GOLD: Global Organization aLignment and Decision - Towards the Hierarchical Integration of Heterogeneous Business Models

Barbara Steffen[1] and Steve Boßelmann[2(✉)]

[1] Rotterdam School of Management, Rotterdam, Netherlands
barbarasteffen@gmx.net
[2] TU Dortmund University, Dortmund, Germany
steve.bosselmann@cs.tu-dortmund.de

Abstract. The so-called fourth industrial revolution (Industry 4.0) is changing the landscape in the manufacturing industry. Although recognized as an essential factor to preserve competitiveness, organizations are still figuring out drivers, enablers and barriers as well as suitable business models to pave the way for innovations in fields such as highly customized products or exponential technologies. The central challenge for a successful adoption of Industry 4.0 is not primarily the required technology, but the emergence and aggregation of a common view and sound models focusing on paramount aspects like quality, customer perception and margins. We argue that available solutions for modeling business strategies fail at providing sufficient guidance for organizations in analyzing opportunities and driving innovations due to their narrow nature as well as missing combination and aggregation possibilities. In contrast, we outline a multi-perspective framework to support organizations in analyzing their context at multiple levels and discuss technological requirements as well as challenges for the development of modeling tools that support hierarchical integration of analyses and models as well as different perspectives to converge on an organization-wide aligned business strategy.

Keywords: Global organization alignment & decision framework
Global organization alignment & decision tool
Hierarchical integration of heterogeneous business models
Multi-level business modeling · Industry 4.0 context · B-2-B market

1 Introduction

Today SMEs in the manufacturing industry serving the global B-2-B market while producing in western countries (in the following addressed as SMEs) are trapped. First, "increased competition due to globalization and therefore increased commoditization of products" [20] necessitates that SMEs fully satisfy

T. Margaria and B. Steffen (Eds.): ISoLA 2018, LNCS 11247, pp. 504–527, 2018.
https://doi.org/10.1007/978-3-030-03427-6_37

the customers' needs and differentiate themselves from their price-driven competition. As superior quality and increased productivity measures are not enough they are forced to find novel ways to the balancing problem of economies of scale and scope [2]. Second, they cannot handle the steadily increasing complexity of their products and supply chains due to their customers' rising demands [9]. Especially, the integral quality constraint i.e., the requirement that the newly bought equipment must adhere to the existing infrastructure, processes, and products already in place [21] characterizes most deals in the B-2-B market and asks for invasive product or machine modifications.

To survive in this complex setting SMEs have to offer single unit customizations or solutions as standardized or mass customized offers fail to adequately meet the individual customer expectations [11]. Evanschitzky et al. [8] defined solutions as "individualized offers for complex customer problems (...) whose components offer an integrative added value by combining products and/or services so that the value is more than the sum of its components". Solutions make it possible to offer a 'worry-free' customizable mix of products and services that fully satisfy the customer's specific needs. In this context the supplier is highly dependent on the customer and enters specific investments prior to the transaction. This supplier-side burden due to the exploding diversity of the effective product portfolio leaves only low profit margins in comparison to the incurred additional effort [13]. For the suppliers this means handling more product and machine variations in smaller lot sizes, which significantly decreases the standardization potential and positive scalability effects. Thus, it is not surprising that these invasive single piece customizations/solutions typically only benefit the customer directly, while the supplier faces major cost and effort investments which can be hardly compensated with the indirectly gained advantages [12].

To stay competitive in the manufacturing industries, e.g., automotive, product and plant industry, Industry 4.0 acts as essential enabler to make this diversification economically worthwhile [2]. This is further confirmed by the observation that Industry 4.0 is currently moving from a 'Schrittmacherkonzept' (pace maker concept) to a 'Schlüsselkonzept' (key concept) [10]. In other words, it advances from a movement one can invest in to gain competitive advantage to a movement one has to invest in to prevent suffering e.g. severe competitive disadvantages.

Typical definitions of Industry 4.0 are rather vague, like the following two: Industry 4.0 is "the comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the internet with conventional industry" by Angela Merkel, the German Chancellor [4], and Industry 4.0 is "the introduction of Internet technologies into industry" by Drath and Horch [6]. Common to both definitions is the underlying implication that the novel aspect of Industry 4.0 is not so much the technology itself, but rather that it combines existing technologies in a new way.

