	2009	SOAP	CoAP	10.65
4	Agriculture	Embrapa	Control the soil humidity	2010	SOAP	MQTT	10.92
5	Logistics	SPEEDPAK	Dispatch air cargo	2017	RESTful	AMQP	11.97
6	Energy	FURNAS	Statistics on electricity consummation	2015	SOAP	AMQP	12.85
…	…	…	…	…	…	…	…
n	Industrial processing	GM	Use sensors to manage production	2011	SOAP	MQTT	18.70

6 Contributions and Future Work

This paper presents an approach for applications discovery and reuse in the context of IoT. The approach was validated by means of a proof of concept that has shown a promising answer to this problem. It can highlighted three contributions: *(i)* definition of features that characterizes firmly an IoT application, *(ii)* creation of an application repository to maintain IoT applications for reuse, and *(iii)* adaptation of *k*-NN data mining algorithm to use both Euclidean and Levenshtein distances in order to identify similar applications of a given search vector in the repository.

The main limitation of this work was the impossibility of testing the solution based on real data. Since a real world application repository is not available, it was necessary to create a simulated repository. Anyway, even using a simulated example, we could show that it is possible to create a mechanism for IoT platforms aiming at the reuse of applications.

Deploying a complete IoT application discovery solution in a real-world situation is not a trivial task. There is a need for an agency or institution that centralizes all the management and maintenance of the required infrastructure. Obviously, the best way to turn this facility available is to provide this tool in the IoT platforms. Therefore, organizations that develop and use IoT platforms may benefit from the presented solution.

Based on the findings of the current study, we could identify the following possibilities for future work: *(i)* extend the model to recover IoT services; for this, it will be necessary to evaluate the applicability of the features set used for applications, with possible inclusion of new ones; and *(ii)* in addition to IoT applications, we could also add the search and reuse of functionalities of the main sensors and actuators.

Finally, the textual similarity approach used in this research can be compared and/or adapted to the following textual similarity analysis alternatives [15]: *(i)* Latent Semantic Analysis (LSA), which is a textual similarity based on a text corpus; and *(ii)* the semantic relationship similarity metrics used by WordNet, which is based on a hierarchy of knowledge and concepts.

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Towards an Improved ASUM-DM Process Methodology for Cross-Disciplinary Multi-organization Big Data & Analytics Projects

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Abstract. The development of big data & analytics projects with the participation of several corporate divisions and research groups within and among organizations is a non-trivial problem and requires well-defined roles and processes. Since there is no accepted standard for the implementation of big data & analytics projects, project managers have to either adapt an existing data mining process methodology or create a new one. This work presents a use case for a big data & analytics project for the banking sector. The authors found out that an adaptation of ASUM-DM, a refined CRISP-DM, with the addition of big data analysis, application prototyping, and prototype evaluation, plus a strong project management work with an emphasis in communications proved the best solution to develop a cross-disciplinary, multi-organization, geographically-distributed big data & analytics project.

Keywords: Big data · Analytics · Project management
CRISP-DM · ASUM-DM · Process methodology

1 Introduction

The development of a big data & analytics project with the participation of several corporate divisions within an organization is a non-trivial problem and requires well defined roles and processes. The complexity of this kind of projects rises mainly when more than one organization participates in the project and these organizations are geographically distributed [13]. Furthermore, since there is no accepted standard for the implementation of big data & analytics projects so far, some authors point out that the project managers have to either adapt to existing data mining/predictive analytics methodologies, such as the *CRoss Industry Standard Process for Data Mining* (CRISP-DM) created by IBM [4] or

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Sample, Explore, Modify, Model, and Assess (SEMMA) created by SAS [12], or create a new one [17,20].

Nonetheless, the usage of CRISP-DM and SEMMA is decreasing [19] and this is, in part, because these process methodologies focus specifically on the improvement of the technical components of the process and not on other project's dimensions such as knowledge management, communication management and project management, which are also crucial for a big data & analytics project's success [1]. Yet, a poll conducted by Piatetsky showed that CRISP-DM is still the most used methodology for data mining and predictive analytics projects [17]. Hence, the authors found out that there is an increasing necessity to adapt an existing process methodology, so that the aforementioned dimensions plus the technical components of the project can be integrated to increase the probability of success of a big data & analytics project.

This work presents a use case of a big data project that made use of an adaptation of the *Analytics Solutions Unified Method for Data Mining/predictive analytics* (ASUM-DM) process methodology, a refined CRISP-DM [9]. This use case shows how the ASUM-DM-adapted process methodology helped address the project's big data peculiarities, including the project management, communication management, technical and knowledge management issues.

This study comprises the first phases of the ASUM-DM process methodology: Analyze, Design, Configure and Build, along with Project management, and illustrates how an adaptation of ASUM-DM can help solve the project management, communication management, technical and knowledge management issues that might occur in big data & analytics projects, specifically a big data project in which several geographically-distributed teams from different organizations and backgrounds participate.

This paper is organized as follows. Section 1 presents the motivation for this research, the research objective, research questions and the contribution of this paper. In the Sect. 2 the authors define the required concepts to understand the research. Section 3 presents the related work with respect to team coordination and big data process methodologies for project management. Section 4 presents the research method undertaken in this study. Section 5 presents the use case for the ASUM-DM based process methodology and the suggested prototype for a process methodology, which are the core of the authors' research. Finally, Sect. 6 presents the conclusions and future directions in relation with the authors' research.

1.1 Motivation

According to Saltz and Shamshurin, there is no accepted standard for a big data & analytics process methodology so far [20], therefore the work teams participating in a big data & analytics project often have to create an ad hoc methodology to handle the work dynamics within each team and among teams. The latter shows a low process maturity level [2] and might cause poor coordination and, consequently, the failure of the project. At the beginning of the reviewed big data & analytics project the designated work teams worked using an ad hoc methodology in an isolated way. Nevertheless, without a clear methodology to handle team work dynamics, integration and coordination several problems started to appear:

1. **Isolated research groups and corporate areas.** The research groups and corporate areas started to operate as isolated units without knowing what the other groups were doing.
2. **Communication issues.** There were situations where a team made an important decision and this decision was not communicated to all the teams or were only known by only some members of a team.
3. **Mistrust.** The teams did not know each other and so their research topics, objectives and interests. There was a generalized feeling of mistrust towards the other work teams. This hindered the cooperation among teams and the knowledge transfer.
4. **Unclear workflows.** There was no defined workflow. Thus, the teams did not have clear what inputs to expect from other teams and what outcomes the other teams were expecting from them.
5. **Different definitions and points of view about big data.** The work teams participating on the project had different points of view about what big data and big data & analytics were. This lead to delays in the implementation and the delivery of outcomes.

1.2 Research Objective

Propose an implementation style for big data & analytics projects, whose main characteristic is that the work teams are cross-disciplinary and are geographically located far away from each other.

1.3 Research Questions

- **RQ1.** How to integrate and coordinate several cross-disciplinary geographically-distributed teams belonging to different organizations to the success of a big data & analytics project in an experimental stage?
- **RQ2.** How can a workflow be defined for different research groups and corporate areas to achieve a big data project's goals?
- **RQ3.** Which criteria have to be taken in account to classify a data analytics project as a big data & analytics project?

1.4 Contribution

This proposal extended the External ASUM-DM process methodology for the implementation of big data & analytics projects. The use of the first phases of the methodology along with an analysis of the 5 V's of big data [6], the incorporation of a Business Process Model and Notation approach (BPMn) [14] and a strong communications management strategy was found to be the best solution for the coordination and communication of the different knowledge areas integrating a cross- disciplinary research-oriented big data project.

2 Concepts

Big Data. So far, there is no accepted definition for big data. However, the authors are going to use the definition proposed by Jin et al. Big data refers to a "bond that connects and integrates the physical world, the human society, and cyberspace in a subtle way" and can be classified into two categories, concretely, data from the physical world (e.g. sensors, scientific experiments and observations) and data from the human society, which (e.g. social networks, Internet, health, finance, economics and transportation) [10].

Big Data's 5 V's Model. Big data has certain characteristics also known as the 5 V's of big data:

1. *Volume* - high volume - refers to the size of the data. Big data sizes are given by multiple terabytes and petabytes.
2. *Variety* - high variety - refers to the different structural formats in a dataset. The data can be unstructured (e.g. text, audio, images, video), semi-structured (e.g. XML files) or structured (tabular data).
3. *Velocity* - high velocity - "refers to the rate at which data are generated and the speed at which it should be analyzed and acted upon".
4. *Veracity* represents the unreliability inherent in some data sources. Big data is often uncertain and imprecise.
5. *Value* refers to the real value which can be obtained from analyzing big data. The purpose of big data is to obtain a high value from its analysis of large volumes of data [6].

Analytics. The leading international association for professionals in analytics, The Institute for Operations Research and Management Sciences (INFORMS), defines analytics as "the scientific process of transforming data into insights for making better decisions" [15,16].

Big Data Analytics. Big Data Analytics (BDA) refers to doing the analytics work directly in a big data environment. This activity requires more technical talent and programming skills than the traditional analytics [5].

CRISP-DM. The *CRoss-Industry Standard Process for Data Mining* (CRISP-DM) is a data mining model created by IBM and Daimler AG in the late 1990s. This model encourages best practices and offers organizations the structure required to get better and faster results from data mining [21]. Despite its benefits, CRISP-DM lacks templates and guidelines and is weak on other activities that are also necessary for the success of big data projects, namely, infrastructure/operations, project management and deployment [9].

ASUM-DM. *The Analytics Solutions Unified Method for Data Mining/predictive analytics* (ASUM-DM) is an extended and refined version of CRISP-DM for implementing data mining and predictive analytics projects, which was created by IBM in 2015. ASUM-DM tried to compensate the weaknesses of CRISP-DM by adding new activities, incorporating templates and guidelines, and enhancing existing activities. There are currently two versions of ASUM-DM: an external version, which is offered in the web for free, and a proprietary version used by IBM internally [8]. This proposal is built upon the external version of ASUM-DM.

3 Related Work

Kaskade [11] surveyed 300 organizations and found out that 55% of the big data projects are not completed, 39% of the times because of lack of cooperation. A poll conducted in 2014 by Piatetsky [17] showed that CRISP-DM remains the most popular methodology for data mining and data science projects. However, Saltz and Shamshurin [20] identified that the usage of CRISP-DM and SEMMA is decreasing and [1] pointed out that this is, in part, because the existing process methodologies do not consider knowledge management, communication management and project management.

Moyle [13] presents a CRISP-DM based Data Mining framework as well as guidelines for undertaking Collaborative Data Mining as a solution to the communication, coordination, cultural and social difficulties that resulted from the collaboration among geographically distributed laboratories and organizations by using collaborative internet-based tools. Also, Espinoza and Armour [5] identified that building big data & analytics abilities is not enough to successfully carry out a big data project, but coordination and governance also play a major role on this purpose. On the other hand, Grady [7] identified that mission expertise, domain data and processes, statistics, software systems and engineering, analytic systems and research and algorithms are the required skills that a big data team needs to successfully undertake a big data project. Bhardwaj et al. [2] identified that collaborative data analysis and data science is often done following and ad hoc methodology and by doing trial-and-error. The latter shows a necessity for process maturity to guarantee the collaboration and coordination inside and between teams. Saltz [19] found out, that having a big data process methodology incorporating sprints, phases or some other set of well defined processes helps understanding the roles and allowing coordination in and between teams.

4 Research Method

To validate the proposal, the authors used an adaptation of the case study approach proposed by Runeson and Brereton [3,18]. The tasks of this adaptation are Design, Data Collection, Data Analysis, Interpretation, and Reporting. This tasks allowed the authors to research the adaptation of the ASUM-DM process methodology within a realistic context of a big data & analytics project.

Use Case. Bancolombia Group required to find a more precise measure of its clients' risk and profitability for strategic decision making within its corporate divisions. To achieve this goal the bank started a big data & analytics project named *Bancolombia Communities*. Bancolombia joined Eafit University and Icesi University, and together they sketched a solution consisting in a big data & analytics and network analysis approach that identified relevant communities of clients in function of their associated risk and profitability. *Bancolombia Communities* required specialized knowledge in statistics, economics, data visualization, applied mathematics, information technologies and project management. However, this knowledge was spread across several corporate divisions within the bank and research departments within the universities. Moreover, these corporate units and research departments were geographically-distributed in two distant cities (Medellin and Cali). This made the integration, communication and coordination among teams difficult and a key issue for the project's success.

The work team formation for the *Bancolombia Communities* project is explained as follows. Bancolombia's marketing department contributed with one work team consisting in two people: one person that was both domain expert and data scientist, and one data analyst. Eafit University counted on the participation of its school of engineering, school of sciences, and school of economics and finances. Each school contributed with a work team. The school of engineering contributed with one big data architect and IT infrastructure specialist, one knowledge management and database specialist, and three data engineers. The school of economics and finances contributed with one economics specialist, one statistics specialist, one economist and two finances analysts. The school of sciences contributed with two data scientists and one applied mathematician. Likewise, Icesi University counted on the participation of its design department, IT department, and accounts and finances department. The design department counted on the participation of one design and user experience specialist. The IT department counted on the participation of one data scientist, and one software engineer. The accounts and finances department counted on the participation of one economics specialist.

4.1 Use Case Design

The type of study used in the research was a primary qualitative study *in vivo* based on direct observation.

After data collection and analysis, the authors identified two stages for this case study. At the end of each stage the authors collected the generated information.

- **As-is stage.** The first stage lasted for 6 months. In this stage, all the work teams worked with their own ad hoc methodology and there was no knowledge of process methodologies for big data & analytics projects.
- **To-be stage.** The second stage lasted for one year and corresponded to the milestone, when the participants started to incorporate the proposed ASUM-DM process methodology.

The analysis at the end of each stage allowed the authors to establish a comparison point, where they could determine what influence the proposed process methodology had in the teamwork dynamics.

4.2 Use Case Data Collection

The authors' data sources consisted in *in situ* observation of the daily activities, meeting reports, and both in-person and virtual meetings. Additionally, the authors reviewed all the generated work artifacts made by the work teams during one year, from March 2016 to October 2017, such as notes, technical reports, procedural reports etc.

4.3 Use Case Data Analysis

The authors analyzed the collected data and identified the activities undertaken by the work teams during both the As-is and To-be stages.

Likewise, the authors mapped the developed activities with the ones proposed by ASUM-DM to recognize which activities were necessary and which not. The result of this analysis is an adaptation of the first phases of ASUM-DM - Analyze, Design, Configure, Build along with Project Management -.

5 Use Case: ASUM-DM-Based Process Methodology

Figure 1 shows the proposed workflow for the ASUM-DM adaptation. Each shape corresponds to one activity and the arrows correspond to loops among activities. The activities proposed by the authors are depicted in blue. These activities are, namely, (3.2) "Describe data against big data's 5 V's", (4) "Build prototype", (4.1) "Define prototype workflow", (4.5) "Build visualization" and (5) "Evaluate prototype". The rest of the activities are represented by white shapes and already existed in the original ASUM-DM process methodology. The blue arrow corresponds to a loop proposed by the authors. The black arrows, on the other hand, correspond to already existing loops in the original ASUM-DM process methodology [9].

The main differences between the original ASUM-DM and the proposed adaptation are the introduction of the activity (3.2) "Describe data against big data's 5 V's" to classify, at an early phase, whether the project is about big data. Another main difference is the introduction of the activity (4) "Build prototype". This activity was introduced because the proposal focuses on having a functional big data application prototype and not on only having a valid and validated model. Since the scope of this article is the adaptation of a process methodology for big data & analytics projects, an expected final outcome would be a functional big data application prototype, which may be developed from scratch or be based upon existing commercial software. Additionally, the authors introduced the activity (5) "Evaluate Prototype" because, besides evaluating a model, the evaluation of the functional application prototype is necessary to determine how well it satisfies the business success criteria stated in the activity (2) “Understand Business”. For this reason the authors also introduced a loop between the activity (5) “Evaluate model” and (2) “Understand business”: if the prototype does not satisfy the business success criteria stated in the latter activity, the process has to be repeated from the activity (2) “Understand Business” up to the activity (5) “Evaluate prototype”, until the prototype satisfies the business success criteria.

The rest of the loops follow the same pattern: they are repeated if the activity corresponding to the start of the arrow has not been successfully accomplished with respect to the business success criteria. There is also the case where the model built does not fit the prepared data and the people involved with the activity have to return to the (4) “Prepare Data” activity.

Furthermore, in the activity (4.1) “Define Prototype Workflow”, the authors proposed the creation of a workflow by using a BPMn notation [14]. This activity is proposed to model the development process of the functional application prototype and, with that, guide the work teams on the expected inputs, outputs, and activities required for the construction of the application prototype.

5.1 Understand Data

Data Sources. The complete clients and transactions dataset is stored in a traditional Relational Database Management System (RDBMS) and has more than 100,000,000,000 records containing all the clients of the bank and their transactions with other clients. The clients can be either personal or corporate clients. Bancolombia sampled this dataset with a non-random sampling criterion: selecting only the corporate clients (ca. 30,000). The purpose of this sampling was to start gaining useful insights at an early stage from the clients, from which the bank gets the most profit: its corporate clients. This is due to the fact that the corporate clients are the clients that carry out the transactions with the highest amount of money and move more money through the bank. Nonetheless, the processing and analytics of Bancolombia’s complete clients and transactions dataset is left as a further phase and is not covered in this paper. Bancolombia sampled the input data and saved it into seven text files in the form of CSV. This was the input data set for the project. There was a total of seven CSV files analyzed with a total size of 3 GB. At the end of this activity, the project management team elaborated a data understanding report.

Describe Data Against Big Data’s 5 V’s. This proposal suggests an analysis of the collected data against the 5 V’s identified by Gandomi and Haider [6]: Volume, Variety, Velocity, Veracity and Value. The purpose of this activity is to identify the challenges inherent to the collected data, business requirements and business success criteria. With this information, the work team can easily identify the data challenges for the project in terms of big data and assess whether the project is about big data.

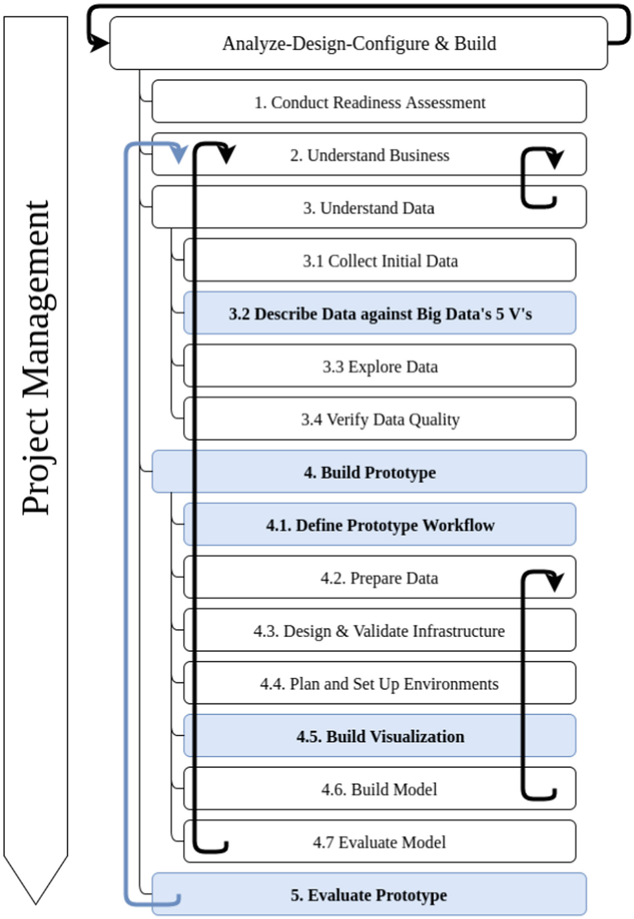

Fig. 1. Proposed adaptation of the ASUM-DM methodology

5.2 Build Prototype

This activity involves the construction of a functional application prototype that fulfills the business success criteria rather than a single model as proposed by ASUM-DM [9].

Define Prototype Workflow. The authors propose the modelling of an application prototype using a Business Process Model and Notation (BPMn) approach [14]. The project management team (Eafit University's school of engineering) found this approach to be easily understandable among all the different corporate departments and research groups. Thus, the activities to be carried out by each area for the prototype development were modelled as a Business Process. To solve the problems presented in the Motivation section, the authors carried out a series of meetings with each of the work teams to understand and model the activities that each team was undertaking and, hence, understand the responsibilities of each team, what each team received as input and what outputs a team should give to other teams.

Build Visualization. Eafit University and Icesi University created a visualization application based on graph plotting and dashboard design for the detection of risk and value communities.

5.3 Evaluate Prototype

In this activity, a functional application prototype is evaluated against the business objectives and business success criteria rather than a single model. With this activity, the stakeholders may identify if a potential big data & analytics application would fulfill its business necessities. The work team in charge for this evaluation was Bancolombia's marketing department.

5.4 Project Management

One of the key activities for the project management was the joint creation of the project plan. This activity allowed the project management team to record the common business understanding, to determine the business objectives and goals and to identify and assess the available resources, associated risks, constraints, and methodologies to use in the project. The work included from three to eight researchers in complementary disciplines for each corporate division and research group. To consolidate the confidence and relationships within each team, each work team held weekly in-person meetings. Likewise, to consolidate the confidence and relationships among teams from the different universities and cities, the teams held virtual meetings. The purpose of those meetings was to synchronize the work developed by each research team. Moreover, the work teams undertook quarterly in-person workshops to improve the interactions among teams and to ease the knowledge transfer among the three organizations. Undoubtedly, the technical committee support (Eafit University's school of engineering) among the researchers from different universities was fundamental, because it allowed to share challenges found and learned lessons by the work teams about the projects carried out under the CAOBA Alliance. From a technical point of view, the project management team established some minimal configuration management practices to support the engineering activities and project management within the project. The project management team built a document management system incrementally to have a register and a traceability for the decisions made in the meetings and workshops undertaken throughout the entire project. Also, all the technology products generated by the different organizations, such as software applications and process methodologies was saved in this document management system.

6 Conclusion and Future Work

With the ASUM-DM-adapted big data process methodology for multiorganization, multidisciplinary, geographically distributed teams, it was possible to define a solution that supported the necessities of a big data & analytics project in the project management dimension. Those necessities were not explicitly defined by the ASUM-DM activities themselves, because the ASUM-DM methodology addresses neither the problem of a big data project, nor the context of cross-disciplinary, geographically-distributed and multi-organization research groups and corporate divisions.

Likewise, this adaptation generated a teamwork dynamic that improved the communication and team collaboration through the organization around a workflow and the help of communication policies. The authors think that this adaptation will set a start point for researchers and practitioners when choosing or tayloring a process methodology for the experimental phase of a big data & analytics project in the context previously described.

A further work for this study might be the evaluation of the proposal by carrying out surveys and focus groups to researchers and practitioners participating in big data projects. Also a study about similar data analytics projects might be carried out with the aim of knowing the challenges and learned lessons when adopting this adapted process methodology as a base methodology for the implementation of projects in a similar context.

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Technical Development of a Security Platform for IoT Based on Blockchain

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Abstract. The motivation of this paper was to establish how the Blockchain can be used to ensure the authenticity of information intended to be used by an IoT device so that the integrity of it can be guaranteed. In this way, the case of use of an IoT device such as a drone or unmanned aerial vehicle UAV is considered as a practical application studying the needs of this system, the implementation of the Blockchain platform chosen but not the implementation of the drone.

Keywords: Blockchain · Internet of things · Security · Drone

1 Related Work

The security for IoT related deployments through Blockchain [1] could solve the security issues present in centralized models for IoT such as the tampering of the information or the loose of the historical transaction ledger. Other need that comes around when working whit IoT is the Transaction Longevity and the user identity [2] where the users are the devices. The longevity is provide by the Blockchain, however not all platforms provide permissions and roles.

In [3] the authors mention how the common sensors into a common IoT system cannot be connected directly to the Blockchain to send transactions so it is needed a gateway between a group of sensors and the Blockchain network that solves the security problems present in non-decentralized networks.

Cloud versus fog implementations of Blockchain as a service for IoT is discussed in [4] to manage device configuration, store sensor data and enable micro-payments. The author conclude the network latency is the determinant factor. In consequence the fog outperforms the cloud.

The use of smart contracts and trustless networks becomes possible whit the Blockchain [5]. Introduces the possibility of automated process without an authority or intermediary.

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2 Blockchain as a Mechanism of Authenticity and Support for IoT

As seen in the related work section the IoT devices need low latency. For this reason the proposed model consist of IoT devices that consult the Blockchain but do not make transactions, reducing significantly the latency of the system. In this way, the reason because Blockchain is ideal as a mechanism to guarantee the authenticity and integrity of sensitive information that IoT devices consult is the fact that it is tampering proof. In the first place the information is stored in multiple locations, it has multiple synchronized copies in storages that are under the control of different administrators without influence on each other, which guarantees autonomy over the management. Change some data in all the network could not be carried out since the administrator of each system don´t have access to other systems.

The second important feature and why this technology is called Blockchain is the constitution of chains of information whit unique references called hash. With this mechanism the data is changed at some point, the entire chain is altered and in this way even the smallest change is detected and the other storage locations or nodes detect if tampered information has been introduced rejecting that node.

3 Security for IoT Through Blockchain

In some cases IoT devices receive instructions from unknown sources, for this reason they need a mechanism with which they can verify these instructions before executing them, knowing that it had not been tampered and has no flaws.

In the case of an unmanned aerial vehicle commonly known as a drone that receives a flight plan from an unknown source remotely the drone must decide if the plan is authentic and has not been altered, for this purpose it makes a unique representation of the flight plan and sends it to the security system on Blockchain, this is called a Hash and allows to determine if the information is authentic or not, as shown in Fig. 1.

In the Fig. 1. The smart contract compares the received hash whit the stored one, if equal the result is that the information is authentic so the IoT device can trust it, otherwise the device can know the data has been altered.

Whit another section of the smart contract, the Blockchain stores a unique representation of each flight plan that accepts from authorized sources, not IoT, carrying out a verification of the identity of those sources, as shown in Fig. 2.

Only the authorized personnel can introduce information to the variables associated in the smart contract once authenticated through the smart contract using the password and any secret file chosen at the registry time, this secret file and password is verified against the Blockchain.

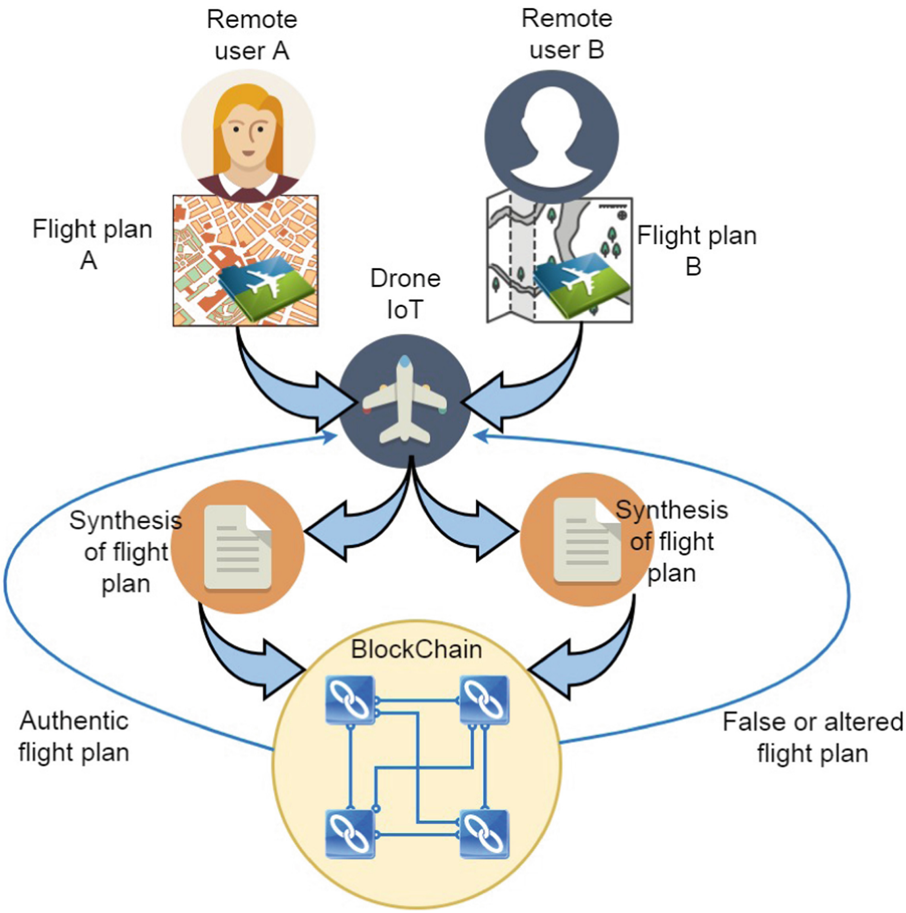

Fig. 1. Security of the IoT drone flight plan using Blockchain

4 Development of the Security Platform on Blockchain for IoT

The first step to start the development of a security platform for IoT over Blockchain is to choose a specific Blockchain distribution. In this way the Bitcoin distribution is discarded due to the lack of smart contracts or chain code that allow the execution of programs inside the Blockchain. Following this criteria appears Ethereum, Hyperledger fabric and some others, however this two have plenty of documentation [6–10], at the time of writing this article that accelerates the development process and reduces the dead points due to bugs of the Blockchain platform. Now to choose between Hyperledger Fabric and Ethereum is used the criteria of the infrastructure possibilities. At this point Ethereum have three options of infrastructure that are private, test and live where the last is accessed by the public and have real cost in terms of the ether, the test is

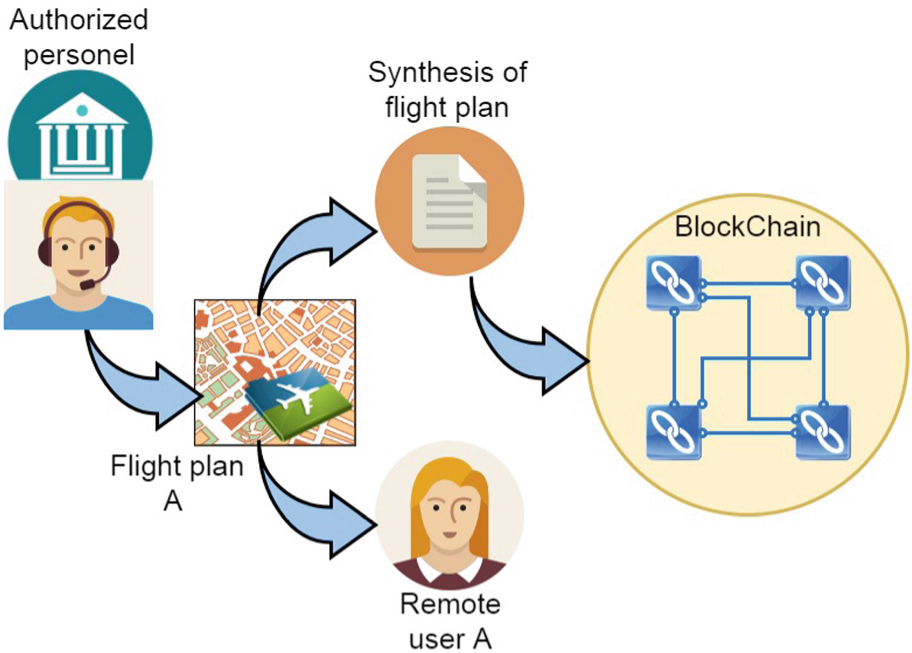

Fig. 2. Storage of the synthesis of the flight plan A in the Blockchain

public but have no real cost and the private requires own infrastructure but it is not open to the public and have no cost in terms of ether. Hyperledger Fabric have the option of private network and requires own infrastructure. Because of these reasons is chosen the Ethereum network in order to have the possibility that the IoT devices connect to a public network.

4.1 Application Requirements

The application has the following security and operation requirements:

The IoT devices need a low latency network.
It is required that the flight plans are generated digitally by a trusted entity or authorized person.
It is required to verify the identity of the trusted entity or authorized person to upload the flight plans.
It is required that the integrity and authenticity of flight plans can be verified without the need to log in.
Digital flight plans are required to be unalterable.
It is required that the registration of each flight plan cannot be eliminated.

Infrastructure Management. In the development of the project infrastructure, the following components are implemented (Fig. 3):

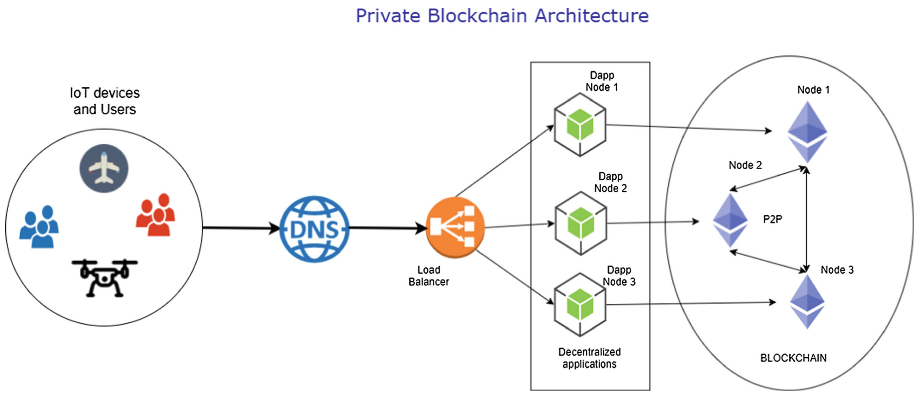

Fig. 3. Infrastructure of the private Blockchain network.

The load balancer allows the IoT devices make calls to any node that has a copy of the DAPP, decentralized application. This way there is no need for specialized software. Only the transactions show low latency but these are not executed by any IoT in this model, only calls to the information stored by administrators on the Blockchain.

Each node is a Linux machine, Ubuntu 16.04. The Ethereum node is deployed whit Geth.

Deployment of the Development Environment. The development environment is made up of different platforms both frontend and backend as seen below (Fig. 4):

Fig. 4. The development environment

The backend is realized in Node JS and additionally other components and libraries are used to prepare the development environment, these are:

Express JS: It is a framework that allows us to manage web applications in node js and restructure in MVC (model view controller).
Nodemon JS: It is used to improve the development times of the application so that if a change is made, the web service is automatically restarted.
Pm2 JS: Used once the application is in production for it to start automatically.

In addition to the implemented backend development environment, specific libraries are needed to connect to the Blockchain, these are:

Web3.0 JS: Is the library provided by JavaScript to communicate with the Blockchain using the JSON-RPC protocol.

For the design of the website, the following components are used:

HTML5: It is the language used to structure and present the content on the web.
Boostrap: It is a framework developed and released by Twitter that aims to facilitate web design and present more dynamic content.
CSS: These are the styles configuration sheets of the entire website.

The components that will interact with the client's logic and communication with the server are the following:

Javascript: programming language that allows creating actions in the frontend of the application for users to interact.
JQuery: A Javascript library that allows to interact in a simpler way between the web browser and the web server.
AJAX: It is an asynchronous extension of Javascript that allows us to exchange information with the server without having to refresh the page.

In the case of centralized applications if data is changed this change will be replicated in all databases, without leaving a trace of the previous data if the administrator delete it. Another problem with the centralized application model is that the people who provide the service could tamper the data for their own convenience unlike Blockchain, which does not mean that the data cannot be erased or changed, but due to the nature of the protocol if a data is deleted or changed, a transaction is generated in which it is recorded that the data was changed and therefore the trace of what happened with this data is decentralized and distributed in all the nodes of the Blockchain.

The logic of the system is carried out through the use of intelligent contracts which are programs executed by each node of the Blockchain created in the programming language called Solidity.

The system has three main components, the first is the storage in the Blockchain of the synthesis of the flight plans that will be used by the IoT devices. The second is the integrity verification logic of the flight plans and the third is the verification of the access permits.

The first component that corresponds to the synthesis of flight plans is carried out in order to reduce the amount of information stored in the Blockchain. This process is carried out by means of a summary function called Hash function. The Hash function generates a unique word that represents each flight plan and that is different with any change guaranteeing that it has not suffered any alteration. To store the record of the Hash function, a unique alphanumeric index is generated for each flight plan.

The second component corresponds to the verification of the integrity of the flight plans accessed by each IoT drone. The verification is done by obtaining the hash of each flight plan and comparing it with the hash stored in the Blockchain so that if both summaries are equal, an integrity response is obtained and, on the contrary, if the hash function obtained is different from the stored one means that the flight plan has been altered. To verify the integrity of the Flight Plan, the alphanumeric code is used in the form of an index that has been assigned to it to find the record with which it will be compared in the Blockchain. To carry out the verification of a flight plan, the device does not need a user or a password, it must only provide the flight plan's Hash and the alphanumeric code of the same.

```
function verify(bytes32 code, string hash)public constant
returns(string message) {
                   if (flights[code] == keccak256(hash)) {
                     message = "Authentic";
                   }else {
                    message = "Altered";
                   }
        return message;
    }
```

The third important component of the system is the verification of permits and identity of special users, not IoT devices. In this part, the system uses a user, a password and a digital file that the user must possess, called secret file compared whit the Blockchain in the form of encrypted hash. If all three data have a successful verification the system will give access to upload new flight plans.

5 Results

Below is the web platform with which a remote user can verify the integrity of a flight plan by entering the file and its code. In the case of IoT devices, the request to verify the flight plan is made directly to the Blockchain system without going through a web page (Fig. 5).

The following is the web platform for access to authorized personnel that can upload new flight plans in which their identification number must be provided with a password and a secret file that is verified against the Blockchain (Fig. 6).

The following is the information corresponding to the registration of a transaction in the implemented Blockchain in which can be seen the location of the smart contract, the block number in which the transaction was included among other data used to verify the authenticity of the Blockchain synchronized.

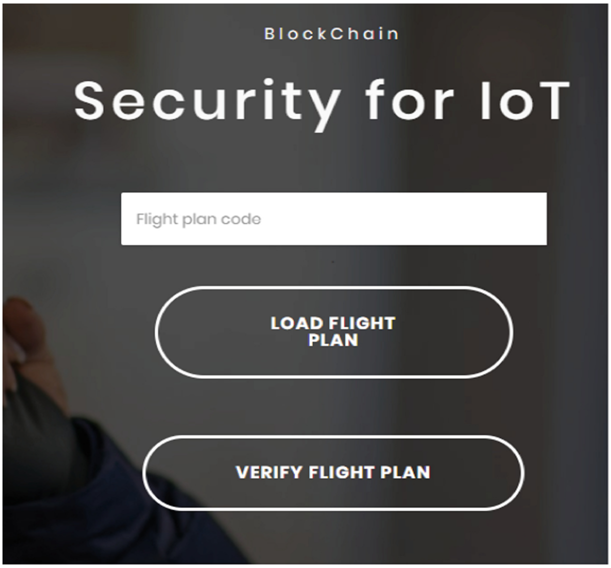

Fig. 5. Web platform for the human users to verify flight plans

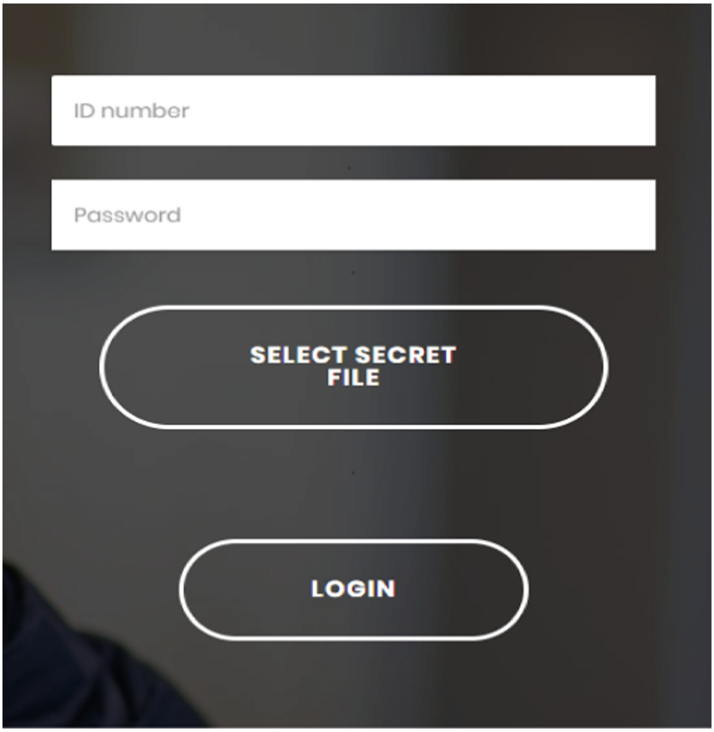

Fig. 6. Web platform for the authorized personnel to add flight plans

6 Conclusions

The Blockchain platform allows IoT device can trust the received information as tampering free and flaw free when using smart contracts that guarantee the origin of the information and its integrity.

The use of the hash function in conjunction with Blockchain allows IoT devices to verify the information received using very little data traffic achieving low latency in calls because it is a medium to represent in and unique way a big amount of information using little digital storage.

The Blockchain platform solves the problem of replication of errors or replication of flaw information between all the replicas of the databases, in this model the IoT becomes more reliable in contrast to a centralized model.

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A Consideration of Service Strategy of Japanese Electric Manufacturers to Realize Super Smart Society (SOCIETY 5.0)

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1 Introduction

"Innovation 25 [1]" is a long-term strategy initiative issued by the Cabinet Office of Japan for the creation of innovation contributing to the growth of the nation with an eye on the year 2025. As its concrete promotion plan, the Fifth Science and Technology Basic Plan [2]) emphasizes the development of future industry and societal transformation and requires successive efforts to realize a world-leading "super smart society (SOCIETY 5.0.)". Under these circumstances, electrical manufacturers have adopted new approaches to materialize SOCIETY 5.0, with customer co-creation business as a key strategy on the basis of the service-dominant logic [3]. In the context of service business initiated by manufacturers, the concept of "value provided" is shifted from conventional "product creation" to "service creation", where new service projects will be undertaken aiming at the co-creation of value with customers (users) and further the creation of value for customers by customers. Against this backdrop, in order to establish the innovation for "service creation," the role of tacit knowledge (senseware) based on the knowledge science (knowledge creation theory) has become important.

In this paper, Japan's comprehensive science, technology and innovation (STI) strategy and related examples of service business by three electrical manufacturers will be introduced. Then, the role and issue of tacit knowledge (senseware) in the customer co-creation business will be discussed based on the knowledge science (knowledge creation theory.)

2 Study Background

Japan's comprehensive STI strategy "Super Smart Society (SOCIETY 5.0)"

"Innovation 25 [1]" is a long-term strategy initiative issued by the Cabinet Office of Japan for the creation of innovation contributing to the growth of the nation with an eye on the year 2025. Specifically, it clarifies mid-to-long term policies to be pursued by Japan to be able to mold an affluent and hopeful future while confronting such global issues such as resources, energy, population increase, water, food, and safety. In this

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part, five kinds of images are depicted in future society: (1) Long and healthy lives; (2) A safe and secure society; (3) Society with diverse work styles; (4) Society that contributes significantly to resolving global environmental issues; and (5) Society that is open to the world.

The goals of the Fifth Science and Technology Basic Plan (2) are: (1) Sustainable growth and autonomous regional development; (2) Ensure safety and security for Japan and its citizens and a high-quality, prosperous way of life; (3) Respond to global challenges and contribute to global development; and (4) Sustainable creation of intellectual property. The Basic Plan includes four policy pillars: (1) The development of future industry and social transformation: bringing about great changes to herself in order to lead in the revolutionary era by advancing initiatives to create non-continuous innovation. A series of initiatives geared toward realizing a "super smart society" where new values and services are created will be further deepened and intensively promoted as SOCIETY 5.0. (2) Addressing economic and social challenges: selecting key national policy issues and promoting works on STI so that appropriate preemptive actions can be taken to address various issues emerging domestically and on the global scale. (3) Reinforcing the "fundamentals": strengthening the foundations of STI with a focus on reform and functional enhancement for universities, along with training and career advancement for younger researchers in order to respond flexibly and appropriately to various possible future changes. (4) Building a systemic virtuous cycle of human resource, knowledge, and funding for innovation: establishing a system under which personnel, knowledge, and funds are circulated beyond all barriers to generate innovations by building collaborations between companies, universities, and public research institutes and also by initiating and strengthening venture businesses, with the aim of the creation of new values and the prompt implementation of these new values in society.

The Basic Plan recognizes the above four policy pillars as schemes to be worked on through mutual-cooperation between interested parties including governments, scientific societies, industrial sectors and citizens in order to guide Japan to become "the best suited nation in the world to innovation".

Thus, in the Fifth Science and Technology Basic Plan (2), the promotion of SOCIETY 5.0 is a main subject of Japan's critical growth strategy toward the development of future industry and social transformation.

SOCIETY 5.0 is defined by the Cabinet Office as a new economic society coming after a hunting and gathering society, an agrarian society, an industrial society and an information society. This human-centered society is capable of offer finely differentiated customized services that meet diverse user needs and provides services to support human activities to achieve higher quality of life by eliminating discrimination in religion age, gender and language, through an initiative merging the physical space (real world) and cyberspace by leveraging ICT (Internet Communication Technology) to its fullest.

As a specific measure, it suggests building a mechanism to link goods, services and information fully through the merger of physical space and cyberspace. Based on the common platform, all systems in any field are advanced and integrated, which will transform the society where interest is shifting from possession to utilization (service providing). As Fig. 1 illustrates, SOCIETY 5.0 is a society which is expected to contribute to the well-being of citizens as the necessary amount of “needed goods/services” are provided to people in need whenever required. And various social needs are met. Any person can receive high quality of service to lead active comfortable life regardless of such barriers as age, gender, region and language (The Fifth Science and Technology Basic Plan) [2].

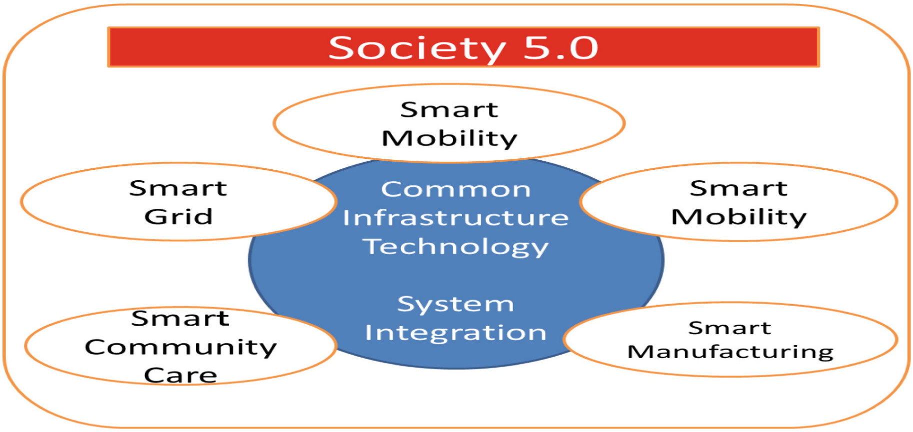

Fig. 1. The concept of SOCIETY 5.0 (Source: the Cabinet Office)

Furthermore, the “Comprehensive Strategy on Science, Technology and Innovation 2015” sets forth an objective to fully embody the new concept of SOCIETY 5.0 introduced by the Fifth Science and Technology Basic Plan.

3 Preceding Studies

3.1 Service-Dominant Logic

The service-dominant logic (S-D logic) proposed by Vargo and Lusch [3] constitutes an idea that all economic activities are services itself. This concept emphasizes “value creation.” The goods-dominant logic (G-D logic) regards value-in-exchange as important, while the S-D logic attaches importance to use-in-value and value-in-context. This theory suggests that value is not signified only by purchase or exchange of goods until they are used after purchase. In the S-D logic, a value factor is shifted from value-in-exchange to use-in-value. The S-D logic axioms are as follows:

(1) Service is the fundamental basis of exchange.
(2) Indirect exchange masks the fundamental basis of exchange.
(3) Goods are a distribution mechanism for service provision.
(4) Operant resources (intangible resources such as knowledge and skills) are the fundamental source of strategic benefit.
(5) All economies are service economies.

(6) Value is co-created by multiple actors, always including the beneficiary.
(7) Actors cannot deliver value but can participate in the creation and offering of value propositions.
(8) A service-centered view is inherently customer oriented and relational.
(9) All social and economic actors are resource integrators.
(10) Value is always uniquely and phenomenologically determined by the beneficiary.

This concept has been placed in the center of service innovation policies in recent years, attracting attention in the industrial, academic and administrative sectors toward the realization of SOCIETY 5.0 as an STI policy for the next generation.

3.2 Knowledge Creation Theory

The knowledge creation theory, proposed by Ikujiro Nonaka and Hirotaka Takeuchi [5], holds a mechanism of mutual conversion between tacit knowledge and explicit knowledge, in which knowledge is created through four processes. The four processes are summarized as follows: (1) Socialization: a process to share, acquire, and create tacit knowledge by holding knowledge and experience in common. As an example, Honda Motor holds a brain-storming session to provide a place for thorough discussions to solve tough problems in implementing a product development project. In Matsushita Electric Industrial (currently, Panasonic), under the project aimed at developing bread machines, the software development staff was instructed to attain the skills of an experienced baker. One senior member, who became an apprentice of a chief baker of a renowned hotel and acquired tacit knowledge of the master, realized that dough was not only pulled but also twisted. (2) Externalization: a process to clearly conceptualize tacit knowledge. While taking forms of metaphor, analogy, concept, hypothesis and model, tacit knowledge gradually becomes explicit knowledge. This is the essential feature of the knowledge creation process. For example, Mazda Motor based the concept of "an authentic sports car exciting and comfortable to drive" on the corporate philosophy of "creating new values and offering pleasures of fun driving," which eventually led to the production of its signature RX-7. (3) Combination: a process to create a body of knowledge by joining concepts together. In this knowledge conversion mode, new explicit knowledge is created by combining different types of explicit knowledge. Kraft General Foods in the U.S., for instance, refers to data from the retailers' POS (Point of Sales) system to formulate a sales strategy. Through its own data analytics method, the company analyzes minutely what types of customers do their shopping in what manners. (4) Internalization: a process to embody explicit knowledge into tacit knowledge, learned from experience. As an example, General Electric Company in the U.S. puts all claims and inquiries from customers together into the call center database in Kentucky. All members of the product development team are glad to information sharing between telephone operators and customers.

As Fig. 2 demonstrates, the knowledge creation (innovation) is brought about by fast spiraling SECI(Model in Fig. 2) through the four processes: Socialization cultivating sympathy; Externalization implying articulation; Combination turning personal knowledge to organizational knowledge; and Internalization implementing organizational knowledge.

The knowledge creation theory proposed by Ikujiro Nonaka and Hirotaka Takeuchi accounts for a mechanism of mutual conversion between tacit knowledge and explicit knowledge through four processes of knowledge creation (knowledge spiral). But their case study dealt with knowledge creation processes in product development within a single company and not co-creation processes with external companies.

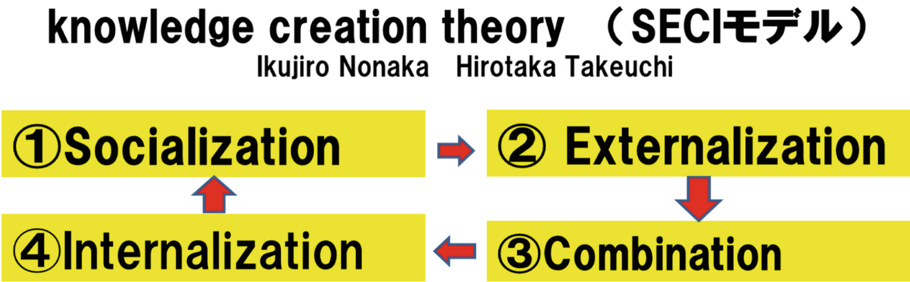

Fig. 2. Knowledge creation process (SECI model) (Source: organized by the author)

3.3 Senseware

The definition of senseware is cited here from preceding studies. Inoue [6] took a wind-bell as an example, stating that a wind-bell is a tool to create a cool and comfortable atmosphere (apparatus of sensitivity) as its sound makes people feel refreshed. An apparatus of sensitivity is defined as "senseware."

According to Watanabe [7], a wind-bell is designed for people to receive information of the outer world by using their senses and imagination. Hara [8] defined senseware as a thing that stimulates sensitivity of people and motivates them.

Kodaira [9] introduced the viewpoint of Sato [10] regarding the concept of senseware in his presentation at the conference "Hospitality and Senseware Required of B2B Business - Establishment of Engineering Brand" held by the Study Group on Engineering Brands, the Development Engineering Society of Japan, on March 24, 2014.

Kodaira explained that senseware consists of three elements: intelligence, sensibility, and earnestness. Intelligence means powers of understanding (logical thinking), knowledge (learning) and experience (skill). Sensibility is sense (artistic sense, five senses and belief in natural powers), creation (invention, discovery, designing, planning and creative ability) and foresight (insight, imagination, judgment, risk prediction, risk management and safety management). Earnestness is spirit, sincerity and altruism. He pointed out the necessity of communication ability (conversation) to hone these three elements. The goal of these integrated senseware is "aesthetics."

In the context of engineering activities, Kodaira [9] also asserted that senseware contains both hardware and software as the conceptual structure of senseware in Fig. 3 indicates. In the process of embodying hardware and software, sensitivity or tacit knowledge is designed with senseware. The roles of hardware, software and senseware in production activities are shown in Fig. 4. Hardware-related production activity is "goods creation," where a thing is designed into a physically discernible form, which means design in the narrow sense. Software-related production activity is "service creation," where functions are put in and requested procedures are designed. Senseware-related production activity is "human development," where the embodiment of sensitivity or tacit knowledge is designed.

Business domains and required capabilities of each ware are listed in Fig. 4. The manufacturing industry has product design and development capabilities. These projects are called hardware. Information communication (IT) and service industry have software capabilities. These businesses are based on solution capability, software specification ability and programming capability. And, "Human training" across all industries requires employees with capabilities such as creative skill, engineering skill and technical management. This is called senseware.