Currently, there is no common understanding of the final impact Industry 4.0 will have nor in which directions the organizations must transform. It is predicted that the Industry 4.0 wave creates "disruptive technologies [...] [which] will enable productivity gains and new business models, and fundamentally alter

the competitive landscape" [5]. SMEs are confronted with many opportunities accompanied by challenges and risks, e.g. extensive investments and invasive changes. However, the biggest risk is to ignore the need for change as it will eventually wipe them out of the market [3]. Thus, the overwhelmed SMEs have to find their strategy in the uncertain context surrounding Industry 4.0. Today, this often leads SMEs to pursue rather incremental adaptations with apparently limited risk, which is itself rather risky: the SMEs may miss out on major business opportunities that could provide competitors with unfair advantages and thereby endanger their own market position. Thus, it is business critical for SMEs to take informed decisions and to establish a winning path that exploits the Industry 4.0 hype. The difficulty of this task lies in the required alignment of the mindsets of the disparate stakeholders involved, in particular experts in manufacturing, business, and IT, to deliver competitive Industry 4.0 business models.

In addition, especially SMEs as compared to OEMs struggle considerably with successfully adapting the applications and technologies offered by Industry 4.0 as they miss the resources and manpower to experiment with ideas and opportunities that go beyond their existing products and processes. This lack disqualifies them from becoming early adopters, as they cannot risk investing into potentially failing emerging technologies [9]. Thus, the concrete pressing question is how to reap the benefits without incurring too large risks.

The successful adoption of Industry 4.0 asks organizations to rethink their strategy and requires a comprehensive top-down driven corporate transformation. The top-management will have to set a new direction, translate it into a vision of the future organization, and guide a consistent and aligned organization-wide implementation. Here, organizations are missing clear strategic directions, and a vision for a value-driven business model which has the potential to establish a competitive advantage. This underlines the demand-pull for a strategic framework that guides the organizations' decision-making process to make the right decisions regarding which Industry 4.0 topic to address and how to stepwise implement it.

Several frameworks and tools already support business analysis and business modeling from various individual perspectives. However, to our knowledge none of such frameworks and tools try to establish a coherent multi-perspective decision making support, and the corresponding available tools, like the Business Model Canvas (BMC) [19], hardly provide any sophisticated guidance.

This paper aims at introducing the concept of a multi-perspective, interactive framework which shall support organizations in analyzing their context and provide them with an initial prototypical navigation tool that directs them through the nontransparent Industry 4.0 landscape along their path to developing a context specific and fitting organizational strategy. This framework, called the GOLD Framework for Global Organization aLignment and Decision, aims at the analysis of an organization's situation in a top-down fashion, uncovering several opportunities and strategic directions while ensuring that no relevant business or technical aspects are neglected or analyzed in a wrong way. The

motivation for GOLD arose in a case study for which the first prototype was developed. In this case study we concretized the requirements and tested the GOLD Framework's usability and functionality.

2 Case Study

The case organization is a SME with an international footprint offering products/solutions in different markets and industries. The analysis focused on a niche in the infrastructure monitoring market. This newly addressed market was chosen as pilot project for the SME's Industry 4.0 adoption. Throughout our interviews we heard statements like "the cloud has a major potential, but entering the market is challenging due to the wind park market's conservative nature. No one dares to be the first adopter" as was stated by an Engineering Services Sales Manager. A member of direction of a scientific association for management and consulting added "organizations are paralyzed in the decision-making process. They identified the need to act, but are afraid of the barriers, potentially adopting the wrong technology and failing at a successful implementation, doing more harm than good". This hesitation is not unsubstantiated as a Software developer and PhD Student confirmed that "Industry 4.0 offers many possibilities not yet adopted in the industry. But the possibilities come with risks like increased security challenges".

Thus, this cautious attitude stands for a widespread general 'trap' between risk and opportunity costs in the generally conservative manufacturing industry. Here, the organizations prefer the traditional cost-driven approach over a value-driven approach which inevitably would lead to more radical business model adaptations. The cost-driven approach aims at ensuring a profit contribution with the aim to at least cover all incurred costs. It is customary for business models to get incrementally adapted instead of radically revolutionized. The cost-driven approach promotes technology-pushes as organizations do not need to orientate themselves at the environment and customer needs. Thus, this approach feels safe and familiar, explaining why many competitors went for it. However, this form of Industry 4.0 adoption only buys limited time and does not cover and satisfy the successful adoption of Industry 4.0 in the long run. To stay sustainably competitive organizations must dare taking the risky step of disruptive and radical changes to both the business model and internal processes to fully exploit the potential of the Industry 4.0 transformation.

Unfortunately, the strategic frameworks and models available to managers, as guidance for their thinking and approach, are merely described concepts. So, it is not surprising that SMEs feel left alone without proper guidance explaining the SMEs' traditional approach and stagnation. For example, Porter's Five Forces [7] model shows several dependencies and interdependencies explaining the power relations present in the market. It states that organizations need to be aware of all the different parties involved to make educated decisions regarding their bargaining power, to actually understand their role and possibilities, and eventually to be able to make the right decisions when forming their strategy and

entering business deals. However, Porter's model does not provide any guidance regarding where to get the necessary information from, how to interpret it and how to adapt the organization's strategy accordingly. Further, Porter does not provide any clear guidance regarding how to connect his own different models (e.g. Porter's Five Forces, Porter's Diamond Model and Porter's Value System) to a coherent framework ensuring that the organization considers all important aspects simultaneously. Instead, all these models are rather meant to be thought stimulators. Sadly, this phenomenon of just hinting at 'important' business concepts and aspects without practical guidance applies to most frameworks and models.