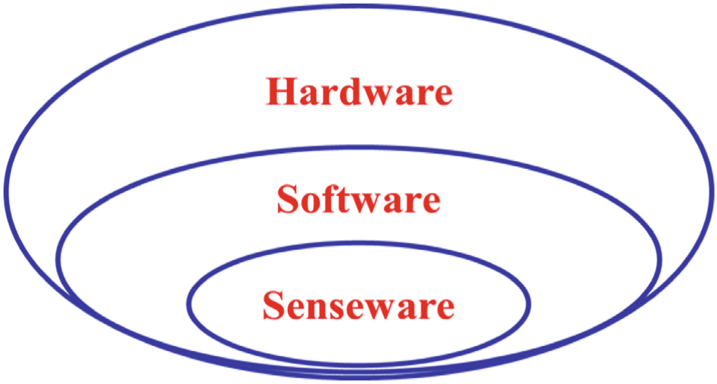

Fig. 3. Conceptual structure of senseware (Source: Kodaira [9])

Item	Business area	Ability to be equipped
Sensware	**All business (human resource development)**	**Creative power (design capability in a broad sense), Engineering, technology management, Human power (source of differentiation) Embody sensibility (implicit knowledge).**
Software	Information communication / service industry	Solution power, Creation of software specifications, Programming skill
Hardware	Manufacturing industry	Design / development capability, shaping power (narrow sense design)

Fig. 4. Business domains and required capabilities of each ware (Source: Kodaira [9])

3.4 Co-creation Strategy

Yasui [11] discussed the trend of service business based on the S-D logic and the concept of value creation toward the realization of SOCIETY 5.0 in the IoT era. With the expectation that companies would connect directly with particular customers and consumers to cooperatively and strategically build a service business model, he looked into the shape of co-creative relation.

In the business world, with the aim of leading the realization of SOCIETY 5.0 of the IoT era, Hitachi, Ltd. has placed its “customer co-creation strategy” in a pivotal position among all the corporate strategies, intending to formulate a new business model by building a cooperative relation with customers of all kinds of stakeholders.

4 Proposition

Among the mentioned studies, the S-D logic proposed by Vargo and Lusch [3] possibly produces significant innovations that will change conventional industrial and business structures as each company works toward the realization of SOCIETY 5.0 of the IoT era.

The process of implementation of such innovations by companies is founded on the value (service) co-created with customers as Yasui [11] suggested. A service business model is formulated through co-creation with other customers (companies and organizations) in the business world. This customer co-creation process is based on the knowledge creation theory proposed by Ikujiro Nonaka and Hirotaka Takeuchi. However, “co-creation of place” and knowledge creation process introduced in the knowledge creation theory are executed within a single company, falling behind the proposition by Yasui [11], namely the “customer co-creation strategy” which suggests to formulate a new business model by building a cooperative relation with customers of all kinds of stakeholders.

Likewise, senseware-related engineering activities discussed by Kodaira [9] were directed towards the creation of tacit knowledge as internal resources for development and promotion of product systems within a given company.

In the light of these have been mentioned above, shortcomings of the previous studies, corporate co-creation strategies towards the realization of “super smart society” of the IoT era are presented below. In addition, senseware and its roles and problems are also examined in this paper.

5 Examination (Case Studies)

5.1 Hitachi, Ltd. (Hereafter, Hitachi)

In its 2018 Mid-term Management Plan [12], Hitachi Group has placed social innovation business using digital technology as a pillar of growth strategy toward the realization of SOCIETY 5.0. In order to promote this project, a comprehensive reorganization was carried out in April 2016, where four areas of focus, that is power/energy, industry/distribution/water, urban (city/transportation), and finance/public/health care, were selected and integrated with the conventional sections of heavy electric machinery and information/communications, these 12 business united organizations (BU) were situated [13].

In addition, IoT Platform "Lumada" to propel SOCIETY 5.0 was put forward. With the technologies of artificial intelligence, symbiotic autonomous decentralization, analytics and security as basic functions, a new IoT service system in which a BU-transversal section (service & platform BU) supports other BUs was established.

A year earlier in April 2015, the research and development group which used to include Central Research Laboratory, Hitachi Research Laboratory, Yokohama Research Laboratory, Design Division and Overseas research centers was thoroughly reorganized into Global Center for Social Innovation, Center for Technology Innovation, Center for Exploratory Research and Technology Strategy Office.

Global Center for Social Innovation has 550 researchers in all: 100 in North America, 70 in Europe, 115 in China, 200 in Japan and 65 in the other Asian nations. Researchers are stationed at a front close to customers to co-create new technology and business innovations. This customer co-creation is not mere technical development but implementation of business creation. Each stage of co-creation process is as follows:

(1) Utilize business knowledge to choose which fields to enter by working with operational divisions that are familiar with business domains (establish a go-to-market strategy.) (2) Identify customer challenges from the social changes that serve as the background to business ecosystems, and develop a shared vision with the customer. (3) Design new service and business model concepts and use prototypes, simulation, and other techniques to make estimates of profitability. (4) Identify extensive Hitachi technologies and other commercial resources through "One Hitachi," then implement solutions and verify their effectiveness. The personnel who push forward these customer co-creation activities are "service business co-creators", working to strengthen "synergy capability" with customers and stakeholders.

With the aim of accelerating these customer co-creation activities, a new research facility "Collaboration Forest" is planned to be built by 2019 within the grounds of the Central Research Laboratory located in Kokubunji.

As academic-industrial collaboration, "Hitachi The University of Tokyo Laboratory" was established in June, 2016. Its objective is to promote a new style of research and development that brings about solutions to issues in society and economic development by co-creating and sharing visions toward the realization of SOCIETY 5.0 proposed by the Japanese government.

In "Hitachi Kyoto University Laboratory," joint-research on the "exploration of basics and theory based on an understanding of humans and culture" will be conducted, where future social issues are foreseen and analyzed to formulate original innovation that solves social problems and at the same time spurs economic development.

The establishment of "Hitachi Hokkaido University Laboratory" will jointly resolve the various societal issues being faced in Hokkaido, such as aging and declining birthrate, depopulation, regional economic stagnation and global warming.

As stated above, efforts between companies and academics toward the realization of SOCIETY 5.0 have developed a new concept of "academic-industrial co-creation" shifting from conventional “academic-industrial cooperation.” These can be regarded as co-creation strategies to build social functions and businesses up from scratch by creating new values through integration of academic and industrial knowledge.

Hitachi Group is sloughing off the conventional framework of general electrical manufacturer on the basis of the G-D logic to initiate a customer co-creation type of business. The group is now drastically transforming its organization structure including all research and development centers and business operating BUs, following the S-D logic in which the definition of value factor is shifted from value-in-exchange to use-in-value. In May 2016, Hitachi announced the plan to train 20,000 service business co-creators in three years as a human management strategy to accelerate customer co-creation.

5.2 NEC Corporation (Hereafter, NEC)

NEC and the University of Tokyo embarked on industry-academia alliance for seeking and implementing solutions to various social issues that Japan faces [14].

This alliance is different from other conventional industry-academia joint projects in the following two aspects: One is that the comprehensive collaboration is not limited to research and development of specific technology, but rather to solve social issues through vision sharing, research and development, cultivation of human resources, and social implementation. The other is the adoption of multilateral resolutions involving capable persons, technology and knowledge together, across the borders of laboratories and departments regardless of humanities or sciences.

The strategic partnership between NEC and the University of Tokyo is a unique approach which has sublimated a linear relationship of industry-academia collaboration into a planar co-creation. Considering the impact of AI on society, NEC established the “NEC/University of Tokyo Partnership Agreement for Future AI Research and Education in the field of Strategic Artificial Intelligence.” In this project, several innovative joint researches are planned by utilizing NEC’s world leading AI technology and diversified AI research results accomplished by the University of Tokyo.

Furthermore, the NEC/University of Tokyo Future AI Scholarship, aiming at developing students in doctoral courses studying AI at the University of Tokyo, will be newly established whereas NEC will accept outstanding students in doctoral courses as long-term interns.

As is the case with Hitachi, NEC has also evolved the AI-based industry-academia co-creation strategy. By forming a partnership with a specific national university, a co-creation strategy can be mapped out through sharing visions, research and development, cultivating human resources and social implementation to solve social issues, not limited to research and development of specific technology. Thus, the role and task of service business co-creators are very important.

5.3 IBM Japan

IBM Japan established GBS (Global business center) Collaborative Strategy Center within the Marunouchi Eiraku building in October 2015, as a base to create the future together with customers [15]. Its objective is to work with customers to build up an image of their future by joining all the forces of IBM, including its consulting skills and knowledge, state-of-the-art technology for research, and outstanding achievements in IT. In this center, strategies for initiating future businesses using advanced technology and for drafting management plans using cutting-edge analytics will be pursued.

The center consists of the "executive board room" where the management is invited to have a discussion, the "collaborative space" where a project is evolved, and the "visitor office" to support the employees about their working style.

Another new facility, IBM Client Experience Center, includes seven areas: (1) Advanced technology area, (2) Creative & design area, (3) Hybrid cloud area, (4) Advanced security area, (5) Partner co-creation area, (6) Session & exhibition area, and (7) Communication area.

(1) Advanced technology area: where advanced IBM technology is introduced to customers, and they can carry on a discussion with R&D engineers while experiencing various demonstrations.
(2) Creative & design area: where new customer experience is provided by making most of IBM's global experience and using the approach of IBM Design Thinking established during the development of IBM products.
(3) Hybrid cloud area: where technical inspection is held for customers; solutions are developed and examined together with customers by using IBM systems technology products and IBM cloud tools; necessary skills are acquired; and planning and implementation of marketing activities are supported.
(4) Advanced security area: where security apparatus is operated and monitored on behalf of customers around the clock, 365 days a year, and a total solution relating to security is suggested and a discussion with experts is held.
(5) Partner (customer) co-creation area: where opportunities to arrange seminars, negotiations and communities leading to effective sales and distribution activities are provided. IBM technologies and solutions useful for business creation are itemized and provided in sessions and seminars.
(6) Session & exhibition area: where the history of IBM and its achievements are introduced.
(7) Communication area: where customers and IBM employees can enjoy a delightful conversation in a cozy cafeteria.

Like this 7 sectors, the new center aim to create new business model co-creation of ideas using design technique, demonstrations, workshops and prototyping methods are provided, in addition to advanced technologies including next generation mobile solutions, cloud, analytics, social and security through cooperation with IBM Watson and Apple that will materialize cognitive computing, in order to perceive and embody new businesses with intelligence and sensitivity both necessary for corporate management in the IoT era.

The Research and Development Division was transferred from the Toyosu office to the main office in September 2015, where experts with broad knowledge including researchers and engineers for the IBM Research-Tokyo and the Tokyo Software System Development Laboratory, as well as the one stop discuss system contact with consultants and specialists from each industry.

As stated above, IBM Japan has also taken approaches to the realization of IoT with co-creation strategies with customers, where the role of "service business co-creators" is substantially important.

Vargo and Lusch	G-D logic	S-D logic
Knowledge creation process	Ikujiro Nonaka, Hiroaki Takeuchi "Knowledge creation theory" Develop mutual conversion exercise between tacit knowledge and formal in-house "Product development process covered" (Case) ① Honda Co-creation of the "BA" (tamadashikai) ② Panasonic Tacit knowledge of breadmaker ③ Mazda Development of new concept (RX-7)	"Collaborative creation strategy" A company designs a service business model in a cooperative and strategic manner with a direct "connection" with a specific customer or consumer New value creation for the realization of IoT era "Super smart society (SOCIETY 5.0)" (Case) ① "Building new business through creation of customer collaboration" Hitachi · NEC · Japan IBM ② "Promotion of industry-university cooperation creation project" Hitachi · NEC
Human resources required	(Promotion of cooperation within the company)	"Service Business Creator" (Through collaboration with stakeholders Construction of new business)

Fig. 5. Co-creative strategies toward the realization of SOCIETY 5.0 (Source: organized by the author)

6 Conclusion

As was stated earlier, several electrical manufacturers in Japan have initiated new approaches for realizing SOCIETY 5.0 with customer co-creation business on the basis of the S-D logic as a key strategy.

In implementing this scheme, it is inevitable to formulate a service model in consideration of value creation with direct and indirect customers.

As seen in the cases of above mentioned three electrical companies, the internal organization is reformed into the S-D logic based structure and the research and development personnel are stationed close to customers so that they can co-create knowledge together, embody tacit knowledge and build up a business model. Those who carry out this co-creation strategy are "service business co-creators."

As Fig. 5 demonstrates, in the phase of the conventional G-D logic based co-creation (developing a new product through knowledge creation within a company), the role of "engineering brand" (Kodaira [9]) is crucial in joint promotion with customers (outside the company). To create unprecedented new businesses toward the realization of SOCIETY 5.0 in the future, it is required to draw tacit knowledge from organizations and people inside and outside of a company and create new integrated tacit knowledge by dynamically revolving four processes in the SECI model(5), namely Socialization, Externalization, Combination and Internalization. It is this integrated tacit knowledge of businesses and customers that can be a core element for the common platform toward the realization of SOCIETY 5.0.

In this light, the process of knowledge co-creation is the most important strategy to realize SOCIETY 5.0. The presence of "service business co-creators" is a key to the success.

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Possibilities of Application a Big Data in the Company Innovation Process

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Abstract. Companies are inundated with huge amounts of data these days, whether from existing company's systems or new information sources such as social media, mobile devices, fitness equipment etc. Many forward-thinking companies are finding that the Big Data can offer possibilities to support the innovation management process. New tools, methods and techniques for obtaining and processing various data can reveal new opportunities for realization of the economically successful innovation on the market.

Keywords: Innovation · Management · Big Data · Innovation performance Process · Decision-making

1 Introduction

The rapid development in the area of information and communication technologies are currently a significant inputs to company's areas and processes. One of the most valuable resources that enter into business processes are information sources. Content respectively, the output from these sources are data which may contain certain information value related to decisions within each business process and with the management. Valuable information are useful on the one hand for decision making in company, on the other hand for gain a competitive advantage. The company has this valuable information mainly from its data sources or from external environment. Within obtaining data, for the data mining, companies may run into a problem with data heterogeneity, i.e. they are structured, unstructured and semi-structured data. A huge information potential for decision-making in the company have mainly unstructured data, which currently represent about 80% of all available data (Černý 2013; Gartner 2013). The use of these data for the needs of obtaining information useful in decision-making processes can be challenging for the company, in the case if in the company absent the technology which allows to work with this data. This problem could be solved by Big Data solution. This technology respectively approach can be used in all areas of business management. One of these areas is also innovation management in the company. Innovations are one of the main drivers of long-term sustainability and development of the company on the market. The creation and

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management of innovation in the company is a complicated and complex process. A key input in this process are information obtained for this purpose from various data sources. Since innovations are successful if they meet the needs and demands of customers, it is necessary to obtain information from customers. This information is often contained just in the form of unstructured (social content, queries in search engines, interviews in call centers, etc.), therefore it is necessary to use Big Data solution for data mining and their use in processes related to innovation (Yang and Wang 2017).

The methodology used in this paper is mainly investigation of the current state of relevant domestic and foreign literature - analyzing, summarizing and evaluating the relations between topics of Big Data solution and innovation. The subject of the analysis was the literary sources and documents (e.g. study cases, catalog sheets, technical documentation, internet resources, etc.) in the area of Big Data, innovation, innovation management and innovation process. The information obtained through the analysis of the documents had qualitative nature. In the process of formulation of conclusions from the literature, case studies, and other papers were used general methods of analysis, induction and deduction, qualitative method, and modeling method. Conclusions from the realized analysis were used to define the capabilities of using Big Data in the innovation management process, while the aim was to point on eliminating or mitigating the impacts of the issues, which arise in the innovation management process according to Lendel et al. (2015).

2 Innovation and Big Data

For better understanding and problem solving in the area of connections between the innovation and Big Data solution, it was important to study the theoretical and practical materials related to the issue of the innovation, the innovation management, and the Big Data solutions.

Rapid developments in technology field nowadays have a significant impact on the development of innovation that is very important for the growth and competitiveness of companies. Innovation represents a thought or behavior that is new to a company, or the creation of new, mutually connected knowledge and ideas to support companies processes and product creation, according to market requirements (He et al. 2007; Du Plessis et al. 2016). Innovation represents the main source of economic development and wealth of several countries. The economist J.A. Schumpeter defines innovation as an enforcement of a new combination of production factors while innovation is presented as a new combination. This hypothesis says that innovation is the use of current processes, technologies, and factors in new, till now unused situation (McRaw 2009).

Innovation is mainly based on the development of production and the market. Innovation leads to the expansion of the production process.

Innovation is a major change in the economy that is tied to the implementation of knowledge, which causes increasing the value in the whole company. The result of innovation is a positive change which leads to efficient use of resources. Innovation capacity of companies is the basis of wealth creation and depends on the formation of their knowledge strategy.

The meaning of innovation represents the transformation process from the outputs of innovation activities to the commercially successful products. Innovation can be implemented only there, where the outputs of innovation activities have a positive impact on increasing the effectiveness and efficiency of business processes and also brings required value to customers (Malichová et al. 2015).

In the terms of Slovak companies, it is necessary to apply new ideas, knowledge and processes into production processes and activities and thereby bring innovations to market. Innovation is an basic tool for increasing the competitiveness of companies. The same importance is on the management of innovation and innovation processes.

Innovation management represents decisions, activities, and processes which transform new ideas to the realization on the market, in order to create business value. Innovation management is controlling and implementing processes, activities, and policies which lead to the generation of new value for customers and the company (Nambisan and Sawhney 2010).

Innovation Management is a comprehensive system of knowledge which makes possible to effectively manage innovation activities in the company. Through the innovation, it is possible to practically transfer people's thoughts and ideas into new products (goods and services), processes, systems, organizational and managerial structures, also into operating procedures, social relations and so on.

Innovation performance of the company can be characterized as "ability to turn innovation inputs into outputs, i.e. the ability to convert potential of innovation into their realization on the market." Successful companies, in terms of innovation performance, are companies that focus their attention on innovation. Demonstration of innovation can be seen in the quality and quantity of innovative ideas, but also in the efficiency and effectiveness of new creative ideas (Ryan 2010).

Big Data represent a loosely defined term that describes a large amount of complex data sets, and at the same time describes the advanced technology for the collection and storage of the data (Kim 2014). In generally, it is possible to talk about big data in three basic senses. For data too bulky on this so that we can easily and in a reasonably short period of time with the appropriate performance of the process (e.g. information about the gravitational potentials of each star, which is located in the two galaxies, which are currently subjected to collision), data is flat (e.g. searching of information through text, video or audio files), or those which need the information almost in real time (such as traffic information from thousands of cameras and satellites) (Černý 2013). The term Big Data can be also understood as a set of hardware and software tools designed to work very quickly together with multiple sets of data that are bulky, diverse and complicated to manage using traditional techniques of data management (Wu et al. 2018).

According to the IBM, Big Data brings platform with options, how to handle large amounts of data in relation to the business opportunities of the enterprise. Big Data platform includes technologies for processing of structured and unstructured data with traditional links to new technologies focused on speed, flexibility, and task force exploring, discovering, analysing the data. According to IBM's defining Big Data the following features (Big Data for beginners and intermediate 2012; Challenges of Big Data 2012):

- Volume represents a very large number of collected data-for analytical processing (e.g. Airbus aircraft generated every half an hour to 40 TB of data, Twitter generates a day 12 TB of data, Facebook 25 TB, etc.) (How to use BigData 2012; Collection of conference papers. Data and Big Data 2013; Gartner 2013), which presents an opportunity for businesses to process voluminous data in a single database summary structure.
- Variety means that the data are well structured in a structured form, i.e., the data entered into the form of messages, images, and other types of data generated by the GPS signals via the Internet and telecommunications equipment.
- Velocity indicates that the data must be gathered and processed very quickly, i.e. in real or near real time, which enables businesses to respond flexibly to changes in the market, or gain a competitive advantage.

The original characteristics of Big Data technology is being defined by three mentioned factors: volume, velocity of data processing and variety. (Collection of conference papers. Data and Big Data 2013).

According to other sources, it is possible to include additional features to Big Data which are gradually emerging with increasing quantity. For example (Big Data: What is it & Why it matters 2016):

- Variability represents an ever-increasing variety of inconsistent data, which are generated on a daily, seasonal in larger quantities. These are high-quality data for processing and understanding.
- Complexity, i.e. the need to associate, to transform, to compare and correlate the relationships and links between the data that is generated in large volumes from a variety of data sources, in order to check the data.

In recent years, Big Data has become a trend as in the company's internal and external environments grows the amount of devices generating a large amount of diverse data, such as for example mobile devices, sensoric networks, video streaming via web interface, and more. These devices generate terabytes up to exabytes of data that may contain potentially significant informational value for managers of the company (Chen et al. 2012). In practice, different solutions are used in Big Data. These solutions are being often used by ordinary users, even though they do not realize this. Examples include Google or Yahoo search engines. These companies within their Web browsers to generate a wealth of data about the users of the Internet (the most common searches for the user what the site visits, etc.). Since the internet is a worldwide available, every second are entered into search engines, millions of queries. All these data are recorded, which represents a very large amount of data, which are then referred to by the technology being processed. The processing of those data then the company adapted to the search results for each user separately, i.e. If two users enter the same keywords in their search results are different. (How to use BigData 2012).

The Big Data solution had also a major impact on Wall-Mart's innovation. This company is one of the largest retail chains in the world. Walmart generates more than 2.5 petabytes of data per hour (Big data and Wal-Mart 2014). The ability to process and retrieve informational value from these data has had a major impact on the company's innovation process. The ability to process big amount of diverse data in a short space of time and the ability to generate advanced predictive analyzes within the innovation process have enabled the company to achieve a number of innovations, for example innovations to support consumers' purchases through mobile devices and Geofencing application to help customers track QR codes at the store and track current product special offerings, another upgrade in the buying process is the Mapping application that allows customers to save time while searching for products in the store and thus ultimately creates space for further purchases and more. Thanks to these Big Data innovations, which were achieved with help of Big Data solutions, Walmart has secured sales growth of up to 77% and revenue from online sales by 10 to 15%. Between other benefits to support the innovation process and the creation of innovation of innovations itself, which were brought to the company thanks to the Big Data platform, can be included data processing from mobile devices, implementation of predictions, better understanding of buying behavior, creating a new online marketing platform, and more. (Mayer-Schönberg and Cukier 2013; Walmart Now Possesses Info on an Estimated 145 Million Americans: Analysis 2013; Walmart Is Making Big Data Part Of Its DNA 2013; Find Items Even Easier with 'Search My Store' 2014)

3 Discussion

In the process of managing the innovation can arise several problems which affect this process, and also innovation itself. The most important problems arising in the process of managing innovation are as follows (Lendel et al. 2015):

- Problem in ensuring information of the innovation process.
- Problem in the ensuring of the innovative expertise.
- Problem with the application of management elements into the innovation process.
- Problem in the evaluation of the innovation performance.
- Problem in the innovation process.

The innovation management is a process that should not be managed only by intuition of managers, but it is appropriate to support this process with relevant information and knowledge. In order to eliminate duplication and misinformation from a variety of available data, it is necessary to select relevant information related to the problem or decision. Currently, managers have an access to amount of diverse information. The problem of managers is editing and gathering of relevant information and knowledge. This problem can be partly eliminated with the Big Data solutions.

3.1 Problem in Ensuring Information of the Innovation Process

While implementing of innovation, it is important to think about the effectiveness of innovation based on available information obtained from the database resources of the company. These resources contain primarily structured data, it is the data stored in a relational database structure. The problem may be a lack of information, irrelevant information to the innovation or the inability of the current information system to evaluate data sources and deliver necessary information into the process of innovation. In the same sense, it is possible to consider the value of unstructured data. In the case, that the company does not use this data, their information value is missing in the company. Unstructured data are unused for several reasons, such as: economic situation of the company, unqualified personal, insufficient technical equipment of the company or just the absence of solution, which enable to company to work with these data structures (Big Data). Impact of various data to the manager is shown on the following figure (Fig. 1).

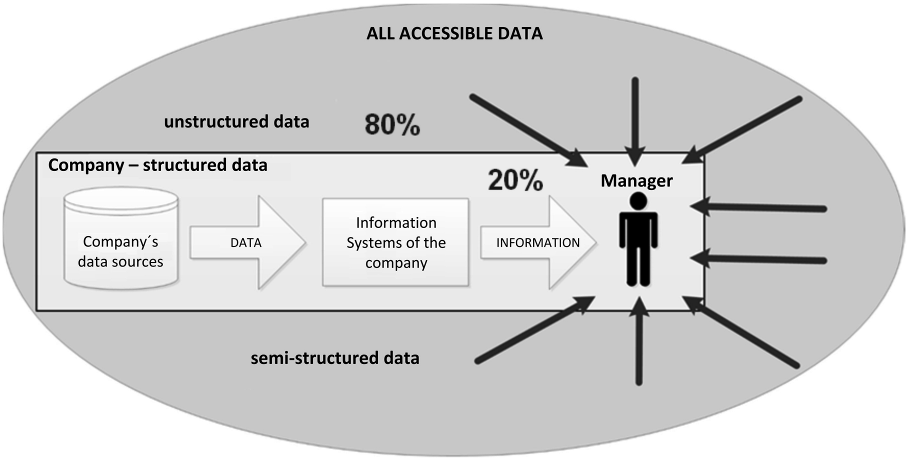

Fig. 1. Impact of the data to the decision making of manager in the company (own elaboration)

The solution of problem with ensuring of information in the innovation process is a usage of Big Data solutions. Big Data solutions makes it possible to extend a company's data base by the ability to process a variety of data in a relatively short time. This allows to the company select relevant information, not only from the company's data sources, but also from the available external environment data. Data from external environment may contain relevant information especially in the field of customer needs and requirements. These needs and requirements show the importance, the scope and the success of innovation in the future.

3.2 Problem in the Ensuring of the Innovative Expertise

The process of innovation creates new data, which should be analyzed by the company. It is also necessary from new data obtain the necessary information and knowledge utilizable further in the innovation process. Problems may arise in situation that the company does not pay attention to this data, respectively data are lost, forgotten or duplicated. Importance of these data is need to be perceive in terms of time and new data available, because customer requirements are constantly changing. It means that customers and the environment produce a variety of new data. Solving the problem by Big Data is the possibility of collecting, organizing, archiving, distributing and analyzing data emerging in various stages of the innovation process. These data of various structures is possible to analyze through the Big Data, in the context of current company´s data and with data from environment. Solving of the problem is shown in the following figure (Fig. 2).

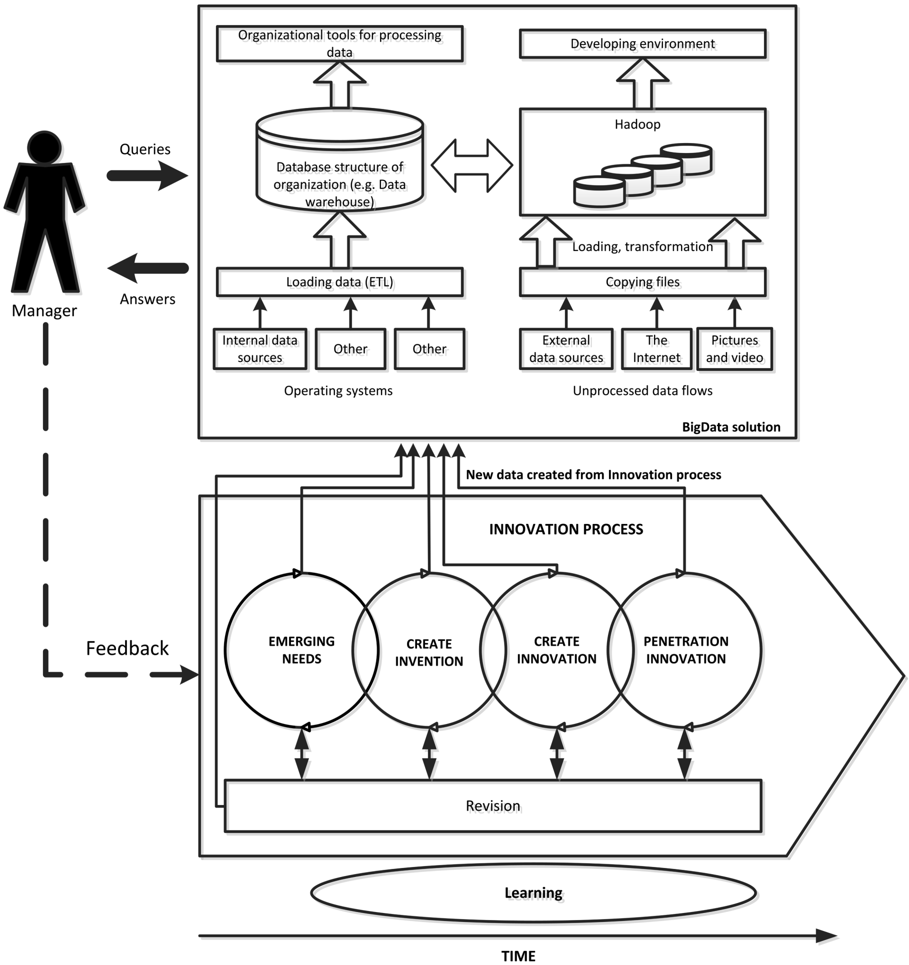

Fig. 2. Capturing and using of data arising in the innovation process (own elaboration edited by Lendel et al. 2015; Big Data: From great expectations to practical use 2014)

The manager responsible for innovation process can assess the appropriateness of continuing in the innovation process. The manager makes decisions based on the information obtained from Big Data solutions.

3.3 Problem with the Application of Management Elements into the Innovation Process

Companies use in creation of a long-term strategy, goals and plans available information (about customers, competition, market, environment, etc.). They should act similarly also in defining the innovation strategy, goals and plans. The innovation strategy supports and contributes to the achievement of business objectives, thereby contributing to the achievement of corporate strategy. The problem in creating an innovation strategy can be lack of information sources for supporting planning, organizing and controlling innovation activities. Big Data helps to partially eliminate this problem. Database of the Big Data solutions provides a variety of data, methods and techniques of their processing that enable companies to identify new innovative ideas or competitive advantage. The support of Big Date solution in the process of creating the strategy is shown in the following figure (Fig. 3).

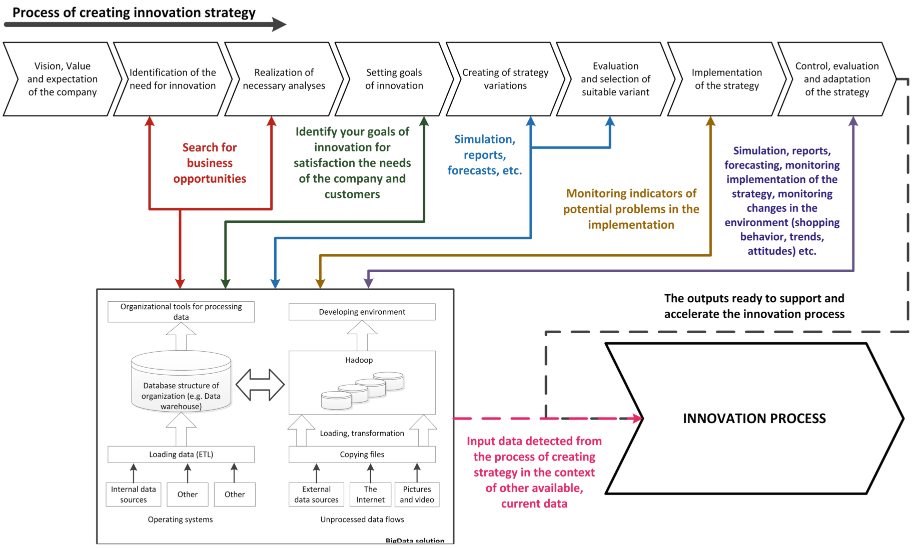

Fig. 3. The support of Big Data solution in the process of creating the innovation strategy (own elaboration edited by Lendel et al. 2015; Big Data: From great expectations to practical use, 2014)

The innovation strategy is based on relevant information obtained from a variety of diverse data, it helps to eliminate problems and duplication in the implementation of innovation projects in the company.

3.4 Problem in the Evaluation of the Innovation Performance

The problem of evaluation of innovation performance is based on inability of the company to evaluate the effects and benefits of innovations implemented. The problem may arise as a consequence of insufficient amount of relevant information from stakeholders (customers, employees, suppliers, etc.). Is very difficult to obtain a feedback with regard of the adaptation of innovation in the market. Most of feedback is available in unstructured form, it means that companies do not use with this data (Fig. 4).

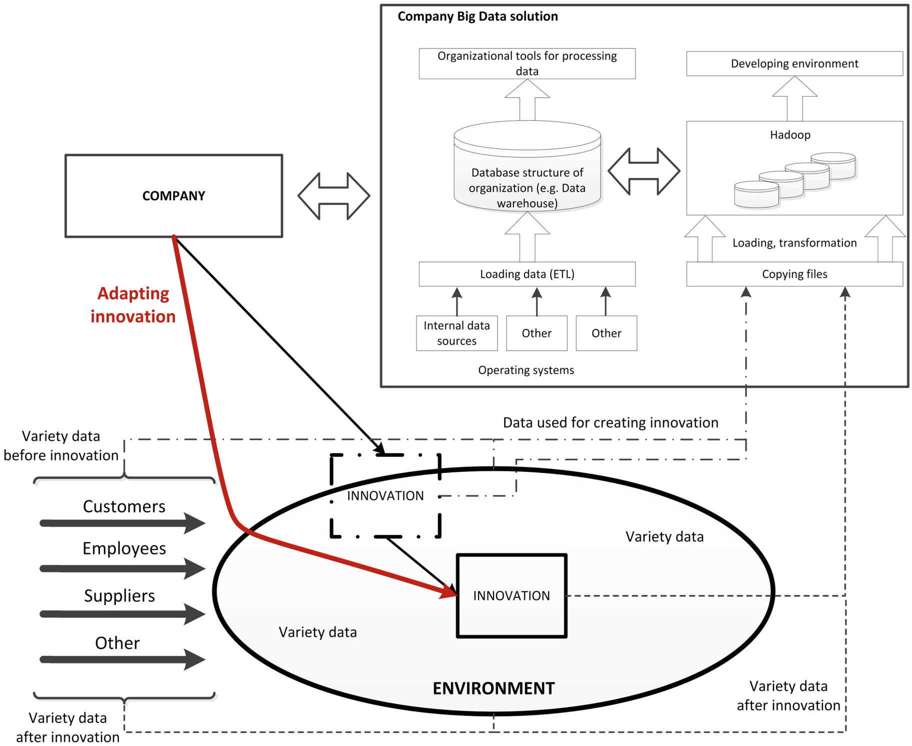

Fig. 4. The support of the innovation through the Big Data before and after launching to the market (own elaboration edited by Lendel et al. 2015; Big Data: From great expectations to practical use 2014)

The solution to the problem is the ability of the Big Data solutions to process unstructured data. Based on the results of the analytical data from the Big Data, the company can choose the appropriate metrics that will evaluate possible effects and benefits of innovation implemented. At the same time is possible to contribute to the evaluation of the innovation performance of companies.

3.5 Problem in the Innovation Process Itself

The main problem arises in the first and second phase of the innovation process, it is creating the need and the creation of the invention. On the basis of available information, company can identify significant innovative ideas, which is trying to transform to the invention. In the long term, this innovative idea or invention can be consider as insignificant. Consequently is necessary to adapt the idea in the way which meets company´s objectives and strategy as well as customer requirements. In many cases, the company is forced to stop the innovation activity. This solution is for the company consuming in terms of time, finance, capacity etc., and negatively affects the overall innovation performance of the company. The solution to the problem is to provide the information base, particularly in the early phases of the innovation process (Fig. 5).

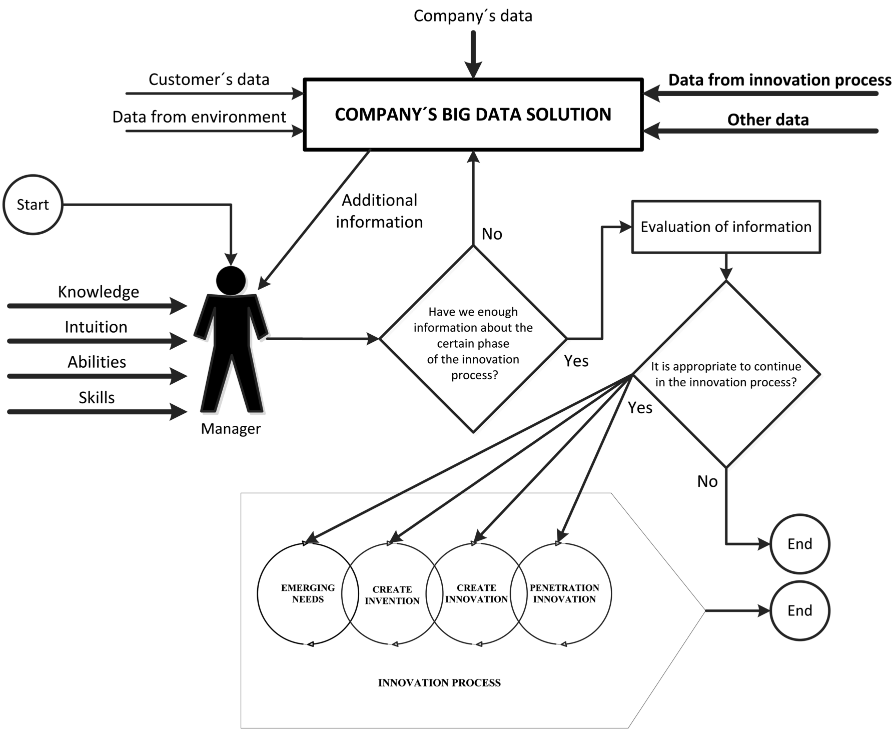

Fig. 5. Assessment of phases of the innovation process through the BigData (own elaboration edited by Lendel et al. 2015; Big Data: From great expectations to practical use 2014)

The relevance of the innovative idea need to be considered within available data during the different phases of the innovation process. The main reason is the need of adaption of innovation to the changing needs and demands of the market. The Big Date solutions allows to conduct a detailed analysis of the various innovative ideas, considering the situation in the market.

4 Conclusion

The continuing development in the field of information and communications technology results in the generation of more and more diverse data. Currently, the data are a major input into decision-making processes of the company. By processing of these data is possible to obtain information that supports decision making across the company, for example, also in the area of the creation and the development of innovation and the innovation process.

As well as in any other process, also in the innovation process can arise problems that have a negative impact on the creation and relevance of the resulting innovation. Possible problems according to Lendel et al. (2015) that were stated in the article, can be removed or mitigated their impact through the Big Data solutions. Based on the innovation process problems assessment, literary resources, and Big Data solutions, we can identify the major capabilities of Big Data solutions application to support the company's innovation process and to eliminate the above-mentioned problems. Between these capabilities can be included:

– Extending the company data base to unstructured data, enabling company managers to uncover new opportunities for innovation based on analyzing unstructured data of customers, eliminating the lack of information resources, eliminating the distortion of results on the basis of structured, internal business data, or eliminating duplication in the innovation process, and so on.
– Acquisition and analysis of the data in real time to define goals, plans and an innovative strategy based on quickly available relevant information.
– Bringing knowledge from all available data, what will enable to increase flexibility of managers in the innovation process when changing actual state (e.g. changing consumer buying behavior).
– Generate predictions over all the different data and make decisions based on possible future predictions (e.g., prediction of the results of individual activities within the innovation process).
– Advanced analytic tools for working with a lot of data (e.g., to quickly evaluate the state, meaning and variants of the innovation creation process).

Successful implementation of the innovation process and its individual parts has a major impact on the relevance of the implemented innovation.

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New Trends in IT

From Traditional Cities to Smart Cities

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Abstract. The transformation of traditional cities to smart cities becomes increasingly important for the actors that interact with it; government, public and private organizations, and citizens in general, in addition to making easier its implementation thanks to the development of ICTs (Information and Communications Technologies). Each project deals with specific needs according to the city's characteristics (technological development, educational level, quality of provision of public services, number of inhabitants, climatic and environmental conditions, etc.), however, it is possible to establish a general methodology for developing this transformation. The present article develops a methodological proposal for the implementation of a smart city which includes five stages; analysis of current situation, preparation of a work plan, strategic formulation, action plan and management plan. Each stage is developed by integrating components such as infrastructure, technologies, processes and human capital in order to satisfy established strategic objectives and, overall, to create a better quality of life of its inhabitants and a sustainable environment.

Keywords: Smart city · Methodology · ICTs · Integration · Sustainable

1 Introduction

The concept of smart city began to be utilized at the end of the 20th century with the aim of providing solutions for the problems of sustainability in cities around the world [1] and it was even more promoted by the urban growth trends which predict that in 2050 about 70% of the world population will live in cities [2]. In recent years, the word has been linked to the use of ICTs (Information and communications technology) as a way to promote economic growth and improve the quality of life of the different cities' inhabitants in harmony with the environment [1, 2]. A smart City is attractive for citizens, businessmen and workers because it offers a safer space, better services, creation of jobs and reduction of inequalities through creative solutions [3].

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2 Smart Cities

2.1 Concept of Smart City

According to the International Telecommunications Union "A smart and sustainable city is an innovative city that takes advantage of information and communication technologies (ICT) and other ways to improve the quality of life, efficiency of operation and urban services and competitiveness, responding at the same time to the needs of present and future generations with regard to economic, social and environmental aspects" [4].

2.2 Architecture of the Smart City

Although each smart city project looks for specific solutions associated with problems that affect the greatest number of people, they agree on the need to integrate people, technologies and processes [3]. From the technological point of view, a smart city can be considered as an integral system that includes different levels associated with providing intelligent services in different categories [5].

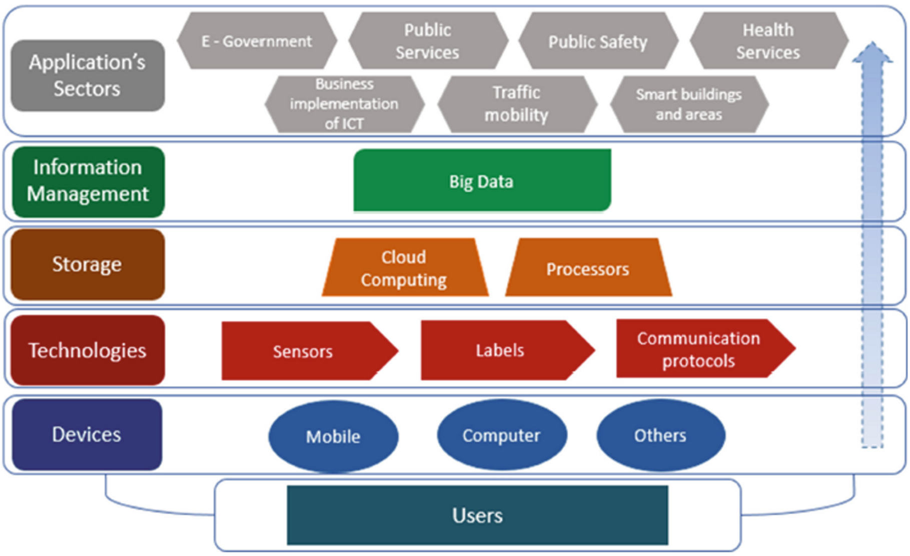

Fig. 1. IoT proposal architecture for smart cities [6].

The Fig. 1 presents an IoT (Internet of things) proposal architecture for smart cities [6] in which the general characteristics of different IoT's architectures examined has been identified. In this the information flow goes from user to the interested sectors, being users the main source of data. The flow levels can be classified into:

Devices. It corresponds to mobiles, computers and other intelligent devices that are equipped with microprocessors and allow machine-machine connections [3].

Technologies. They allow the capture of different stimuli from the physical world and intelligence to monitor and communicate this information of the city [5].

Storage. It is about the provision of the necessary information to provide the services by the smart city [7].

Information Management. It refers to the intelligent understanding and analysis of stored data in order to structure it and make it available through different means such as applications [7].

Application Sectors. Constructed from the smart city solution, they comprise the client interface and the integration with the customer's systems [7].

The proposal architecture establishes the necessary links to develop apps with a standard that can allow integrations of software and reduce the gap of compatibility [6].

2.3 Benefits of Becoming a Smart City

Unquestionably, smart cities are destined to become one of the most powerful tools in public policies in the field of cities in the coming years [8]. By integrating the use of information and communication technologies (ICTs) in the construction of an intelligent city, as well as significantly improving the provision of services, it will also allow us to build a sustainable path for economic and social development in the future years of this and your country.

In practice, the benefits will be much broader, studies on technical reports carried out in Spain on smart cities, allow the identification of benefits and risks of the implementation of smart cities [9]. Among the benefits are: the improvement of the effectiveness and efficiency of public administrations, the obtaining and analysis of the information generated in real time, the reduction of expenses in the maintenance of buildings and infrastructures, the reduction in the congestion of the systems of transport, increase of the citizen security, increase of the competitiveness of the cities and of the quality of life of the citizens. Smart cities also allows the latter, companies and third parties in general to help solve the problems presented by cities, by democratizing access to information and services in a transparent manner [8, 9].

The following Table 1 summarizes the benefits obtained by becoming a smart city.

Table 1. Benefits of the smart city [3, 8]

Good management of current and future problems	It generates integration, which in turn provides the public administration with necessary and transparent information for better decision making and budgetary management
Promotes innovation	It presents an ideal platform to create an environment of innovation and generation of new business and ideas, favoring economic and social growth

(*continued*)

Table 1. (*continued*)

Optimizes resource allocation	It optimizes the allocation of resources and helps reduce unnecessary public expenditures
Greater satisfaction of citizens	It allows providing a better service to users of services and improves the image of public bodies and, in this way, increases the level of satisfaction of the inhabitants
Greater participation of civil society in administration	Through the use of technological tools that help monitor public services, identifying problems, reporting and interacting with the municipal administration to solve them
Minimization of environmental impact	Optimization of operations to minimize environmental impact and improve the results of the use of resources, maximizing performance

2.4 Major Smart Cities in the World

In 2017 the IESE cities in motion index revealed the most outstanding cities in 10 key dimensions: economy, human capital, technology, environment, international projection, social cohesion, mobility and transport, governance, urban planning and public management, meeting in the first three places the cities of London, New York and Paris respectively, cities that, according to the study, have a higher level of sustainability and quality of life for its inhabitants [10].

New York, United States. New York has been concerned to offer access to internet on a large scale [11], also the transit department receives real-time images generated by cameras installed on the most important routes and junctions, and together with the meteorological information they have improved the signaling, change the times of the traffic lights according to the needs and generate traffic alerts by applications, Comp Stat was developed, a data collection service for the visualization of the criminal record of suspects involved in different crimes and has been implemented the use of cameras in police uniforms [3].

London, England. Since 2013, it has installed sensors to regulate car parks through a Smartphone application. It has also carried out initiatives such as “Source London”, a network of charging points for electric vehicles in the city [12].

Paris, France. In Paris, the use of shared bicycles has been implemented, with approximately 2,000 parking spots and 20,000 bicycles at present [13]. It is also proposed to use different techniques of energy production in buildings, the construction of automated metro lines, and the use of electric buses and shared vehicles, increase the length of bicycle lanes in Paris and the installation of Wi-Fi in each metro station [14].

3 Methodology Proposed for the Construction of a Smart City

To make a smart city there is no single approach, each one represents an independent system with different actors and organisms interacting at different scales and using different platforms and infrastructures [5]. However, the main intelligent services that intelligent cities are expected to provide are the following:

Table 2. Intelligent services of the smart city.

Service	Description	Applications
Urban mobility	The aim is to build a sustainable, integrated, safe and interconnected system with real-time information [15], reducing pollution, congestion and increasing the level of accessibility to it [16]	Traffic management in real time Management of means of transport Parking management Payment of tolls Shared vehicles Electric vehicles [8]
Energy efficiency and environmental management	It seeks the environmental sustainability of the city, reduction of water consumption, energy and raw materials, reduction of operation and maintenance costs, as well as the times of action in cases of incidents [15, 16]	Smart energies Smart meters Management of public parks and gardens Waste treatment Measurement of environmental parameters [8]
Intelligent management of infrastructure and public services	The optimization of four basic elements is sought: structure, systems, services and administration [17]	Management of public and inmotic buildings Management of public infrastructures and urban equipment Urban incident report [8]
Government and citizenship	It seeks to have greater transparency in the processing of data in real time and that these are required by everyone, in addition to helping in citizenship education [15]	E-Administration E-Participation Smart economy Open Government and Open Data Analytical applications [8, 15]
Public security	The promotion of a safe lifestyle is sought, increasing capacities and response time of the different emergency systems [8]	Management of public emergency services and civil protection Video surveillance Prevention of fire detection [8]

(*continued*)

Table 2. (*continued*)

Service	Description	Applications
Health	The aim is to reduce healthcare costs and contribute to maintaining the expected levels of quality of service [8]	Telemonitoring and telemedicine Telecare and social services Public health [8]
Education, human capital and culture	It seeks to support the administration, management and monitoring of the bodies responsible for offering them [8]	E-learning and teleworking E-tourism and cultural information services [8]
E-commerce	It seeks to offer multi-service payment platforms [8], in order to streamline transactions, avoid unnecessary costs and reduce waiting times [18]	Payment platforms [8]

After carrying out a bibliographic review, the methodological proposal for the elaboration of a smart city was established (Fig. 2), which consists of 5 stages.

Fig. 2. Methodological proposal for the implementation of smart cities

These stages contemplate the key aspects to consider in the transformation towards smart cities: the analysis of the current situation, which is of vital importance to know the progress made, the weaknesses, as well as the available resources and establish feasible objectives; the preparation of work plan, which establishes the team and work schedule and specifies the areas or services in which you want to work -it is recommended to take into account the intelligent services described above-; the strategic formulation, which is the basis for measuring progress and the results obtained in the transformation process; the action plan that specifies the resources and strategies that will be carried out; and finally the management plan where the action plan is implemented and the process is fed back through the results obtained. Without a competent team, proper planning, implementation and a continuous review process, it is not possible to guarantee the achievement of the expected results.

The proposed methodology highlights the importance of strategic planning, the establishment of the necessary technologies and economic resources, as well as a process of feedback and measurement through some proposed indicators.

Once the analysis of the current situation is carried out, the city in the process of transformation identifies what service or intelligent services it wishes to implement, and following the steps of the methodology focused on these, guarantees that the transformation process adjusts to its particular needs.

This is applicable both for new cities and those that face changes. For new cities it is recommended to work from the beginning in all areas or proposed intelligent services, while for cities that must face changes, it is proposed to start with the areas of highest priority for the proper functioning of the city [8].

3.1 Analysis of the Current Situation

It consists in identifying which issues merit attention, and deciding to what type of programs and services to allocate the available resources [19], ensuring the relevance of a program and defining the best way to proceed.

Carry Out an Analysis of the Needs and Results of Previous Plans. Identify the starting situation by analyzing the needs and results of plans or actions previously carried out in the scope of action of each topic [7].

Identify Existing Resources. Identify existing or available resources (natural, infrastructure, technology, human and economic resources) for their implementation in each area of action, being important to define the proposals according to the plan [7].

Identify Strengths and Weaknesses. Perform the SWOT diagnosis (Strengths, Opportunities, Weaknesses and Threats), making it possible to know and evaluate the actual operating conditions of the city based on the analysis of these four variables for each area, in order to propose actions and strategies for their benefit [20].

Identify the Challenges. To manage and improve cities, it is necessary to know what happens in them, bearing in mind the challenges that must be faced, in order to set clear, realistic and concrete goals.

3.2 Preparation of a Work Plan

In this stage the guidelines and artifacts that guarantee the realization and fulfillment of the objectives of the plan that will be carried out are established [7], this serves as an instrument of planning and management that allows carrying out the ends efficiently.

Identify the Work Areas. Identify the areas or topics of work that will be contemplated [7], for example: area of mobility, infrastructure, culture, security, trade, environment, among others.

Constitute the Work Team. The work team should be set up to coordinate the process of preparing the plan, according to the areas that need to be worked on, involving all those people and organizations that may be involved or affected by the plan, making known the objectives and the work context [7].

Perform the Work Schedule. Write the work program and the timetable for its development, taking into account the resources and their availability. The process of developing the schedule must be: complete, it must represent all the work to be done; realistically, with respect to time expectations and availability and accepted; you must have the support of team members and those interested in the project [21].

3.3 Strategic Formulation

For strategic formulation, it is necessary to take into account the degree of development, viability in terms of economic, geographic and environmental factors, as well as the priority of development [22]. The importance of the integration of intermediaries in the process to achieve the objectives must also be taken into account.

Identify the Mission and Vision of the Plan. The mission seeks to synthesize the main purposes of the city that should be known by all intermediaries [7]. The vision should reflect the long-term goals of the city in terms of efficiency, sustainability and competitiveness [23].

Establish Strategic Objectives. They are established based on the observed weaknesses and after establishing the priorities for the management of the smart city. They represent the future points to be reached and serve as a guide to the tactical and operational behavior of the plan [7].

Create Strategic Axes and Lines. The strategic axes to be discussed are established based on the strategic objectives and refer to the smart services offered by the smart city. The strategic lines refer to the lines of action necessary to achieve them and are related to the applications of intelligent services [7].

3.4 Action Plan

It is the detail of the initiatives to be developed with respect to the strategic axes and the lines of action proposed, as well as the instruments for their implementation [7].

Create Awareness Among Stakeholders and Citizens. It includes providing greater support to entrepreneurial initiatives, teaching the use of new technologies, the services available and engaging citizens in the communication of information [24].

Perform Strategic Line Description. It is necessary to make a description of the characteristics, objectives and main advantages of each strategic line according to the needs of the city [7].

Describe the Necessary Technology. It includes information about infrastructure providers, service providers, and necessary applications [8]. In addition to this, the most appropriate technologies must be considered to fulfill the established purposes (Table 3).

Table 3. Technologies for the smart city [5, 8].

Function	Specification	Type
Data recollection	Sensors and actuators	Resources (Water, gas, light), security, lighting, presence, weather conditions, transportation infrastructure, movement, position
	Identification technologies	RFID
Data transmission	Communication networks	Fiber optic (FTTB, FTTA, FTTH), (Integrated, aerial, down, indoor cable)
	Wireless technology	LTE-A, 4G
	Communication protocols	Wi-Fi, Bluetooth, ZigBee
Data storage and analysis	Data warehouse	
	Data mining	
Data access	Technological devices	Computers, cell phones, tablets
	Communication interface	Applications, platforms

Integration Plan Through the Control Center. It requires the provision of computers and software applications that receive process and analyze data, as well as communication interfaces that send and receive information from the population and encourage collaborative participation [3].

Economic and Financial Study. The financial aspects are associated with the need to make the smart city tangible and, based on this, the business plan that supports the implementation of the new solutions, products and services is developed [25]. It is necessary to carry out adequate financing, studying the possibilities of public-private collaboration or with other institutions worldwide. A clear objective of return on investment from the economic, environmental and social point of view is established. Since this is a long-term investment, project cost control must be followed so that any specific deviation does not jeopardize its development [26].

3.5 Management Plan

The Management Plan should include the instruments and mechanisms that allow coordinating the actions of the plan, promote them and ensure adequate compliance with the objectives set [7].

Perform Pilot Test. The general plan should start with one or more pilot projects, and move forward with firm steps and in accordance with the city's institutional and financial capacities [3]. The pilot tests should be designed in such a way that if they are successful they can be expanded, so that the key factors that will be needed for an extension decision are already explored during this phase [27].

Implement Project. To implement the project, the technology required to start up an efficient collection, transmission, storage and analysis of data is acquired, allowing an adequate management of the information when it is stored in the cloud. This large volume of information exists in a great variety of data, which can be represented in different ways around the world, which can measure and communicate, in such a way that the applications that analyze These data require that the speed of response is very fast in order to obtain the correct information at the right time, promoting greater interaction with citizens, raising their level of satisfaction [5]. For this, it is necessary to have the execution capacity to concretize that vision; an intelligent government that has trained professionals endowed with this multisectoral perspective is the key to start this process [3].

Supervise the Project. The results must be recorded, measured and analyzed to identify the improvements achieved by the different initiatives in contrast to the initial situation. The degree of success of the smart city project will be given by long-term economic, social and environmental results [26], for this it is necessary to have a set of objective indicators to measure intelligence, establish comparisons and rankings of cities, quantify objectives, establish actions and detect deviations or effects not sought [25]. Table 4 shows a description of some indicators based on the smart cities services mentioned in Table 2.

Table 4. Smart cities assessment indicators [28]

Service	Indicator
Urban mobility	*Local accessibility*. Efficient local communication channels that allow reducing the time and cost of transportation, as well as reducing polluting emissions, providing ample travel satisfaction *Local internationality*. External communication channels, which allow a correct connection with other local cities, airports, railway terminals, ports, etc. *Availability of ICT infrastructure*. Infrastructure fiber optic network, satellite network, telephone network, computer equipment, video surveillance, etc., available to be used by the inhabitants of the city *Sustainable, innovative and safe transport system*. Shared electric vehicle system, free of traffic and green transport

(*continued*)

Table 4. (*continued*)

Service	Indicator
Energy efficiency and environmental management	*Pollution*. Level of particles suspended in the air, damage to the ozone layer, population with respiratory diseases caused by pollution *Sustainable management of resource.* Efficient use of water, efficient use of electricity, rescue of contaminated land *Waste generation*. Waste generated by city *Energy.* Percentage of use of clean energy on the total use of energy, legislation to improve energy efficiency
Smart management of infrastructure and public services	*Infrastructure connection to public services.* Water piped, sewage, electricity services, waste management services, knowledge infrastructure services
Government and citizenship	*Participation in decision-making.* Representatives in the city by local residents, national inhabitants in political activity, participation of female representatives *Public and social services*. Satisfaction for the operation of drainage, cleaning services, day care, procedures through ICT solutions, etc *Transparent government*. Institutions of transparency and information established and efficient
Public security	*Individual security.* Local crime, number of deaths per assault, police units per capita *Emergency care.* Number of ambulances and firefighters per inhabitants, average time of response to emergencies
Health	*Health conditions and services.* Life expectancy, hospitals per inhabitant, doctors per inhabitant *Quality housing*. Minimum satisfaction of the occupied dwelling, good general conditions of the dwelling, compliance with minimum standards in housing
Education, human capital and culture	*Cultural facilities.* Number of theaters, cinemas, museums per inhabitant *Educational centers.* Students per inhabitant, educational level of schools, satisfaction with the education system, access to the education system *Tourist activity.* Importance of tourist sites, visit days per year per inhabitant *The social cohesion.* Poverty rate, perception of aid to the poverty rate
E-commerce	*Universal accessibility to the internet*. Percentage of households that have access to the internet, active population in social networks, free Wi-Fi points, population with smartphones

To select or create the correct indicators, it is useful to ask these questions: What do you want to measure? Why? Do you monitor the results of one of the objectives? Is it a key factor? Who is responsible for supervising it? With what frequency should it be supervised?

Feedback. This plan must be in permanent construction, so it is necessary to ensure its continuous adaptation to new elements or changes in the environment, whether changes in regulations, technology, budgets or the same result of projects involve that technical decisions and situations are changed in which it is necessary [7], so it must always be in a continuous improvement process, using the results to provide feedback and make the necessary modifications.

4 Conclusions

The implementation of smart cities is not easy, it is a complex task that requires analysis, planning, supervision and permanent feedback, however it brings many benefits for both the government and the population in general.

The implementation of each initiative seeks the solution of specific needs of the city in which the project will be carried out, however, the methodology proposed in this article provides a general idea of how this transformation can be carried out, in such a way that it is applicable both for new cities and for those that are going to carry out a process of change with a view to becoming smart cities.

The transformation and modernization of cities generates concrete and positive effects, since it improves efficiency by integrating different areas of action (mobility, energy efficiency and environmental management, infrastructure and public services, government and citizenship, safety, health, education, culture, electronic commerce, among others), so it is necessary to highlight the importance of carrying out this project in a comprehensive manner, where both objectives, actors, means and strategies to carry them out are done collaboratively and in this same way to share the benefits of its implementation, because if each one of these initiatives is developed individually, the obtaining of favorable results is not guaranteed.

It is hoped that this methodology will be used, serve as a reference for different cities of the world and at the same time be complemented thanks to new technological and scientific advances.

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Use of Gamification Techniques to Encourage Garbage Recycling. A Smart City Approach

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Abstract. One of the main problems in urban environments is the accumulation of waste. A large percentage of waste can be recycled, preventing it from being deposited at landfills or uncontrolled sites, contributing to air, soil and water pollution. Although today's systems collect and separate different types of waste, a large part of waste is not disposed at recycling centres. In order to increase the amount of waste that is recycled, it is necessary to motivate our society to become involved in recycling activities. For this reason, this paper proposes a system that encourages citizen participation by obtaining reductions in the waste rate applied by their local government, so that the amount of waste collected to be recycled is increased. This system employs a virtual organization of agents that obtains and manages the knowledge of each city and that through gamification techniques produces a change in the habits of citizens, motivating and increasing citizen participation in recycling regardless of the urban environment in which it is implemented. A case study was carried out in order to evaluate the performance of the proposed system, the results show that citizen participation would increase by 32.2% and the amount of recycled waste would increase by 17.2%.

Keywords: Behavioral change · Serious games · Context-awareness
Social computing · Multi-agent system

1 Introduction

Unusable waste is a problem for many societies due to the large amount of waste that is produced and the absence of a destination to maintain it sustainably. It is a major problem that affects not only those living in large cities but the entire population of the planet. The increase in population, the development of modern human activities and high consumerism have all greatly increased the amount of waste produced. This increase in the growth of waste production together with the inefficient handling of such waste (open burning or storage in garbage dumps, among others) causes problems

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such as water, soil and air pollution, this triggers health problems and damages to the environment, including social and political conflicts.

One of the solutions that were implemented to reduce pollution was to adopt measures that would allow the recycling of this waste. In this sense, many countries began to build urban waste treatment plants to manage the garbage generated in metropolitan areas. At the beginning of their implantation, these plants only allowed to recycle some residues such as paper and cardboard, glass or some plastic components, allowing the recycling of new elements (oil, tyres, electronic products, etc.) as the knowledge and technology in this field has evolved. However, in order for these plants to perform their recycling function, it was necessary to develop a waste collection network. There is no common method of waste management in the European Union. Some countries have deployed a series of colorful containers in which the user introduces waste according to its typology, in other countries it is in the supermarkets where the consumer is allowed to deliver a series of waste and packaging for recycling. The use of these measures has made it possible to recover many tons of garbage that were previously disposed at landfills, obtaining numerous benefits for both man and the environment. Although these measures have been widely accepted, there are still many tons of recyclable materials that end up at landfills without any reuse. The rate of glass recycling in the European Union reached 73% in 2013 according to The European Container Glass Federation (FEVE) [25]. The recycling rate for paper/cardboard is around 83%, plastic around 34.3% and wood around 37.7% [5, 26]. This shows that the glass and paper/cardboard recycling model works well, but a higher recycling rate for the remaining materials needs to be achieved.

One of the ways that would help to increase the recycling rate would be a more active participation of citizens in the recycling chain. One of the ways in which greater citizen participation can be achieved is by providing benefits to citizens who participate more actively in the recycling chain. The concept of gamification is a technique that allows the recycling process to be stimulated and carried out in a more dynamic way so that certain results are achieved. For this reason, it is necessary to develop a system that increases the recycling rate of all materials through greater citizen participation. The objective of this paper is to provide a new multi-agent context-aware which grants economic benefits, promoting citizen participation. In this way, the amount of waste collected in the recycling chain increases.

CAFCLA (Context-Aware Framework for Collaborative Learning Applications) was used to develop the proposed system, this framework provides a basis for the implementation of its technical and social features [7]. The system will learn from the actions taken by citizens to adapt to them and provide new solutions that will increase recycling rates and citizen participation. To this end, the system is developed using the multi-agent systems paradigm (MAS) for learning user actions and decision making.

This article is organized as follows: Sect. 2 describes the state of the art of multi-agent systems and gamification, Sect. 3 describes the proposal, Sect. 4 presents the results and Sect. 5 conclusions.

2 Background

This section reviews the different methods that are currently implemented for waste recycling in the European Union, detailing their characteristics, advantages and disadvantages. It also explains the current state of the techniques used by the proposed system for its adoption within the problem of waste recycling, and how these techniques will help us to increase citizen participation.

2.1 Recycling Methods in the European Union

To prevent many tons of recyclable materials from ending up at landfill sites, different ways of collecting waste were developed for subsequent recycling. In 1982, the first glass container was installed in Spain. That year, collaboration began between the Autonomous Communities, local authorities and manufacturers of glass containers for the recycling of this material. In 1994, Directive 94/62/EC sets out the framework within which all legislation in each of the European Community countries will be developed.

Within the European Community there are mainly two models in the recycling chain. The first method consists of various colored containers deployed in cities and urban environments for each citizen to deposit their waste, each colored container indicates the type of waste to be introduced. In Spain, this method consists of three containers: blue for paper and cardboard, yellow for plastic waste and green for glass. There is also a container for organic waste as well as clean points for collecting oil, tyres and electronic waste. In France there are five containers with different colours and symbols to distinguish them at a glance. In addition, there is an annual schedule to follow, which sets the days for littering, usually two days a week. Citizens have to follow this schedule to know on what day the garbage truck passes, this allows them to take out their rubbish the night before. A citizen who does not recycle receives a fine. In Italy, the recycling system is also based on colours, although the colour of the containers varies in comparison to Spain and France. The citizen who does not recycle can also receive a fine and the collection of waste also follows a plan. In Norway the system is similar, with one container for organic waste and another for paper and cardboard. The plastic is placed in a special bag placed next to the paper and cardboard container. The glass is left in special containers next to the supermarkets. The collection is carried out following a schedule set by the town council of each locality. The second method is Deposit Refund System (DRS) which is used in Germany, Sweden and Denmark. In this method, citizens pay a tax when they buy a container, which is returned once the package is deposited in perfect condition in a series of machines located in the supermarkets where they bought it. Customers receive a voucher that can be exchanged for cash, receiving 0.25€ for each bottle. This method in some countries such as Germany is found along with the method of color containers.

Although the two main models are widely accepted, these methods are not as efficient as our cities want to become a real intelligent city of the future. Both the colour container model and the DRS model have several drawbacks. The main one is that it can only be used to recycle water, soft drinks and beer containers, whether plastic or metal containers. Any other type of packaging is not accepted. In total, it handles 8% of the packaging, while in the colour container model, almost 80% of the waste can be managed through yellow and blue containers. This model normally works through supermarkets, rather than containers, so that citizens can only come to deposit their packaging when the stores are open. Another major drawback of DRS is that, when buying a product, the citizen has to pay for the packaging. This packaging will only be refunded if the packaging is returned in perfect condition (in case of dent, for example, the machine rejects it). Thus, the citizen is not assured that their money will be returned.

2.2 Gamification as a Technique for Behaviour Change in Recycling

Games have always been associated with training and a playful way of spending time, although they have also been used in educational tasks. These games employ the typical mechanisms of a training game with a purpose related to learning, understanding or social impact, addressing both cognitive and affective dimensions. Dynamics and concepts that stimulate and make the player's interaction with the learning process more attractive.

The term employed to describe the use of a game for an educational purpose as opposed to entertainment, is called gamification. This technique allows city dwellers to feel that by recycling they are participating in a game, in which they receive a reward when they do it well and receive penalties if they do not. This allows for higher levels of societal commitment in this area and stimulates the development of habits that are environmentally friendly. Although this technique has been used in other fields such as energy efficiency with very favorable results [6, 7], currently in the field of recycling no system has been developed that would use this technique to encourage citizen participation and with it the increase in the amount of waste deposited for recycling, so it is interesting to evaluate whether this technique produces satisfactory results in this area [22].

2.3 Multi-agent Systems for Data Collection, Action Learning and Decision Making

Multi-agent systems (MAS) have been used in a variety of contexts because of their ability to model behaviors, simulate situations or solve problems that are difficult or impossible to solve for an individual agent or a monolithic system [10, 11]. Due to the multiple characteristics of this type of systems that allow agents to communicate, coordinate, interact and cooperate for the realization of different activities, they have been applied in works with varied objectives, such as the obtaining of genes whose behavior patterns signify of particular diseases [9, 12, 16, 20], detection of drivers under the influence of drugs [1], facial image classification according to gender and age [13], and all of them performed well. In addition, the autonomy of agents in virtual agent organizations to interact with each other without any need for user action or the ability to perceive and react to changes in the environment makes it an ideal approach to data collection, learning behavior patterns and decision making for certain actions that can occur. Characteristics such as extensibility, flexibility imply the possibility of adding new functionalities such as the inclusion of new algorithms or new infrastructure that is managed by MAS. This is why multi-agent systems have been used in different proposals within the field of recycling, from simulation of behaviour, learning of recycling habits, efficient waste management within the supply chain or learning of user behaviour actions.

Meng *et al.* proposed a system that simulates the separation and recycling of solid household waste along with social surveys [14]. The system is based on a multi-agent system in which three agents simulate behavior and decision making under two set condition scenarios. In this work, a multi-agent system is used that simulates behavior under various conditions but does not encourage citizen participation in recycling tasks. Another work employing agent-based technology is that proposed by Yang *et al.* in which the economic sustainability of an agent-based simulation-based waste recovery system is assessed [27]. In this work, in addition to agents, sustainability metrics were used to evaluate and compare two recovery processes to determine their economic sustainability, recycling rate in the process and economic efficiency. In the work conducted by Mishra *et al.* A multi-agent system makes autonomous judgments for the effective recycling of waste. System agents coordinate effectively to perform different tasks such as waste categorization, transport, waste recycling, waste management and allocation of reusable products [15]. As many of the tasks involved in the supply chain are very complex, the use of a multi-agent system allows them to manage them effectively by being able to cooperate and communicate between the different agents that make up the supply chain. In addition, agents continually learn from past experiences to make effective judgments in the future. The proposed framework will therefore contribute to effective decision making, from the collection of scrap to the distribution of recycled components and manufacturing using the environment of the green supply chain.

One of the great advantages of using virtual agent organizations to model this type of problems is the possibility of programming agents with the capacity to learn action. This ability allows them to recognize behaviors through the repetition of certain actions [3, 4, 24]. In addition, within the existing multi-agent architectures there are a series of shortcomings in learning and decision-making aspects. Therefore, it is necessary to develop a multi-agent architecture that adapts to the needs posed in our work (integration of different devices, distributed services, applications). For this reason, the adoption of virtual agent organizations makes it possible to develop distributed systems deployed in different environments for common management. This is necessary because an agent-based system will manage the waste collection services distributed within a Smart City. In addition, this architecture allows for the use of applications and services that can communicate in a distributed way, even from mobile devices, regardless of the programming language or operating system they incorporate. The above typology will be used together with the model proposed by Rodríguez *et al.* [18], whose main novelty lies in its dynamic and adaptive planning abilities which allow for the effective distribution of tasks among the organization's member agents. This will make it possible to distribute the tasks among the agents in charge of managing the data of each container.

3 Proposed Architecture

This section details the technical side of the architecture. It describes aspects related to the required infrastructure to install the system in a smart city (data collection by sensors, data transmission) and the gamification system of citizen participation in the recycling process.

3.1 Required Infrastructure

In order for our system to know when each user recycles, it is necessary to derive an infrastructure that allows us to determine the quantity, the type of waste deposited, the user that recycles, the state of filling of the city's containers, and the occupancy rate of the nearest waste treatment plant. The necessary infrastructure does not imply a change in the current model of coloured containers that is implemented in several countries (France, Italy, Norway, Spain, etc.). However, it will be necessary to incorporate in the containers (i) a QR code reader to identify the user, this code will be provided by its urban environment. (ii) GPS Locator, indicates the coordinates in which the container is located [17]. (iii) Weight sensor, weighs the material introduced by the citizen. (iv) Volumetric sensor shall measure the filling status of the container. (v) NarrowBand IOT (NB-IoT) communication technology, for data transmission to MAS. The choice of this communication technology is due to the need to communicate information over long distances. This type of LPWAN network has been chosen using ICM bands to reach long distances, up to 50 km in rural areas and between five and ten km in urban areas. (vi) Solar panel, which feeds the various sensors deployed in the container so that the system is energy independent.

When a citizen inserts a waste bag into the corresponding container, a data structure is generated with the following information: user id, type of waste, amount of waste, container id, location of the container, container filling status. This data structure is sent via the MQTT protocol using the NB-IoT network to a local station. The local station will act as a MQTT Broker sending the data in JSON format through REST services [19]. Communication also exists between the deployed container infrastructure and the urban waste treatment plant so that once a container is full, the waste recycling plant sends a truck to collect and transport the waste to that plant.

3.2 Virtual Agent Organization Architecture

As the proposed system requires the deployment of an associated infrastructure which may undergo changes. These changes may include an increase in the number of containers or their location, etc., it is necessary for the management system to be a highly dynamic platform employing self-adapting capabilities at runtime. Thus, each agent's behavior is determined by the goals it wishes to achieve (amount of waste to be recycled, participation percentage, etc.), however it also considers the goals of other agents and any changes that may arise in the environment. The core of the architecture is a group of deliberative agents that act as controllers and administrators of all applications and services. The functionalities of the agents are not within their structure, instead they are modeled as services. This approach provides greater error-recovery capability and greater flexibility to change agent behavior at runtime [21].

The architecture has been developed for the incorporation of multiple heterogeneous sensors, so that functionality can grow in the future for the incorporation of new services, as explained in the methodology developed by Dante et al. [23]. Pangea has been chosen for the development of virtual agent organizations [28]. PANGEA is a better option than other agent framework technologies because it provides a number of agents that encapsulate elementary functionality, such as data access, service discovery [2] or rule control, and supports standard inter-agent communication protocols. Pangea incorporates agents that manage security at the system level, unlike other types of systems in which it is necessary to develop this type of measures so that the information collected is really the one that is transmitted and analyzed [8]. In this way, the developer can no longer worry about these modules and it is PANGEA that is responsible for defining their function. Thus, the developer's efforts are directed primarily at the functional part of the system they want to implement. The system is specifically designed to analyze sensor data and include data from external information sources.

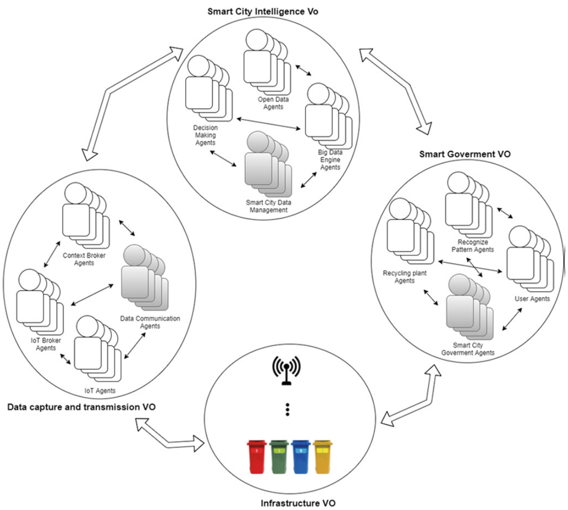

Fig. 1. Proposed architecture based on virtual agent organizations.

The virtual agent organization system distributes the operation of the agents that make up the system and their roles are assigned; grouped in three layers according to the activities performed by each one as shown in Fig. 1.

- **Infrastructure VO.** This virtual organization is made up of basic agents that act as middleware between users and the system. Each container is associated with an agent that generates a data structure (cannon, deposited type of waste, user that recycles, filling status of the container, occupancy rate of the nearest waste treatment plant). LPWAN agents send the information to Data collection and transmission VOI agents.

- **Data collection and transmission VO.** The agents in this layer are responsible for collecting data from the infrastructure deployed in a Smart City. IoT agents communicate with agents deployed in the VO Infrastructure to build the data structure that collects the data on waste deposit in a container, which is sent in JSON format through REST services. IoT Broker performs the NGSI-to-NGSI (Next Generation Services Interface) conversion between IoT agents and the Context Broker agents, and the data is collected by Data Communication agents which transmits it for analysis to Smart City Intelligence VO.
- **Smart City Intelligence VO.** Once the data structure of each recycling process has been received, it is checked whether the container is full and the decision is made to send a truck to collect the waste. In the next stage Big Data Engine Agents analyze the data using Complex Event Processing (CEP) for pattern recognition. The system has Open Data Agents that incorporate mechanisms for the incorporation of data that may be relevant for analysis, such as information on temperature or the weather forecast so that more information is available for more effective decision making.
- **Smart Government VO.** This VO manages the results obtained from the analysis performed in the Smart City Intelligence VO. On the basis of this analysis, containers that are full are collected, more containers are moved to areas where a greater amount of garbage is produced or garbage trucks go to these areas more frequently to collect the waste. This layer is in charge of rewarding or penalizing the user by decreasing or increasing the garbage fee that must be paid to the local government.

4 Results

The experiment was divided into two phases and took place between August and November 2017. The first phase of the experiment was carried out during July and August, this phase measured the number of people that recycle and the amount of waste collected in the different recycling containers. The second phase took place during the months of September and October, at this stage the data was acquired exclusively through the developed virtual organization-based system.

The evaluation of the prototype was carried out in an urbanization outside the urban nucleus of Zaragoza with an estimated population of 2200 inhabitants, in which the sound system kit was deployed in thirty containers (ten blue paper and cardboard containers, ten yellow plastic waste containers and ten green glass containers), with the collaboration of the city’s urban waste collection company.

In the second phase, users had to download the Android mobile application, Fig. 2, to log in into the system when they were going to deposit waste in the recycling bins. The process consists of the user once the application is downloaded to the mobile terminal, the user can read the QR code that identifies the container and identifies the user in such a way that the opening of the waste deposit and weighing container is enabled. Once the waste is introduced in the container, the generated data structure is

Fig. 2. Screenshot of a user profile involved in the experiment (color figure online)

sent (waste quantity, type of waste deposited, user recycling, container filling status, occupancy rate of the nearest waste treatment plant) through the local relay antenna deployed using LPWAN. The information reaches the system and the agents of the different virtual organizations are responsible for making decisions such as sending a truck to collect the waste from a specific container if it is full or updating the user's profile. The mobile application allows to visualize the achievements that the user has accumulated during the month (every month the profile is restarted, achievements are not cumulative for the next month). If the user reaches the goals proposed by the city council, in the case study it was proposed to increase the amount of waste by 18%. The users who achieved this obtained a reduction of 5€ on the monthly waste rate (48€). At the end of the experiment, the amount of waste deposited in the containers has been measured in such a way that the efficiency of the system is measured, as can be seen in Table 1. In which an increase of 17.2% is observed.

Table 1. Quantity (Kg) of waste collected from each container

	Before system	After system
Blue container	2,214.15	2,625.98
Yellow container	1,731.24	2,023.82
Green container	1,595.07	1,851.88
Total	5,540.46	6,501.68

The system also allowed us to detect the ages of the users who have participated in the experiment, so that the local government can obtain data on the age ranges of the inhabitants who least recycle and to promote social awareness campaigns. Table 2 shows the sample of participants in the second phase. The system's functionality allowed the system to be used as a tool for social measurements and learning about users' behavioural patterns (average amount of waste deposited, frequency with which it goes to containers, timetables, days of the week, etc.).

Table 2. Distribution of the users who participated in the case study distributed by age range

	18–30	30–40	40–50	50–60	60–70	70–80	80–90	Total
Blue container	56	163	153	130	97	2	0	601
Yellow container	85	118	163	164	85	5	0	620
Green container	61	141	142	169	84	1	0	598
Total	202	422	458	463	266	8	0	1819

5 Conclusions

This work presented an innovative approach based on Virtual Organizations (VO) of agents to increase citizen participation in recycling tasks and thus increase the amount of recycled waste. To this end, our proposal consists of gamifying the recycling process in such a way that rewards are offered to users according to the amount of waste deposited in the container. For this purpose, it was necessary to deploy a small infrastructure in each recycling container to obtain data every time a user deposited waste in a container (amount of waste, type of waste deposited, user that recycles, state of filling of the container, occupancy rate of the nearest waste treatment plant).

In the conducted case study, it was demonstrated how our proposal offers an innovative method in the field of recycling that has made people aware of recycling. The results of the case study confirms this statement, since citizen participation increased by 32.2% and the amount of waste recycled increased by 17.2% in comparison to the data obtained before the implementation of our system. At the social level, the system has allowed us to identify that people between the ages of 43 and 56 have been more involved in the experiment. It is proposed in the next version of this work to make partial achievements, so that the benefit for each user depends on the amount of waste deposited.

Acknowledgements. This work has been supported by project "MOVIURBAN: Máquina social para la gestión sostenible de ciudades inteligentes: movilidad urbana, datos abiertos, sensores móviles". SA070U 16. Project co-financed with Junta Castilla y León, Consejería de Educación and FEDER funds.

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Knowledge Management Strategies to Improve Competitiveness by Incorporating Renewable Energy into Small Companies Called "Mipymes" in Colombia

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Abstract. This paper about knowledge management strategies to improve productive processes in Small and Medium size Enterprises - SMEs through the benefits offered by a law that allows the incorporation of renewable energy for cost reduction, improvements in competitiveness and making more efficient products and services. The Generation of energy from renewable sources is an alternative to the supply, support, and interconnection of electricity to meet the energetic needs of homes and companies, these sources are characterized by being friendly to the environment, decreasing impacts caused by traditional electric power generation systems.

Law 1715 of 2014, "By which it is regulated the integration of Non-Conventional Renewable Energies - NCRE - mainly Renewable to the National Energy System", encourages the use, promotes development and provides the opportunity to natural and legal people to invest in projects of NCRE and energy efficiency management EEM. Through tax, commercial and financial incentives which are very important in the purchase, implementation, import, research, advice, and development to satisfy the country's electricity sectors. Based on the above, the main objective of this study is to analyze how the incorporation of renewable energy sources impacts the cost of producing goods or services in small businesses, to make them more competitive, exploring in the framework of the efficient use of energy also consider the possibility of taking advantage of the incentives offered by Law 1715 of 2014.

Keywords: Technological surveillance · Small companies · Renewable energy Productivity · Photovoltaic solar · Energy · Competitiveness

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https://doi.org/10.1007/978-3-319-95204-8_57

1 Introduction

In Colombia the SMEs (commonly used to refer to "small and medium sized enterprises") are economic organizations that develop industrial, commercial, and service activities. Its denomination is due to the number of people and assets that conform it according to the classification established by Law 905 of 2004. Their produce or service provided are of vital importance for the various sectors that they serve and especially for the country because of the employment generation, economic support, and resources supply.

One of the most relevant resources in the produce and service of SMEs is electricity, in many cases this energy consumption influences the service it provides. Electricity is generated in a traditional way mainly by the hydroelectric system, Law 1715 of 2014 allows by means of tax, tariff, and commercial incentives to spare a large part of the costs in NCRE and EEM projects, which help in the reduction of supply costs, greenhouse gases, and in the implementation of new technologies and tools which aid in energy reliability in the productive sector interested in accessing the incentives offered by the Law.

2 The Business Development of SMEs in Bogotá

SMEs, are economic organizations and the main source of employment, they are able to adapt to technological changes, economic development, strengthen productivity, respond to the specific demand of consumers, creation and improvement of new products, services, and resources (any unit of financial, commercial, industrial, agricultural, service, rural or urban) that help develop industrial, commercial, and service activities. The denomination of SMEs depends on people and assets that conform it according to the classification established by Law 905 of 2004. Their produce and service are of vital importance for the various sectors that they serve and especially for the country in terms of their relationship with the generation of employment, economic support, and the provision of resources. In Colombia, micro, small, and medium companies represent at least 90% of the national business park, they generate 73% of employment and they contribute 53% of the gross production of the industrial, commercial, and services sectors [1].

In 2016, the *Cámara de Comercio de Bogotá* (CCB) reported that it has registered 704,501 companies, of which 1,823 are large, 3,724 medium, 384,241 small, and 704,501 micros. In the following year, the CCB issued the *Tablero de indicadores de Bogotá y Cundinamarca 2017*, where they indicated that microenterprises were the fastest growing and were the most recurring around the capital, followed by small, medium, and then large companies [2]. Figure 1 shows the percentages in sectors of SMEs in Bogotá registered and operating in 2016. Most of the Large and Medium Enterprises are based in the following localities: Chapinero, Usaquén, Fontibón, Barrios Unidos, and Suba; Meanwhile, the largest number of microenterprises are in

Barrios Unidos, Kennedy, Usaquén, Chapinero and Engativá while Small companies are located in the areas of Chapinero, Usaquén, Suba, Teusaquillo and Engativá.

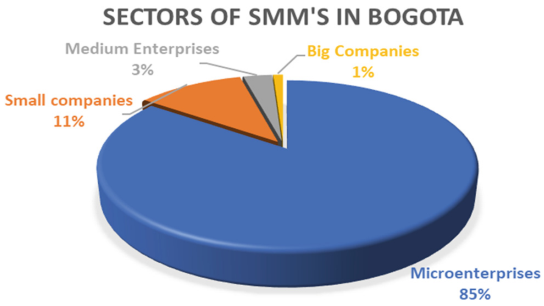

Fig. 1. SME sectors in Bogotá in 2016. Source: Cámara de comercio de Bogotá

In Fig. 2, the service sectors are shown, Trade and Industry totaling 91%, and the remaining percentage refers to sectors of construction, mining and quarrying, finally, ranking companies of which the sector is not known, which are not as relevant as major business associations in the city.

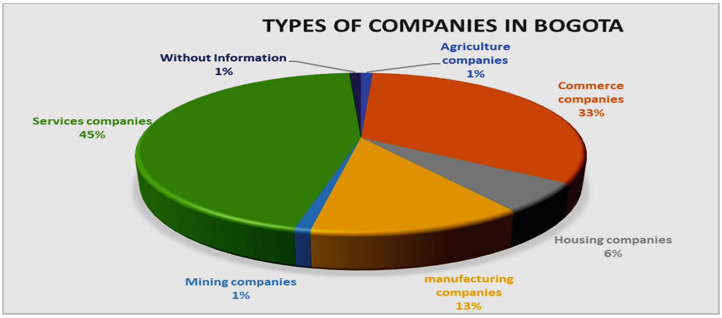

Fig. 2. Economic activity of SMEs in Bogotá. Source: Cámara de comercio de Bogotá (2016)

3 Methodology and Analysis Approach

A Survey that Allows to Know the Problems of Electrical Energy of Companies
Based on a survey of SMEs of manufactures and services companies in Bogota, the risks that they are facing the city are related to economic and financial policies are identified in the Table 1.

Table 1. Technical details of the survey (Source: Authors)

Survey data sheet	
Survey completion date	April and August 2017
Population	6586 SMEs Bogota localities
Directed to	Managers and/or directors of companies
City	Bogotá DC
Methodology	Survey. Written and e-mail questionnaire
Director of the study	Investigator on the project
Experience earned	95%
Error range	3.115%

In the sample design, the following variables were taken into account: Population size: N = 6586 companies, Confidence interval or Margin of Error: E = 5%, value for confidential level: Z = 95%, Proportion probability of success: P = 52% and Proportion probability of failure: Q = 48%, to determine the size of the sample formula was used finite populations that resulted in 242 companies to be surveyed. The data Sheet which summarizes the relevant elements of the sampling design is presented in the Table 2.

Table 2. Mails sent results of the survey (Source: Authors)

Bogotá manufacturing companies International code CIIU number 31	Quantity	Percentages (%)
Companies database	6586	100
Bounced emails	1468	2.3
E-mails delivered	5118	77.7
Mails answered by companies	244	4.8
Mails answered	2	0.04
Total posts	*242*	*4.728*

The results of the business survey allowed that main problems faced by Bogotá's SMEs are placed here:

- Multiplicity of objectives and products in a company.
- Incorporation of projects and programs that allow the reduction of costs based on energy efficiency, equipment improvements and environmentally sustainable processes, reduction of greenhouse effect, generate partial or total conventional sources and reduction of electric energy uses.
- Lack of formulation in the generation of employment and productivity.
- Insufficient supply of information from entities and even from the State in programs, projects, activities, training and participation of SMEs in orderly, economic, financial, political and commercial plans of the city.

- Not all SMEs are part of associations, committees, unions, organizations and unions in defense and development of their productive sector.
- Support in programs, governmental projects for the participation of SMEs in economic, environmental, energy, participatory and other developments.
- Gap between the educational and business sectors for the strengthening of economic, commercial, financial and technological activities.
- Lack of equality in the sector of balanced competition of each productive sector, which generates a variety of prices, misleading advertising, deficiency in the quality of the product, product importation, among others.

An Opportunity Based on the Incentives of Law 1715–2014

Law 1715 of 2014, aims to promote the development and use of Non-Conventional Sources of Energy -NCSE-, mainly those of a renewable nature which are biomass, solar, wind, geothermal, small hydroelectric power stations among others, in the national energy system. Through its integration into the electricity market, to participate in the ZIN and in other energy uses as a necessary means for supplying energy in order to develop sustainable economic profits, reducing emissions of greenhouse gases and the provision in energy security [3].

The purpose of Law 1715 of 2015 is divided in two mainly aims, the first one pretends through four (4) incentives related to tariffs rates and commercial taxes, for the supply, support and interconnection of electricity to businesses and households in the national territory. The second one is the creation of the Non-Conventional Energy Fund and Efficient Energy Management in spanish: *Fondo de Energías No Convencionales y Gestión Eficiente de la Energía* (FENOGE) for partially or totally financing, among others, programs and projects aimed at the small-scale self-generation residential sector and improvements in energy efficiency with product practices and equipment to use this energy resource.

3.1 What Impacts the Tax Benefits of Law 1715 of 2014 Entails in the SMEs on Bogota's

Special Reduction in the Determination of the Income Tax

- Article 11 of the Law 1715 of 2014.
- Article 2.2.3.8.2.1 By Decree 2143 - 2015 (Decree 1073 de 2015).

Individuals or SMEs that declare income tax and have resources for renewable energy projects, may decrease by 50% the income statement of the investment made in the project for up to 5 years after the year in which the investment is made. Who invest in the promotion of the FNCE. These reductions on the tax on the declaration of income will be guaranteed when a certificate of environmental benefit generated by the competent entity is issued in accordance with Law 1715 of 2014 [4].

3.2 Exclusion of Value Added Tax (IVA) for Products and Services in Enterprise

- Article 12 of the Law 1715 of 2014.
- Article 2.2.3.8.3.1 By Decree 2143 de 2015 (Decree 1073 de 2015).

For the implementation of projects related to the NCRE require design, implementation, commissioning, materials and equipment, facilities, resources, among others. Law 1715 of 2014, allows that the purchases of equipment, elements, machinery and national or imported services used to produce energy from FNCE, involved in the project or consultancies in design stage are exempt from this tax, thus achieving produce a significant reduction in the costs of different alternative energy projects [4].

3.3 Tariff Incentive

- Article 13 of the Ley 1715 of 2014.
- Decree 2143 de 2015 Arts. 2.2.3.8.4.1.

Purchases of equipment, components, machinery and services abroad for the development and implementation of the project on NCRE in the respective process must be subject to import tariffs defined by the competent entity. Law 1715 of 2014, provides in one of the incentives to exempt imports of equipment required for the commissioning of a project with renewable energy, thus achieving reduction in project costs. This exemption should be requested from the DIAN (national taxes and customs division), presented the project documentation plus certification MME [4].

3.4 Accelerated Depreciation

- Article 14 of the Law 1715 of 2014.
- Article 2.2.3.8.5.1. By Decree 2143 - 2015 (Incorporate by Decree 1073 de 2015).

Equipment, machinery, equipment and civil works acquired for the production of products and services companies are subject to variables accelerated depreciation of assets accounting life way for the respective balance sheet are issued annually. Through Law 1715 of 2014, provides benefits of increased depreciation of assets implemented in alternative energy projects, thus achieving a further reduction in the accounts of companies the annual rate of accelerated depreciation would be maximum 20% of the Total value of the investment [4].

Law 1715 of 2014 determines by issuing guidelines for policy, regulation, benefits, among others in NCRE [5] promotes Integration to the electricity market, participation in Non-Interconnected Zones NIZ [6] and other energy uses; while, the EEM [7], is in charge of involving the different sectors of the country, programs, projects and sustainable development, reduction and compensation of affect greenhouse gas emissions, security of energy supply of energy efficiency and response of the demand [8–10].

4 Characterization of SMEs According to Energy Consumption

4.1 Power Generation in Bogota SMEs Benefits the Economy

According to the CCB, the SMEs service sectors have greater upgrade in Bogotá due to strategic business areas, development and growth of new employment niches, daily needs in transportation, food, technologies and habitat. According to the Figures from the entity, the most representative sector of the regional economy is the one of services, with a participation of 47% in the total of companies and establishments of active commerce; followed by the commercial sector, with a 38% share; and industry, with 15%. Of the total active companies, 90.8% are microenterprises, 6.6% are small, 1.9% are medium and 0.7% are large.

In Bogotá, micro and small companies made up of family businesses and associations, manufacturing capacity is still handmade and are of little purchasing power; while medium-sized and large companies have strong financial, administrative, commercial and industrial muscle, which there is greater demand for products and services in the energy sector to establish themselves in the business value chain of the city, therefore it is reflected in energy consumption for service and supply of products, Fig. 3 shows the productive sector of SMEs regarding average monthly energy consumption.

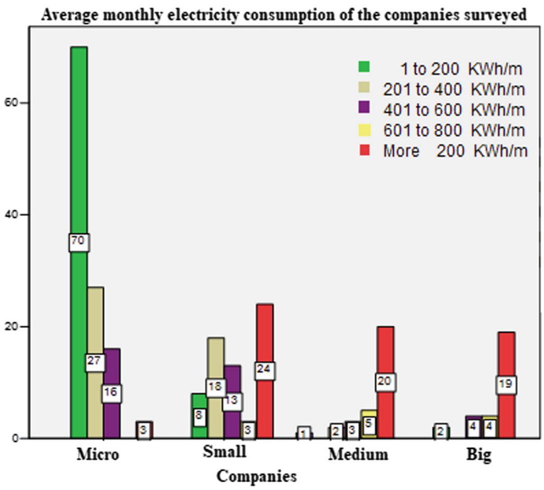

Fig. 3. Electricity consumption in SMEs. Source: Based on SPSS software

In addition, the average monthly consumption is associated with the costs KWh/m charged by operators of electricity supply. The response of SMEs consumption billing is represented in Fig. 4, the micro consumption cost focuses on low power consumption due to the acquisition and use, presenting few teams and machines, while the other companies the cost of monthly turnover is more than $360,000 COP, this indicates that it is the signifier and the use of technology and manufacturing to offer and develop its services and products.

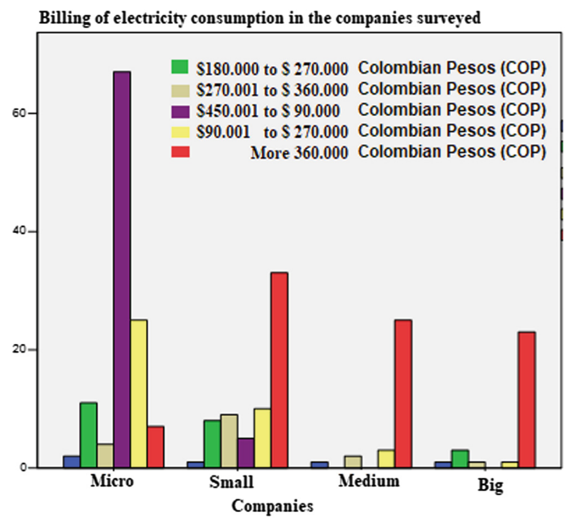

Fig. 4. Approximate cost of monthly turnover of SMEs. Source: Based on SPSS software

Figure 5, shows that electricity as a dispensable resource in the development, manufacture, supervision, control and production of products or services in SMEs, is relevant in the productive sectors, in micro-enterprises due to its production is not so important manual; while, in small and medium-sized companies, the use of technologies, equipment and services consumption is essential.

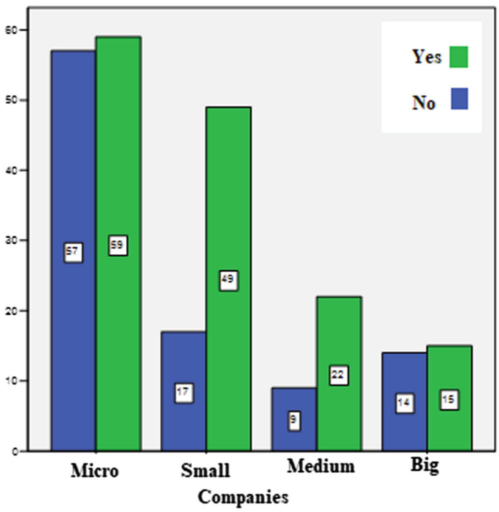

Fig. 5. Energy consumption affects the production of the company. Source: Based on SPSS software

As it has being mentioned, energy consumption is very important in the related business sectors in SMEs. Law 1715 of 2014 is a normative tool to counteract the cost overruns of electricity, mitigate the greenhouse effect, raise and establish energy efficiency systems and programs and be sustainable and sustainable at the energy level with a project that covers the uses of Non-Conventional Sources of Renewable Energy (NCSRE) [11].

According to the provisions of the Law in Fig. 6, it shows the cost reductions that at the moment of presenting and obtaining the respective guarantees of a project which can participate for several or all tax, tariff and commercial incentives, which they are savings of a considerable sum which helps the company's economy and it has the advantage of generating and producing its own energy in order to be sustainable and sustainable and a friendly reason with the environment.

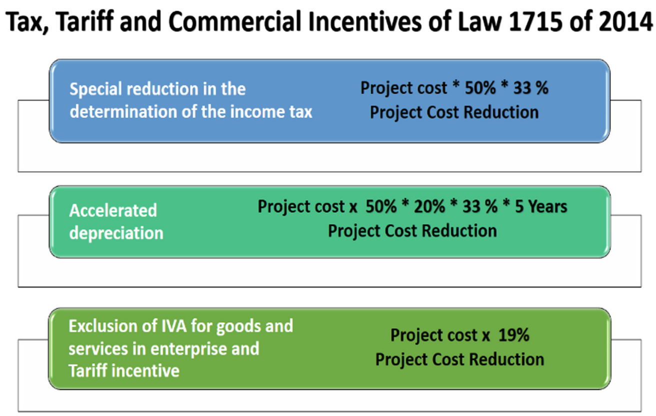

Fig. 6. Cost of a project for a project that applies to the incentives of Law 1715 of 2014. Source: Authors

4.2 Systems for the Generation of Photovoltaic Solar Energy Applied to SMEs

The proposed solutions are implementing a solar photovoltaic system consist of solar panels, regulators, batteries and inverter in order to convert to the direct current into alternative current to power some circuits of the electric installation of the SMEs for used electricity in the machines and services. The mode of operation these systems will be disconnected from the electric grid or autonomous, because this is the best mode of operation since the value of the kilowatt hour (KWh) generated will be paid at the same rate that the SMEs pays it to the supplier. The projects solar Photovoltaic for 200 Kilowatt * hours/month (KWh/m) and 800 Kilowatt * hours/month (KWh/m) prototypes of commended electricity power by companies in of Off Grid or autonomous solar photovoltaic to generate from photovoltaic solar systems, the costs of the electric power are 450 $/KWh.

According to the classification of SMEs on the consumption of electricity for this production of products and services. Table 3 shows six alternatives for autonomous solar photovoltaic systems, determined by the range of electricity consumption mentioned in the survey.

Table 3. Prototypes of electricity consumption of SME's (Source: Authors)

Project solar photovoltaic in companies	Power solar panels watt (W)	Batteries ampere * hour Ah	Inverter watt (W)	Cost project $COP	Cost project $USD	Installed cost watt $COP	Installed cost watt $USD
Prototype 1	1 × 200 W	1 × 100 Ah	1 × 500 W	$2.564.400	$902	$12.822	$4,51
Prototype 2	1 × 320 W	1 × 200 Ah	1 × 500 W	$3.855.650	$1.356	$12.049	$4,24
Prototype 3	2 × 320 W	2 × 150 Ah	1 × 500 W	$7.347.930	$2.585	$11.481	$4,04
Prototype 4	2 × 240 W	1 × 200 Ah	1 × 500 W	$5.984.034	$2.105	$12.467	$4,39
Prototype 5	3 × 270 W	2 × 200 Ah	1 × 1000 W	$9.635.428	$3.390	$11.896	$4,18
Prototype 6	3 × 320 W	2 × 200 Ah	1 × 1000 W	$13.923.000	$4.898	$14.503	$5,10

All the solutions have the same elements described in the model varying their capacity in terms of power and their energy according to the case for which they are required in Table 4.

Table 4. Cost of savings per month of the SME's (Source: Authors)

Project solar photovoltaic in companies	Installed power watt (W)	Electrical energy survey in companies (KWh/m)	Energy generated per month (KWh/m)	Percentage of savings per month (%)	Cost of savings per month ($COP)	Cost of savings per month ($USD)
1	200 W	200 KWh/m	30 KWh/m	15,00%	$13.500	$4,75
2	320 W	200 KWh/m	48 KWh/m	24,00%	$21.600	$7,60
3	640 W	200 KWh/m	96 KWh/m	48,00%	$43.200	$15,20
4	480 W	800 KWh/m	72 KWh/m	9,00%	$32.400	$11,40
5	810 W	800 KWh/m	121.5 KWh/m	15,20%	$54.675	$19,23
6	960 W	800 KWh/m	144 KWh/m	18,00%	$64.800	$22,80

This table shows the consumption of lower, similar and greater capacity required by the company, the more electric electrical energy is produced by the prototypes from photovoltaic solar systems have greater savings in the costs of this type of projects.

In Table 5 Law 1715 of 2014 is shown, offers the incentive for the exclusion of goods and services from IVA-article 12 and exemption from tariff levies-article 13, also the reductions of the costs of the prototype projects are shown.

Table 5. Incentive for the exclusion of products and services from IVA and exemption from tariff levies on photovoltaic solar prototypes (Source: Authors)

Project solar photovoltaic in companies	Reductions for tax invectives of law 1715 of 2014				
	Cost project		Exclusion of IVA for goods and services in enterprise and tariff incentive		
	$COP	$USD	Reduction project	Cost project $COP	Cost project $USD
1	$2.564.400	$902	$487.236	$2.077.164	$731
2	$3.855.650	$1.356	$732.574	$3.123.077	$1.099
3	$7.347.930	$2.585	$1.396.107	$5.951.823	$2.094
4	$5.984.034	$2.105	$1.136.966	$4.847.068	$1.705
5	$9.635.428	$3.390	$1.830.731	$7.804.697	$2.746
6	$13.923.000	$4.898	$2.645.370	$11.277.630	$3.967

Law 1715 of 2014 offers the incentive exclusion of IVA for goods and services in enterprise and Tariff incentive to reduce costs in projects with solar photovoltaic energy reduced 19% cost of savings in the project, Table 6 shows those reductions of cost of savings of the six prototypes.

Table 6. Incentive special reduction in the determination of the income tax on photovoltaic solar prototypes (Source: Authors)

Project solar photovoltaic in companies	Reductions for tax invectives of law 1715 of 2014				
	Cost project		Special reduction in the determination of the income tax		
	$COP	$USD	Reduction project	Cost project $COP	Cost project $USD
1	$2.564.400	$902	$423.126,0	$2.141.274	$753
2	$3.855.650	$1.356	$636.182,3	$3.219.468	$1.133
3	$7.347.930	$2.585	$1.212.408,5	$6.135.522	$2.158
4	$5.984.034	$2.105	$987.365,6	$4.996.668	$1.758
5	$9.635.428	$3.390	$1.589.845,6	$8.045.582	$2.830
6	$13.923.000	$4.898	$2.297.295,0	$11.625.705	$4.090

Companies which use the accelerated depreciation incentive provided by Law 1715 of 2014 allow to consider reducing costs in solar photovoltaic projects reduced 17% cost of savings, Table 7 shows those savings of companies using this inventive and reduced 3% cost of savings.

Table 7. Incentive accelerated depreciation on photovoltaic solar prototypes (Source: Authors)

Solar photovoltaic in companies	Reductions for tax invectives of law 1715 of 2014				
	Cost project		Accelerated depreciation		
	$COP	$USD	Reduction project	Cost project $COP	Cost project $USD
1	$2.564.400	$902	$84.625	$2.479.775	$872
2	$3.855.650	$1.356	$127.236	$3.728.414	$1.312
3	$7.347.930	$2.585	$242.482	$7.105.448	$2.500
4	$5.984.034	$2.105	$197.473	$5.786.561	$2.036
5	$9.635.428	$3.390	$317.969	$9.317.459	$3.278
6	$13.923.000	$4.898	$459.459	$13.463.541	$4.736

With the reduction of costs and energy supply in SMEs through projects promoted by Law 1715 of 2014; Even if they are the reduced value as observed in the analyzed scenarios, it allows counteracting the increase in unemployment, reduction in investment, delays in projects, reduction in levels of development and environmental evolution of industrial production areas, financial deterioration of Companies interested in accessing tax benefits and increasing levels of pollution, since these financial savings allow SMEs apart from replacing the obtaining of energy by photovoltaic solar systems is creating an environmentally sustainable culture.

4.3 Strategies to Improve Competitiveness by Incorporating Renewable Energy

The previous survey mentioned that 60.9% of the companies, the costs of electric power have a considerable impact on the value of the products and/or services by the production. The companies use machinery, computer equipment, lighting and others services that electricity used for the production, manufacture of services or products. In addition, it is important to establish, that energy is dispensable for communications, marketing and operation of the service provided.

The strategies which allow by solving the needs and problems of companies taking into account Law 1715 of 2014 are the following.

Photovoltaic solar energy is recognized worldwide as a renewable source, with low environmental impacts and diminishing costs over time compared to other sources of electricity generation. In Colombia, geographic and environmental conditions favor the implementation of this type of technology and at the same time it is a beneficiary of the governmental level through Law 1715 of 2014. The use of photovoltaic solar energy in companies has strengthen production and competitive performance with Law 1715 of 2014 for reduction from 19 to 3% of the value of the project, in the following aspects:

– Electricity for the production of the companies
– Controlled and/or autonomous reservation systems for the total or partial supply of electricity to specific locations
– Public and outdoor lighting

- Electrification for indicators, alarms, monitoring belonging to the emergency system
- Signaling and control of traffic measures
- Visualization and monitoring systems in the security of the company
- Electric fences
- Pumping and purification of water
- Water heating from solar photovoltaic systems
- Automation of greenhouses and irrigation controls.

The management of knowledge as a catalyst of business innovation processes and as an engine of economic growth, through the development and implementation of policies in science, plays a fundamental role in the generation of competitive advantages for production of its own products and services that depend on electric power.

This proposal consists of providing you with an advisory through the consulting of the design and installation companies for the implementation of photovoltaic energy systems all the elements, accessories, devices and technologies are implemented in the incentives offered by Law 1715 of 2014. This allows companies to invest the money saved due to the implementation of the photovoltaic energy to strengthen the production of products and services.

Many Colombian SMEs are not aware of the benefits that government institutions provide for the implementation of renewable energies, mainly solar photovoltaics. Having made a survey, it was concluded there exists a huge need of electricity to strengthen trade and the productivity of companies that depend on electricity for the production, manufacturing of services or products. The strategy is to promote that companies participate in partnerships in government proposals such as Law 1715 2014 to strengthen its sales productivity in the SMEs from generating photovoltaic solar energy in the for the elaborated of products and service companies.

Another strategy consists in the implementation of national and international regulatory mechanisms, policies and practices such as the supply of solar generation systems, solar leasing, solar power purchase agreement (PPA), rent the space and solar communities. This incorporated technical, economic, environmental and political analysis in photovoltaic solar energy. The mentioned mechanisms in the SMEs the incorporation of solar photovoltaic technologies will allow them to be implemented in the incentives of Law 1715 of 2014 to strengthen the energy security of the country and promote uses in productive sectors.

5 Discussion

The survey provides information on the needs, opportunities, difficulties, weaknesses and strengths of SMEs, it is investigated also on consumption of electricity, billing costs and sectors incidence costs of electricity. The interest and participation of companies, it is also focused on the installation of renewable energy in their enterprises.

The business sector that includes SMEs, not only in Bogotá but also in the rest of the country, It is facing a strong economic, commercial and financial situation of belonging and competing in the markets, facing great challenges ranging from tax reform, free trade agreements, low demand and supply of products, unemployment among others. Therefore, the permanence of the market and reduce costs, through Law 1715 of 2014, it is a competitive tool that seeks that the electric service is supplied in its value chain to produce its product or services, through the participation of tax, tariff and commercial incentives, which do not affect the companies own economy.

The strategies based on knowledge management to implement renewable energy in companies are based on the use of the incentives of the Law 1715 of 2014 to help the production, marketing and sales of products or services. Strengthen their competitiveness by reducing electricity consumption, which is an important source for the development of its services and products.

6 Conclusions

The autonomous photovoltaic solar energy systems allows a considerable reduction in projects of this technology, there is a reduction in supplying the superior energy of 15%. If the companies increase the use of renewable energy, it generates the reduction of costs by means of the Law 1715 of 2014, they diminish a lot more thus offering to improve and be competitive in the production of products and provide their services

Project cost is the value of the devices, elements and labor, with the solar photovoltaic project there is a reduction between 15 to 48% of the project's investment value for the company. With the approval of Law 1715 of 2014 of the National Government, the people or companies which join the implementation of projects with renewable energies will be benefited through different mechanisms for its realization. Among the most important are the tax incentives in the reduction of tariffs in the importation of equipment, machinery and technology related to the chosen power generation system; In addition, they could access to a reduction of up to 50% in the annual income tax return and IVA (sales tax) elimination of all products related to renewable energies.

Although the cost of the equipment, devices, tools and technologies necessary for a photovoltaic solar system has been reduced significantly in recent years, there is still an important barrier to the massive dissemination of distributed self-generation systems of this type due to the high capital requirements for investment by a user of SMES companies. Therefore, it is necessary to explore the most important financing mechanisms identified in the market in order to facilitate the massification, through the tax and accounting incentives of Law 1715 of 2014, allows that the implementing of this type of technology, reduce the investment costs according to the consumption proposal. If those companies could generate more energy than they need, they could even sell that extra energy according to new laws which have been developed recently, saving costs for their own benefits and they will reduce the time for recovering their internal rate of return.

The Law 1715 of 2014, is a promising legislation, since the incentives proposed are those that have generated the most development in the leading countries, surplus delivery, bidirectional measurement, compensation for benefits delivered to the networks, energy credits market, disclosure programs, financial incentives and accelerated depreciation mechanism. However, it is necessary to streamline the regulation of the responsible entities with the aim of beginning their application, it still remains to define: the guidelines for the surplus delivery on a small scale; the connection and operation guidelines of distributed self-generation; the guidelines for the operation of the unconventional energy fund; surplus delivery; bidirectional measurement; remunerations for benefits and the market for energy credits.

In summary, it could be concluded, that the use of renewable energy is a great opportunity to improve production processes, decreasing the environmental impact due to the use of clean energy and using it on a large scale by all industries could mitigate the risks of global warming, especially if thermal generation is replaced by Photovoltaic Solar Energy. Finally, the incorporation of renewable energies in SMEs allows to innovate, reduce the cost of the energy used for production that implies a lower cost in the production chain, which directly impacts on the final price of the goods or services, making them more competitive.

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Proposal to Measure the Quality of Open Data Sets

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Abstract. Currently in Colombia, steps have been taken towards institutional transparency and one of the most important components for this purpose is the publication of data in open formats. These data can be analyzed by people through computer systems to obtain new knowledge. In this case, a proposal is presented in which, based on the rules of logical consistency, measures can be constructed that, when applied to open data sets, determine a minimum quality.

Keywords: Open data · Quality · Government · Rules

1 Introduction

Thanks to the technologies of the information, public entities have been able to streamline their interaction with citizens in a rapid and effective manner. Liquidation and tax payments, utility payments, requests and complaints are of the procedures that can be done electronically by facilitating the relationship between citizens and the government. The public sector generates, manages and retains a lot of quality information. Such information is potentially reusable by both citizens and by companies. This information has enormous economic potential and at the same time contributes to transparency in governance and building trust by citizenship. Open data is thus a mechanism of generation of value in itself both information and economic that are very useful in countries that like Colombia are not of high income.

In Colombia, the strategy of open government allows citizens to have access to much of the information produced by different entities. Thanks to the law 1712 of 2014 known as the transparency law, entities are obliged to carry out the opening. Given the active role in this matter, since the year 2013 has been one of the countries with the greatest growth in the field of open data. On the one hand the Open Data Barometer, that measures the preparation, implementation and impact of the open data, located at level 24 in the world with a score of 51.65 [1]. On the other hand the Global Open Data Index, which measures the amount and diversity of data in different areas, located to Colombia in the post 14 at the global level [2]. This shows that the country has great potential and should contribute to the real use of open data in order to get to develop this potential.

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This document proposes a model to define the minimum quality standards in the open data sets by finding metrics of logical consistency of each data set. As an object of study analyzed the district data datosabiertos.bogota.gov.co platform and following the selection of a set of data consistency rules were applied to evaluate the quality. This document is structured in four parts: Background, prototype, results and conclusions.

2 Background

The open data movement can be explained as a philosophy that pursues certain data are available freely to everyone, in formats allowing them to be used, reused and redistributed without any legal, financial or technological restrictions [3]. The opening of the data has benefits for all who participate in it: for citizens, for businesses and for the administration. For businesses because from these data they can design and create new products and services to improve productivity and competitiveness. For citizens because it allows for better informed public management, contributing to better decision making; public administration itself because the fact of providing as much information to its citizens allows them to find solutions to problems for which the institutions do not have the time or resources [4].

Therefore, promote open data initiatives is a challenge for all the actors involved, and it depends on exploiting the potential that it has. An important factor for the reuse of the data value is the quality. The poor quality of the data can lead to a low efficiency of use of data and even bring serious errors in decision-making. The quality of the data has been studied extensively for many decades and many approaches have been proposed for the management of the quality of the data. However, these approaches are often based on internal data sets of organizations, with metadata and domain knowledge of the semantics of the data. Open data, on the other hand, often are not familiar to the user and may lack of metadata [5].

Measure and compare the quality of open data is not a simple process because it involves taking into account multiple dimensions of quality and this may vary among themselves, as well as several interested in open data which, depending on their function/needs, may have different preferences with regard to the importance of the dimensions. The aspect of quality in the open data sets can be tackled from different approaches, the first based on the quality of the metadata, the second from its content, the third since its structure [6, 7]. In Table 1 we present quality metrics proposed by different authors with the aim of measuring quality of data sets.

For the development of this proposal was selected the representation in a consistent manner specifically logical consistency that evaluates the interdependence of the fields to detect errors before publishing them. In Socrata and CKAN platforms cannot automatically apply this metric because it is technically not possible, it is therefore requiring the development of a functional proposal for the implementation of the Metric data sets to determine their quality and facilitate the detection of errors.

Table 1. Quality metrics for data

Metric	Definition
Accessibility	What data are available, and retrieved easily and quickly
Appropriate amount of data	What is the volume of data appropriate to the task in question
Credibility	What data can be considered true and credible
Completeness	Which data is not missing and is of sufficient breadth and depth to the task at hand
Concise representation	What data are represented compactly
Consistent representation	What data are represented in the same format
Ease of handling	Which data is easy to handle and apply to different tasks
Error free	What data are accurate and reliable
Interpretation	What data are in languages, symbols and appropriate units and its definition is clear
Objectivity	Which data is without bias, without prejudice and is impartial
Relevance	What is data is applicable and useful for the task in question
Interpretation	What data are in languages, symbols and appropriate units and its definition is clear
Reputation	Which data is considered in terms of its source or content
Security	Which data have appropriately restricted to maintain security
Punctuality	What data are sufficiently up to date for the task
Understanding	Which data are easily understood
Value added	Which data is beneficial and provides advantages in its use

3 Prototype

With the aim to standardize the data the Ministry of information and communication technologies and the mayor of Bogotá have proposed a series of guidelines, in particular, the common language of trade and the Directive 22 of 2011. The common language of exchange, hereinafter referred to as the GEL-XML, seeks to develop a functional and technical specification to allow modeling and properly manage the exchange of information, in this way, facilitates the process of obtaining information and execution of the process for both entities and citizens.

The development, adoption, implementation and use of the standard GEL-XML allows interoperability, creating an initial base of data elements for the exchange of information, which comply with international standards of W3C and develop a specification for the exchange of information independent of hardware, software, communications infrastructure or processes, among others [8]. On the other hand the Directive 22 of 2011 [9] establishes the need to adapt the instruments in which are recorded the data of citizens. For the information of the population served by the different entities must be obtained under defined standards for the capture and recording of data, the consolidation of information, processing and the generation of the output. This will minimize the risks for the District that may arise in terms of timeliness of delivery, accuracy and reliability, and that permit the realization of crosses of databases between the different entities and agencies.

Colombia has a national portal of open data and two regional portals (Bogota and Tulua). For the development of the prototype is selected the portal of Bogotá (http://datosabiertos.bogota.gov.co/). To define the applicable rules are reviewed data sets (29) identifying common aspects as each field in the data set has a name, each field has a data type defined can be alphanumeric, numeric, date, etc., each field can have a value with a minimum or maximum length, each field can store well-defined values or can be unique values for each record (heterogeneous).

Each data set belongs to a different and unique context, which makes it difficult to apply general logical consistency metrics that apply to all data sets. From the aforementioned aspects, it was possible to generalize three types of rules for the automatic definition of logical consistency metrics based on the relationship between the values of the fields of each data set. These metrics are described as brief semantic premises, for example "the identification number of a person is composed of 10 digits".

Next, the three types of rules are specified:

Table 2. Base example data set

Field 1	Field 2	Field 3	Field 4
A	47	Green	3704581
B	39	Green	4431899
C	22	Blue	9392172
B	24	Yellow	9809066
C	20	Green	11829251
C	10	Blue	11421426
A	47	Yellow	10387287
A	30	Blue	11566299
C	14	Yellow	11898424

3.1 Rules Type Value to Value

This type of rules is characterized because the values go from a domain field to a range field. This rule has the peculiarity that for every value in the domain, there must be at least one value in the range. This rule would only apply for fields that have well-defined values in their domain and range, that is, that the values appear several times in the records of the data set. The structure of the semantic premise is "a VALUE in the domain has a VALUE of a set of values in the range". To symbolize this type of rule we used (->). Applying this rule to the previous data set on Table 2, based on fields 1 and 3 would be as shows Table 3 the generated metrics.

Table 3. Example of applied rule type domain value to range value

Field 1	Rule	Field 3
A	->	Blue
A	->	Green
A	->	Yellow
B	->	Green
B	->	Yellow
C	->	Blue
C	->	Green
C	->	Yellow

3.2 Rules Type Value to Regular Expressions

There is another case in which the values of fields have a domain also defined but the range is defined by a comparison of features in the value chain, it can be length, alphanumeric or numeric, etc. This type of rules will be referred to by the expression and symbolize with (E), due to the fact that the form of evaluation is done by the use of regular expressions and of which shall be known as the "A value in the domain and a feature of the value in the range" (Table 4).

Table 4. Example of applied rule type domain value to regular expressions

Field	Rule	Feature
Field 4	E	Character length between (7–8)
Field 4	E	Character allowed (0–9)

3.3 Rules Type Value to a Range of Values

This case refers to values in the domain that have a set of numerical values in the range. As a condition is that the value in the range must be a number. This rule uses the common logical binary operators to be symbolize, symbols like >, <, =, <=, >=, principally. Apply this rule to the example data set on Table 2 is shown at Table 5.

Table 5. Example of applied rule type domain value to a range of range values.

Field 1	Rule	Field 2
A	>=	30
A	<=	47
B	>=	24
B	<=	39
C	>=	10
C	<=	20

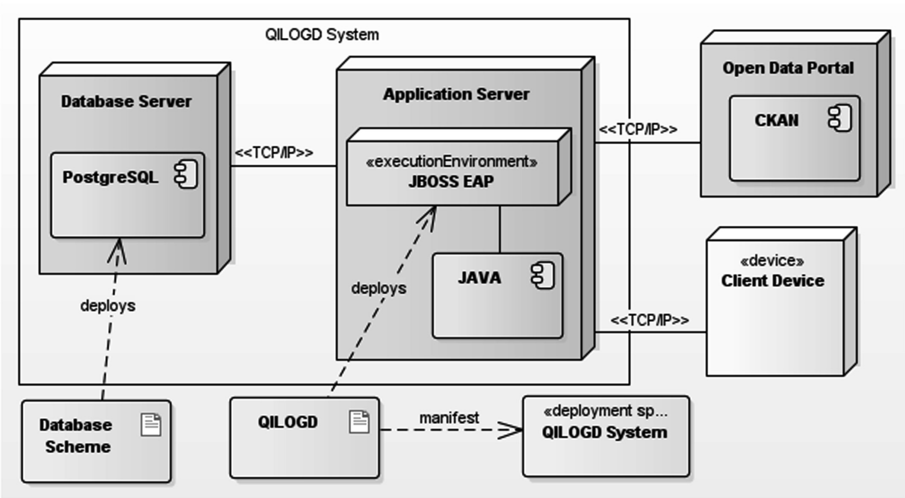

Fig. 1. View of the QILOGD system deployment

To find rules of logical consistency in the data sets on the district it was necessary to develop a prototype of software that would automate the task because the amount of possible relations between the fields tends to be complexity n $\times$ m. It is important to clarify that the prototype presented here provides the metrics based on the type of rules of value to value.

The proposed system has a name of Quality Inspector Linked Open Government Data (QILOGD). The view of the deployment of the system is shown in Fig. 1.

To connect to the selected open data portal, download open data published, open data sets and gets the domains of each of the fields to define the metrics of logical consistency depending on the type of rule value to value, as well gets the percentage of each metric, and displays the results of the rules obtained in a table.

4 Results

Once the prototype was implemented in the datosabiertos.bogota.gov.co URL, the following results were obtained (Table 6):

Table 6. Joint results of evaluated data

Detail	Total
The data sets in the portal	29
Data sets with data file	29
Data sets with description	2
Sets of machine-readable data	13

That some of the data sets do not have a suitable structure which does not allow you to perform a read by machines. There is a policy within the district in the use of the separator so that some of the fields are separated by commas (,) and other by semicolons (;). It is also noted that failure to comply with the principle of granularity and atomicity of the data, it does not have a proper classification. Another relevant aspect is that fields with null values are presented in the data sets.

As a case study was evaluated the data set called “activities-of-non-profit-entities” that has 40,911 records, of which 5426 records are null, equivalent to a 13% error. When applying the rules of consistency to the case study data set, it can be observed that it has the field structure of Table 7.

Table 7. Field structure of the selected data set

Field	Type	Observations
ID not-for-profit organization	alphanumeric	Unique id in the system of the non-profit institutions
Category	alphanumeric	Activities carried out by the non-profit institutions
Population according to cycle	alphanumeric	Population according to a range of ages
Population by condition	alphanumeric	Population according to the social, economic
Population by group	alphanumeric	Population classified by group
Location	alphanumeric	Territorial division where it is the non-profit institutions

We selected the combination of the fields of “category” and “population according to cycle”, which has the values described in Table 8.

Table 8. Values of the fields “category” and “population according to cycle”

Category	Population according to cycle
• Democratic culture, peace and coexistence • Democratic culture, peace and coexistence • Health • Education • Environment and natural resources • Emergency prevention and response • Productive development and income generation • Ideological • Habitat • Mobility and public space • Culture • Science and technology • Institutional development • Recreation and sports • Volunteering • Intellectual property • Communications	• Does not apply • Older adults (men and women over the age of 60 years) • Children (boys and girls between 6 and 11 years) • Young people (men and women between 12 and 26 years) • Early childhood (from the gestation period up to 5 years of age) • Adults (men and women between 26 and 60 years) • All

Taking into account the values of the fields, it can be observed that each field has a set of well-defined values and in addition they are alphanumeric. Figure 2 shows the percentage of erroneous data in three different situations (early childhood, older adults and children).

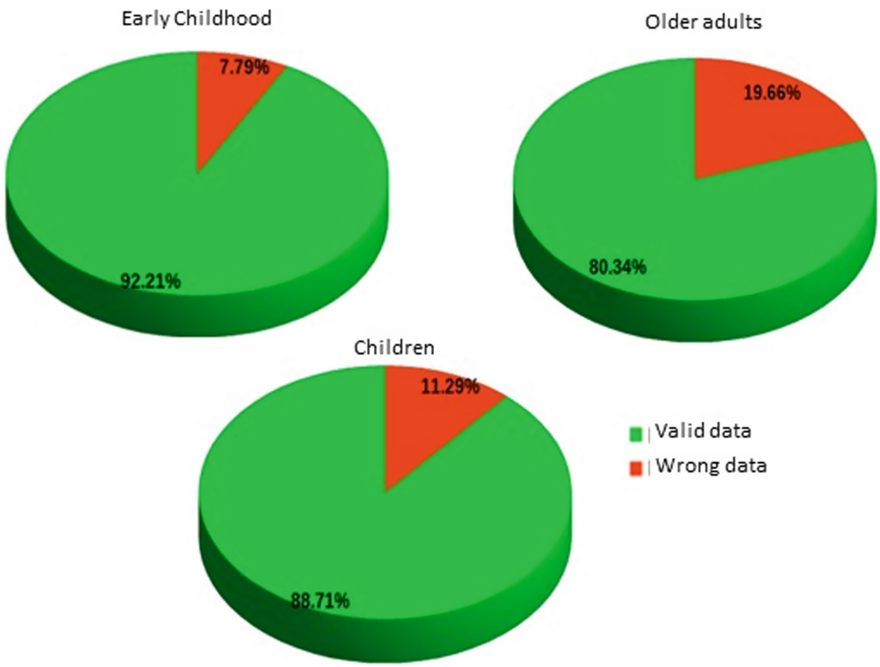

Fig. 2. Error index thrown by the system

The error rate of the data set is between 7% and 19%. What in practical terms wants to indicates that of 40911 records, between 2864 and 7773 records are erroneous. This Index is significant and requires an analysis of the quality procedure of the system from which the data set is obtained, in addition to contrasting that analysis with a professional in the knowledge area of the data set.

5 Conclusion

The information generated by the public sector is presented as a raw material of great potential. In Colombia, although progress is limited, has taken small steps for data to be available and achieve the benefits that in countries like the U.S. and Europe.

To have a tool that allows to evaluate the quality of the data before Daisy platforms could help to increase the reuse and therefore the generation of value. One way of contributing to the quality of the data is ensuring that public institutions are availing themselves of the standards by establishing good practices for the exchange of information. The tool presented here allows you to find deficiencies in the open data sets, from then can be improved by integrating rules of logical consistency in the fields of the different data sets.

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Game Theory Approach to Brazilian Air Traffic Management Using Collaborative Trajectory Options Program

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Abstract. Air traffic management (ATM) has increased the complexity of computational solutions over the last decades to support the discovery process and knowledge management in decision-making process. It involves dealing with more information about flights, weather, delays, forecasting scenarios, and others. An evolution of ATM programs was the Collaborative Trajectory Options Program (CTOP), which is applied in the USA since 2014. In Brazil, some initial studies are analyzing this evolution and how the current air traffic management could be improved. One option is to implement the concept addressed by CTOP and its specificities based on Brazil context. This paper presents a computational solution that uses the main concept of CTOP with a collaborative approach to implement the program in Brazil. The main objective is to reduce delays of flights captured by the CTOP, so that the airlines collaboratively reduce delays in their flights and each airline can their business goals, using techniques of Artificial Intelligence with Game Theory and Folk Theorem. The CTOP approach to Brazilian air traffic management is a first initiative to improve the air traffic programs by using the collaborative decision-making process to achieve better results. The achieved results were important for this initial case study, decreasing about 18% of delays in CTOP captured flights, when it was considered only the priority flights of an airline.

Keywords: Game theory · Collaborative Trajectory Options Program
Collaborative decision making · Decision Support System

1 Introduction

Air traffic management (ATM) has increased the complexity of computational solutions over the last decades to support the discovery process and knowledge management in decision-making process. It involves dealing with more information about flights, weather, delays, forecasting scenarios, and others.

The airspace control organizations support the air traffic by air management programs and computational solutions as a pair to guarantee the entire process is operating in a safety level and with less operational costs. These programs are updated constantly to improve the results, especially in in the USA and Europe, considering the saturation

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problems usually happen firstly in these regions. The problems faced today by them will be usually implemented in other countries in a few years.

Thus, an evolution of these programs was the Collaborative Trajectory Options Program (CTOP), which is applied in the USA since 2014. It has been studied in other countries in order to manage areas where flow capacity is reduced due some weather condition, so flights need to be relocated in other routes with delays.

In Brazil, some initial studies are analyzing this evolution and how the current air traffic management could be improved. One option is to implement the concept addressed by CTOP and its specificities based on Brazil context.

This paper presents a computational solution that uses the main concept of CTOP with a collaborative approach to implement the program in Brazil. The main objective is to reduce delays of flights captured by the CTOP, so that the airlines collaboratively reduce delays in their flights and each airline can improve their business goals, using techniques of Artificial Intelligence with Game Theory and Folk Theorem.

The paper is organized as follows, Sect. 2 presents the decision support concepts and applications, Sect. 3 presents concepts of Air Traffic Management, Sect. 4 presents the Game Theory approach to CTOP in Brazil, Sect. 5 presents an initial case study in Brazil, and Sect. 6 presents the conclusions and future works.

2 Decision Support Systems

The performance of human being for dealing with complex situations of troubleshooting, processing and storing information is low if compared to the use of more efficient and faster computational solutions.

A successful Decision Support System (DSS) potentially handles with high data rates, acts intelligently and cooperatively in complex domains, and it could make decisions as the best experts in the area [1]. The study in this area focuses on how information technology could improve the efficiency to make or suggest decisions, as well as the effectiveness of these decisions [2].

A DSS can be built based on a concise and well-structured definition of the problem that will be addressed following few steps as: recognize the problem, elaborate a definition, generate solutions, develop models, analyze and choose the best alternative and, ultimately, implement it [3].

Most of DSS for air traffic management are made for working in a semi-automatic way, where the system can act by itself on the current scenario. However, it may be possible that in certain situations the intervention of the specialist is required or the system verifies the possible situations to make a final suggestion to the specialist.

An important example of DSS in the air traffic environment is the Future ATM Concepts Evaluation Tool (FACET), a modeling tool that defines precise models for the complex U.S. air traffic management problems [4].

FACET is a system that simulates air traffic based on flight plans and allows the user to analyze the congestion patterns of different sectors through a graphical interface. It also allows the user to change the flow patterns of aircraft through various mechanisms [5]. The FACET overview is presented the Fig. 1.

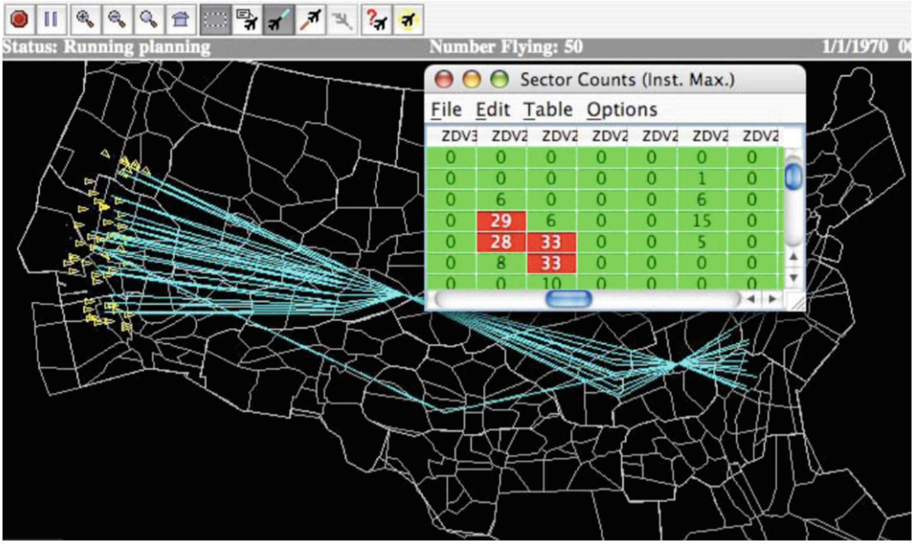

Fig. 1. FACET overview

The system was created to support the impact of aircraft ground delays and redefine routes in addition to improve the predictability of agents' rewards using computed values. In this case, the agents were assigned to individual locations in the ground that comprise the entire airspace and each agent would be responsible for any aircraft passing through that location.

The principle is that multiple agents can access the FACET to simulate air traffic based on measurement, ground delays or redefinition of routes to obtain information on traffic routes and air flow statistics and support in complex decision-making process. It was proposed to use with the reinforcement learning approach [6], because it is possible to intelligently use the DSS information stored to learn with the past actions to achieve better results.

3 Air Traffic Management

The Collaborative Decision Making (CDM) was applied in the US in 1993 when the U. S. Federal Aviation Administration (FAA) through a program called FADE (FAA Airlines Data Exchange) conducted experiments, which proved that airlines who share real-time operational information with the FAA could improve the decision-making process of traffic management [7].

The CDM process is defined as an effort to improve air traffic management through information exchange, development tools, and a shared consciousness. Once each participant involved in the CDM process is willing to collaborate, share responsibilities, information and resources, it makes possible that decisions will be better structured through understanding of preferences, limitations, forecasts and real-time situations of the participants involved [8].

The Collaborative Trajectory Options Program (CTOP) is an initiative that emerged in the U.S. in 2012 created by the FAA to manage the demand for air traffic flow from a restricted area [8] and considering airline business goals. The restricted area is an area where the flow capacity is reduced, so that, part of the flights do not use their most viable routes and have delays due to adverse conditions, for example, unfavorable climatic situations.

It is possible to agree that CTOP uses CDM principle once there are information sharing between air traffic control and airlines. However, there is a question to be addressed, it is possible to improve the results by sharing information between airlines before the air traffic control takes its actions.

4 Game Theory Approach of CTOP in Brazil

The computational solution joined the concepts of CTOP and CDM by proposing the negotiation and collaboration between airlines and flight controllers to try to minimize the impacts caused by restrictions.

A restricted area can be represented by one, or more, and is defined as Flow Constrained Area (FCA). Basically, it is a geographic area that will have its capacity to fly through restricted during a specific period. Thus, airlines can manifest their preferences of routes and schedules through a Trajectory Options Set (TOS), which is an electronic message that allows airlines to choose their desired routes and delay options that they are willing to accept for each flight [10].

By this information of each flight, the CTOP algorithm is executed to allocate every flight. According to Golibersuch [11], it can be simplified in 6 steps:

1. Define the flights participating in the CTOP;
2. Define which flights will be considered exceptions;
3. Allocate the exception flights;
4. Create a flight allocation order according to their Initial Arrival Time (IAT) of each flight;
5. Allocate the route for every flight according to the order of IAT and available capacity;
6. Send the final list for each airline.

Exception flights cited are flights that has already been *en* route when the CTOP demand was shared, which is normally international flights that receive the preference of being allocated first before the other flights once they are already flying.

Considering the original CTOP concept, when every airline sends their route preference, the FAA will execute this algorithm. In Brazil, it is considered the follow one:

1. Define the flights participating in the CTOP;
2. Define which flights will be considered exceptions;
3. Allocate the exception flights;

4. Create a flight allocation order according to their Initial Arrival Time (IAT) of each flight;
5. Allocate the route for every flight according to the order of IAT and available capacity;
6. Share the list for all airlines;
7. Airlines try to negotiate their routes and possible slots to be allocated;
8. Receive an alternative of the prior list;
9. Evaluate if the alternative list is right and could be allocated, if yes, it turns this as final list, if not, consider the first list as final.

The negotiation between the airlines starts when the CTOP generates the final list. The goal is that airlines could cooperate by themselves to decrease their delays and prioritize their priority flights. In this study, the negotiation process was modeled as a game that will dispute slots between the airlines. Thus, it was created two categories to verify how the delay index performance by the time:

- Global delay: the sum of every flight delay in the game for each airline.
- Priority delay: the sum of every priority flight delay in the game for each airline.

The priority flights have been defined as flights that airlines have priority, which would represent flights that are very important and should have the lowest possible delay, for example, flights that have connections could result in a great high delay.

Considering that in CTOP each airline has no knowledge about competitors' flights, the game was developed based on rules, non-cooperative, with incomplete information, dynamic, repeated, discrete, and non-zero sum, in other words, the airlines have their strategies, have just knowledge of their own flights and the information provided by CTOP, have a defined sequence to make decisions, could be extended indefinitely, have a limited amount of decisions and have no constant results.

Thus, the game consists of the slots dispute between the airlines, which each one will bargain against the other to get the best set of slots. The history of acceptance and rejection of the bargains will be stored to learn and improve the decisions taken by the airlines.

The Nash's bargaining concept was used to model the bargain for every negotiation round, which it was set as the result pair (p_1, p_2) that would result in the optimization represented by Eq. 1:

$$\max(p_1, p_2) = (p_1 - d_1) \times (p_2 - d_2) | (p_1, p_2) \in \cup (p_1, p_2) \geq (d_1, d_2) \quad (1)$$

Where P_1 and P_2 would be the preferences of the airlines and the bargain would be accepted just if the preferences of both airlines were maximized, i.e., if there were acceptance of their preferences so that they would be greater than the demands D_1 and D_2.

The Fig. 2 presents the main algorithm used by the game model.

Algorithm 1 Algorithm

```
procedure GAME
    for initial time window to final time window do
        while round is not the maximum or offer is not accepted do
            select flights
            select slots
            player elaborates new offer and sends to competitor
            if competitor's and player's rejection rate are acceptable then
                if offer priority delay and offer global delay are acceptable then
                    offer accepted
                else
                    offer declined
                end if
            else
                offer declined
            end if
        end while
        if offer was not accepted then
            use CTOP result
        end if
    end for
end procedure
```

Fig. 2. Game model algorithm to Brazilian CTOP approach

Therefore, it was defined that after the execution of the CTOP algorithm the airline would bargain with the other airline by expressing its preferences on certain slot period. If the airline that received the bargain accepts, the negotiation is over, but if there is a rejection, so it must propose a new bargain.

The Folk theorem was used in this study and it can be summarized as a game of N-players and a vector of results (k_1, k_2,…, k_n), which if K is a result of a Nash equilibrium of an infinitely repeated game with rewards, then for each player set to i, K_i is possible. If k is viable, then k is the result of Nash equilibrium of an infinitely repeated game with certain rewards. In other words, the Folk theorem says that the countless repetitions of a game leads to all possible game results to be revealed as a representation of a Nash equilibrium and the use of rewards.

So, it was modeled a game with successive repetitions and rewards were defined to be measured by the records of acceptances or rejections of the bargains, regarding to the amount of times that the airline had rejected the competitor's proposals and vice versa. If the value was too high for rejection, the airline would start to reject the bargain of the other even before analyzing the proposal.

The airline that keeps rejecting the competitor's proposal would be forced to start accepting the next proposals for regulating the elevated level of rejection. Otherwise, it would never be able to swap any slot, and it would always be rejected.

Thus, it is encouraged that airlines cooperate with each other and make the negotiations fairer, so the airline who do not cooperate could be punished until change its behavior. The Fig. 3 presents the game theory model to Brazilian CTOP approach.

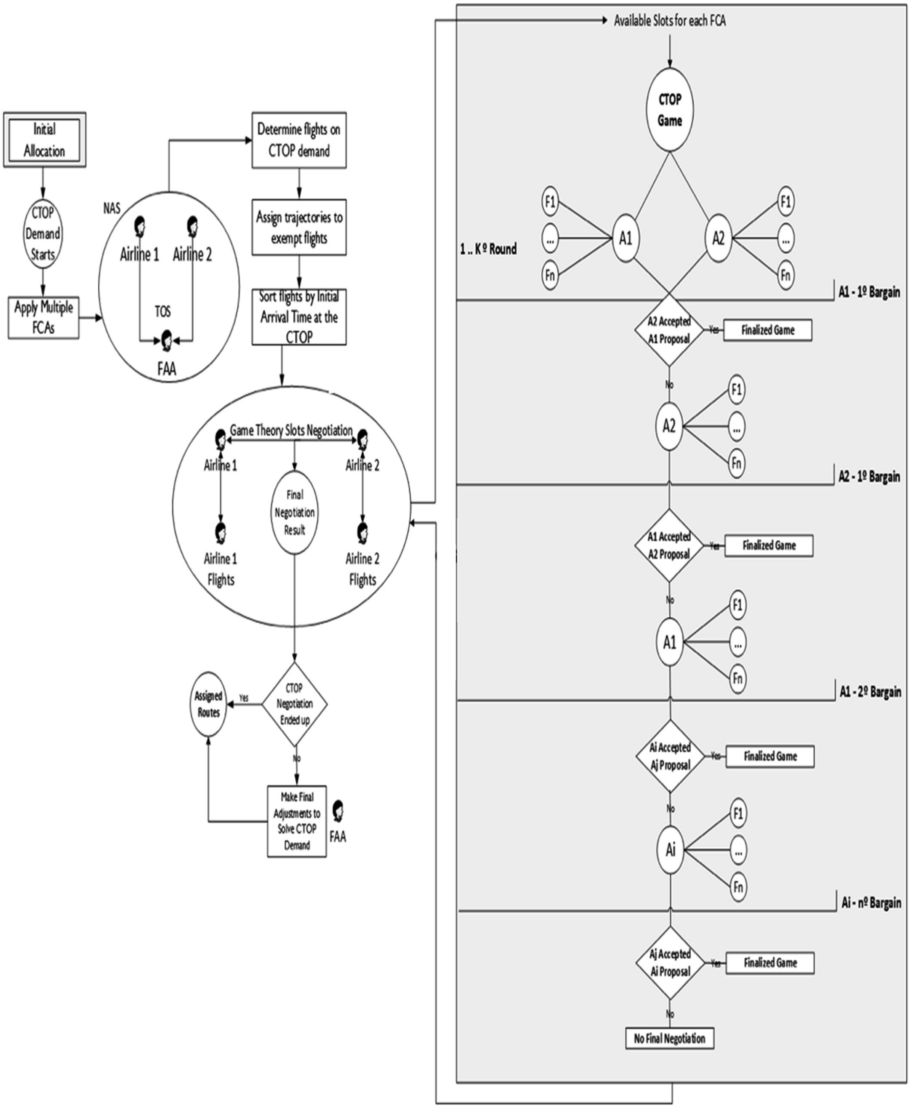

Fig. 3. Game theory model to Brazilian CTOP approach

5 Case Study of Brazilian CTOP Approach

The case study was divided into two stages, which the first stage was initially defined as the allocation of the slots of every flight according to original CTOP concept and the second as the negotiations between the airlines using game theory and a collaborative approach.

Two airlines were defined for the case study, Airline A and Airline B and two FCA's, defined as FCA1 and FCA2. The geographical region of both FCA's was defined close to the São Paulo-Guarulhos International Airport de (SBGR) and São Paulo-Congonhas Airport (SBSP), because they are two of the busiest airports in Brazil. The Fig. 4 presents the FCAs.

Three cases were chosen to model the possible real scenarios and so performance could be analyzed on different distributions of their flights to comprise a greater amount of data for analysis. The cases were:

- Case 1: The both airlines has the same amount of flights captured by the CTOP, 50% Airline A's flights and 50% Airline B's flights.
- Case 2: Airline B has more flights captured by CTOP than Airline A, 75% Airline B's flights and 25% Airline A's flights.
- Case 3: Airline B has more flights captured by CTOP than Airline A, 67% Airline B's flights and 33% Airline A's flights.

It was chosen 20 airports targeted at SBGR and SBSP from 4pm to 11pm due to the large amount of flight at this time and selected 123 flights. Considering the aircraft routes limitation, it was assumed that the capacity to fly through each FCA was per FCA in 10-min period.

The data randomly selected was split into available slots for each FCA, which were drawn 6 flights for each 1 h, i.e., 7 h and 42 slots per FCA between 4pm and 11pm.

The game is the dispute between slots by Airline A and Airline B, including negotiation as bargain, the option to accept or reject negotiation in a certain number of rounds and a reward based on acceptance or rejection rate.

The acceptance happens when the airline receives a proposal that necessarily reduces the delay of its priority flights by 15% or reduces its global delay by 10% if none of these conditions is satisfied, the proposal is rejected.

It is allowed that the global or priority delay increases by 10%, considering that one of the previously mentioned conditions is satisfied, otherwise the proposal is rejected and the airline receiving the proposal should propose a new one.

The negotiations are separated by time windows of one hour starting from 4pm to 11pm and it was set four rounds to make each negotiation. If a negotiation is accepted, then the next time window is negotiated, and, if there are 4 rounds and no negotiation is accepted, then it is assumed the result set by the CTOP algorithm and next time window is negotiated. After the last time window, the game is over and the result is defined as the final list generated by the game.

Analyzing the history of rounds, if the rejection's percentage of the negotiations by the competitors' airline is more than 70% and the rejection's percentage of the negotiations by round of the proponent company is less than 85%, it immediately rejects the negotiation, otherwise, analyzes the negotiation.

For the execution of each case study, it was determined that the CTOP algorithm with negotiation by game theory would be executed 100 times for each case. The intention is that a repeated game is formed through the large amount of repetitions, and a game with successive repetitions can allow all possible results or at least most of them to be expressed in the game.

Fig. 4. FCAs of case study

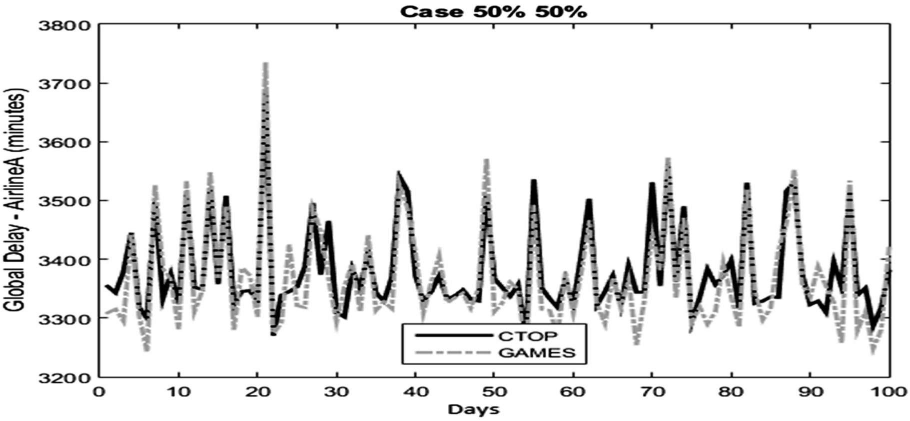

Fig. 5. Global delay for Airline A in case 1

The results considered two cases: global delay for each airline and priority flights delay for each airline. Thus, the Fig. 5 presents the global delay for airline A in case 1, and Fig. 6 presents the global delay for airline A in case 3.

It is possible to verify that in Figs. 5 and 6 approaches the achieved delay were close, about 5% of variation for the global delay of captured flights.

The proposed approach presented in this paper achieved better results regarding to priority flights, considering the negotiation between airlines will improve these specific results. The Fig. 7 presents the priority delay for airline A in case 1, and Fig. 8 presents the priority delay for airline B in case 1.

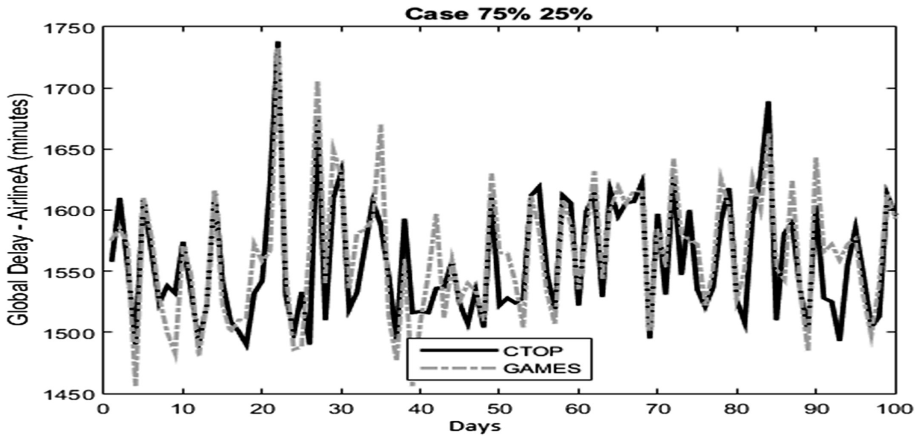

Fig. 6. Global delay for Airline A in case 2

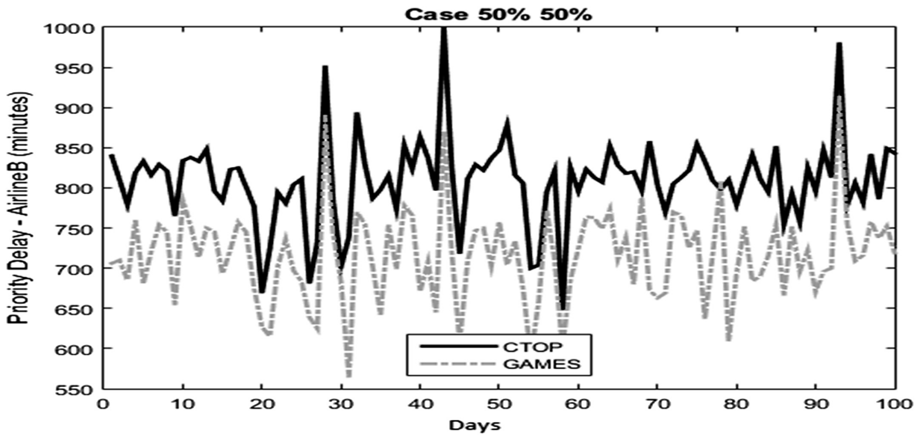

Fig. 7. Global delay for Airline A in case 1

It is possible to verify that in Figs. 7 and 8 that the results for priority flights with cooperation between airlines is better than the CTOP original approach. It was achieved about 18% less of delay for priority flights using the Game Theory approach. The Fig. 9 presents the priority delay for airline A in case 2.

Analyzing the Figs. 9 and 8, it is possible verify that in both cases, i.e., when the airline had 50% or 33%, the achieved result kept about 15% of delay reducement. This demonstrates that the model is achieving great results, especially in priority flights scenario.

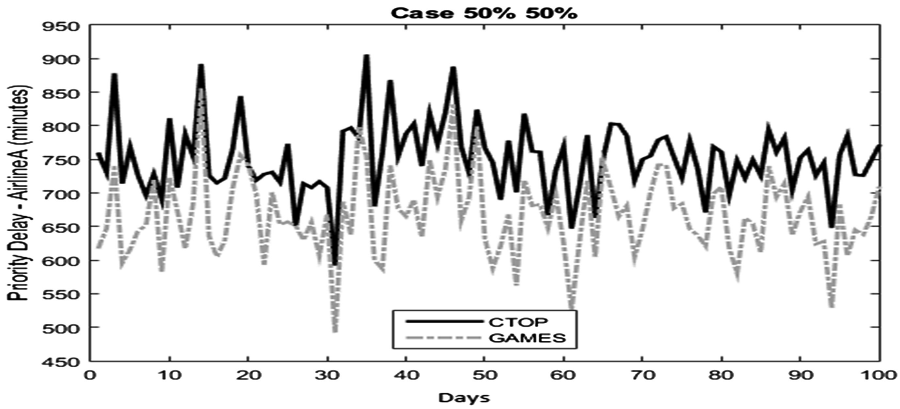

Fig. 8. Global delay for Airline B in case 1

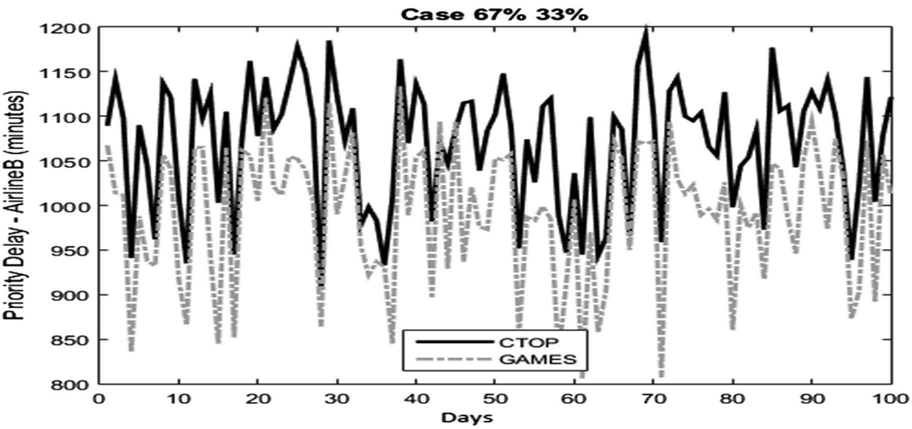

Fig. 9. Global delay for Airline A in case 3

6 Conclusions

The CTOP approach to Brazilian air traffic management is a first initiative to improve the air traffic programs by using an adapted collaborative decision-making process to achieve better results.

The CTOP is a very complex program that make possible to improve airline business goals. Considering the USA market, the competition between airlines is so high, which made possible to adapt this model for a more cooperated approach to be applied in Brazil.

It was developed a Game Theory model to improve the ATM by adapting the CDM and CTOP concepts for Brazilian scenario. It is a key step to keep improving the air traffic management programs and computational applications to support decisions of airline and air traffic controllers.

The achieved results were important for this initial case study, decreasing about 18% of delays in CTOP captured flights, when it was considered only the priority flights of an airline.

The future works proposed is to increase the application of CTOP, and other ATM programs in Brazil and verify how this program applied in the USA could improve the business goals and airline financial results.

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The Development of Learning Materials for Introduction of Animals in Early Childhood Using Augmented Reality

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Abstract. Give the definition of work *Augmented Reality* (AR) and see how the learning process can be arranged outside the classroom with mobile learning. Classify major components (device technology, models of instructional design, media types, and activities/outcomes study). Discuss constraints technical and pedagogical presented by AR, before looking at how that can be used for learning. AR can be used in mobile learning. The important contribution of the two fields can be seen in a discussion of the underlying teaching techniques related to the use of AR; and taxonomy which classifies the various aspects of mobile AR to study in a variety of situations. AR as an alternative medium of learning in the future. In the past, the limitations of AR technology are only used in one place cannot be moved around. However, the development of AR continues to do so has been obtained AR a portable or can be taken anywhere. Utilization of AR in the world of education to the introduction of animals to early childhood through *smartphone* devices and cards.

Keywords: Augmented reality · Smartphone · Mobile · Childhood

1 Introduction

The process of efficiency in the utilization of space and time encourages people to continue to develop various technologies. The developed technology is expected to be able to bridge the human needs in their daily activities, especially related to the efficiency of space and time [1]. Knowledge management is very important for human resource management, one of them related to the development of multipurpose technology for present the best service quality [2, 3].

The role of information technology in learning can be seen through the utilization of augmented reality (AR) the AR function which is to give information in the form of a 2D or 3D images from a mobile device or a laptop. Utilization of AR which originally could only be used on an HP device only and could not be moved is evolving into an AR can be used not only on HP but can be used with a laptop through the application website and its utilization can be switch.

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The use and utilization of AR and mobile learning in accordance with the needs that occur this time viewed from the characteristics of learners who are happy with pictures than read the writing. But these characteristics are more tolerated by children-early childhood than adulthood. Utilization of AR in the process of learning affect interest learners to explore material that is taught through images of 2D or 3D. Utilization of AR also reduces the use of classroom space for props. Tools used by *mobile phone* as reader and cards contained objects 3D images that can be printed or can be stored on laptops in the form of soft file.

Learners and educators must have a mobile phone that is capable of in terms of image resolution and long-lasting battery. A cognitive perspective of digital information with AR can enrich the imagination of learners to accelerate understanding of the material presented. When compared to giving the theory or explanation only in class then the learners more difficult to understand the material. Therefore, very important when content is created educators used for provided the material to students with not only theory but can display images that correspond to reality.

Learners can use the technology of AR in the learning process. By using this technology learners can learn independently although it may be a bit large costs in terms of use of the device. Utilization of AR to introduce the animal to early childhood with 3D images, audio and written into the goal to be achieved in the writing of this. In addition, the development of learning materials may increase, eases and accelerates the understanding of the material presented by educators in the learning process.

2 Literature Review

Reality is added, sometimes known by the acronym English AR (augmented reality), is a technology that combines the two dimensional and virtual objects or three dimensions into a real three-dimensional environment and then projecting the virtual objects in real time. Unlike virtual reality which completely replace the fact, the reality of added simply add or complement a reality. Maya objects display information that cannot be accepted by the user with its own sensory. This makes the reality of the added match as a tool to help users with perceptions and interactions of the real world. Information displayed by the Mayan objects helps the user to carry out activities in the real world. The reality of the added can be applied to all the senses, including hearing, touch, and smell. In addition to use in areas such as health care, military, manufacturing industry, the reality of added has also been applied in devices that people use a lot, such as on a mobile phone.

There are several methods that can be used in augmented reality i.e. one is Marker Based Tracking. This marker is usually a square black and white illustration with black background and a thick background who is white. On your computer can recognize the position and orientation of the marker object and creates a 3D virtual world that is the point (0, 0, 0) and axis consisting of the X, Y and z. Marker Based Tracking this long developed since the 1980s and began developed in the use of Augmented Reality.

In addition, the methods used in Augmented Reality that until nowadays is to use the method of Markerless Augmented Reality, with this method, users no longer need to use a marker to display elements Digital.

A variety of techniques that can be used by using the Markerless Tracking that is as follows:

a. Face Tracking: By using the techniques that they develop algorithms, the computer can also recognize a human face in General by way of recognizing the position of the eyes, nose and mouth. It will then ignore the other surrounding objects such as trees, houses and other objects.
b. 3D Object Tracking: Unlike the face tracking which only recognize a human face. By using the technique of 3D Object Tracking can identify all objects exist such as cars, motorcycles, a desk, TV and others.
c. Motion Tracking: This computer technique can capture movement or Motion Tracking that has been started is used extensively to produce a film that simulates on the movements of the body. For example, in the film James Cameron's avatar, which used this technique to make the film look like more real-time.

Precise digital documentation using a different scanner laser technology as 3D scanning device [10]. Augmented reality is one of the technologies that dramatically shifts the time and location of the study. How AR can apply to study media, and potential impact towards the future [11].

Most of the innovative device offers the opportunity to integrate augmented reality on mobile applications, enabling the combination of virtual information with the real world. This feature can be very useful to improve the informal and formal didactic action based on the collaboration of students [12] (Table 1).

Table 1. Taxonomies are used in the AR project mobile learning, showing how it can be used to categorize various aspects of research

In project	The device or technology	Mode interaction/learning design	Method sensory feedback	Personal/together experience	Static fixed or portable experience	Learning activities or the results of the research
Zapp [4]	Smartphone	Exploration Illustration Understanding Reflection	Visual display: text labels	Personal and shared (small groups)	Portable	Interpreting the geological landscapes of the countryside through the investigation lies and collaboration
Out there, in here [5]	Laptop, tablet devices, smartphones	Exploration Illustration Understanding Reflection Collaboration	A mixture of: visual, auditory, text	Together (small groups)	Portable	Collaboration-based inquiry learning to enable data sharing, development hypothesis, access to resources/information etc. among students in the field and those in the laboratory
Contsens [6]	PDA (Personal Digital Assistants), cell phone	Illustration Understanding Reflection Collaboration	A mixture of: visuals (3D wireframe model), video	Private and shared between 2 users	Portable	Archaeological and architectural survey of the ruins of the monastery; give different visual perspective on mobile devices

(*continued*)

Table 1. (*continued*)

In project	The device or technology	Mode interaction/learning design	Method sensory feedback	Personal/together experience	Static fixed or portable experience	Learning activities or the results of the research
An increase in the visitors experience [7]	PDAs, mobile phones, tablet devices, headup display (HUD)	Exploration Understanding Reflection Collaboration	A mixture of: visual, audio, text, video	Private and shared among users 2–3	Static and portable	Compare different engineering technology to provide information about a view to visitors relaxed; the resulting student criteria is focused on usability and sustainability
History unwired [8]	Smartphone, PDA (Pocket PC) + headphones	Exploration Understanding Reflection performance (by the author)	A mixture of: audio, video	Private and shared	Portable	Informal learning about Venice's Castello region through walking tours using locals to describe the experience of local arts and crafts, history and folklore, public space and private
Mudlarking in Deptford [9]	PDA + headphones	Exploration Understanding Reflection Collaboration	A mixture of: text, audio, visual	Together (small groups+pairs)	Portable	Students act as associates of the designers to create a local tour guide on a mobile device, using multimedia related to the local area and their observations

3 Results

As for the introduction of products for animal's results in early childhood by using AR like the image below (Fig. 1):

Fig. 1. Object card

This card serves to keep or put pictures of animal's objects to be created images in 3D form. So, when reader (mobile) are brought near or on the scan to the card will eject the image as follows (Fig. 2):

Fig. 2. The card has been scanned

To display the 3D image is needed as a mobile reader. Then there is an application that must be installed prior to reading the card so that it could look more real. The following image is the application (Fig. 3):

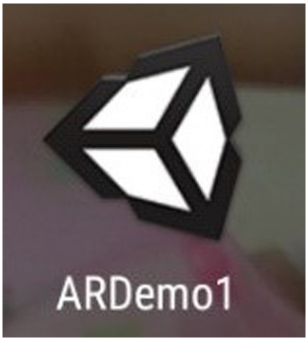

Fig. 3. Application of AR

Application of AR can be installed on the operating system Android. The application used is still in demo version so that the results in the form of new pictures get has not been able to produce sounds and writings. AR was developed by the author for easier to educators in delivering material regarding the introduction of the animals to the learners.

4 Conclusion

The technology of AR can be used as an alternate to develop modern materials at this time. AR or augmented reality can be used to support the learning process of learners and to improve the thinking ability of students to understand materials especially the introduction of the animals. Learners and educators must have a mobile phone to run applications as well as scan objects contained on the card. Objects that are generated at the card can strengthen the imagination of learners in knowing and understanding the content of the material presented. The use of the AR this can give freedom to students in learning independently. AR use to be static or could not be moved now into a product that is in great demand mainly to increase interest in reading learners by displaying objects that look real.

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