However, a systematic strategy analysis is needed for companies and organizations to survive in today's fast developing environments.

2.1 Vision of the GOLD Framework

This paper aims at conceptualizing a comprehensive strategy modelling that comprises the corporate, the business, and the project level together with their inherent interdependencies, and complemented by an ontology-based tool support that actively guides its users through the modelling process. Such active support is particularly important for the proposed multi-level modelling, which by its own nature requires the cooperation of experts of the different levels and in order to globally enforce (dynamically introduced) constraints for guaranteeing overall consistency. The envisioned result is a living multi-level strategy modelling scheme, the GOLD Framework. It incorporates the most important frameworks and models (e.g. Porter's Five Forces, the BMC, and the Value Proposition Canvas) and connects them in a consistent fashion throughout the organization's vertical and horizontal levels. It also aggregates all the requirements and constraints in a comprehensive ontology to provide just-in time modelling support and feedback. It will support both the line of command and the direction of feedback by including cooperative business analyses, aggregating diverse inputs, and guiding the subsequent decision and realization process. As this integrated framework is no longer restricted to the modelling level, it can also support the implementation and operation phases through automatic evaluation and control, e.g. for just in time target-performance comparisons. Of course, these benefits require major organizational changes, and a (meta-) modelling effort that comprises all the involved levels and that imposes some inter-level standardization. The subsequent concrete modelling and implementation for new business scenarios should, however, become much easier and much less error prone. Moreover, if set up adequately, the imposed standardization should not lead to prohibitive constraints. The goal is to derive from a given holistic and consistent strategy a system of level-specific, connected strategy modelling schemes which together cover the intended strategy in a consistent fashion, and therefore form a sound basis for the subsequent strategy implementation.

2.2 The GOLD Tool's Envisioned Functionalities

A first step in the direction of integration and support was made by the Business Model Developer (BMD), a tool inspired by the BMC that offered several advantageous abilities compared to the plain templates [1]. First, it is active, meaning that it can suggest specific modelling entities, restricts the occurrence of possible mistakes and actively supports the process of developing a strategy with recommendations throughout all aspects and levels of the company. Thus, the tool is able to control the user on basis of rule-based regulation. Second, several kinds of links between the fields can be programmed with different meanings, this way drastically increasing its abilities to express dependencies and traceability compared to the original templates. Third, it can be customized to different forms of templates including the original BMC, adapted versions, a mix of them, or completely different models.

The goal is to turn strategy modelling from a business-level activity into a comprehensive process that adequately aligns the required corporate-level, business-level, and project-level activities throughout the entire process of innovation, from the modelling of the ideas to the eventual operation phase. This should be additionally guided by consistency rules and just in time target-performance comparisons.

The envisioned GOLD Tool's main goal is to be holistic, enforce organization-wide alignment and automatically share and provide information/knowledge to allow for educated decisions. It allows the managers in charge to clearly define different kinds of strategy modelling schemes as well as interdependencies both between the fields of a given strategy model as well as between fields of different strategy models. This potential will be further exploited to model the required (multi-level) relationships for expressing consistency rules, target-performance comparisons, and other causal relations useful to provide snapshots for continuous auditing.

The envisaged GOLD Tool with its established transparent global perspective can significantly reduce the risk of misconceptions, communication errors, and failing assumptions by functioning as an early warning system. It also provides the required communication infrastructure to solve revealed problems and support a holistic strategy development.

3 Preliminary Results

In the following, the structure and the use of the GOLD Tool will be explained along the steps managers would take when using it. The pre-suggested structure offers guidance of how to start and how to look at the organization and its environment. It can be adapted if wished, but it ensures that the organization does not necessarily have to start from scratch.

Figure 1 shows the overview of the initial structure of the GOLD models, which embodies a rough vertical abstraction hierarchy of six different levels. The levels depicted from top to bottom describe in diagrams the organization (level 1), the market situation (level 2), an overview of the different industries (level

3), each separate industry (level 4), the industries' target segments (level 5), and their individual target customers (level 6). This hierarchical view is compact yet precise: it summarizes visually the corporate-, business-, and project level of the organization and the business line(s) under discussion. It helps managers orientate themselves by providing a general overview of the organization's different fields of operation while depicting how the different parts are connected.

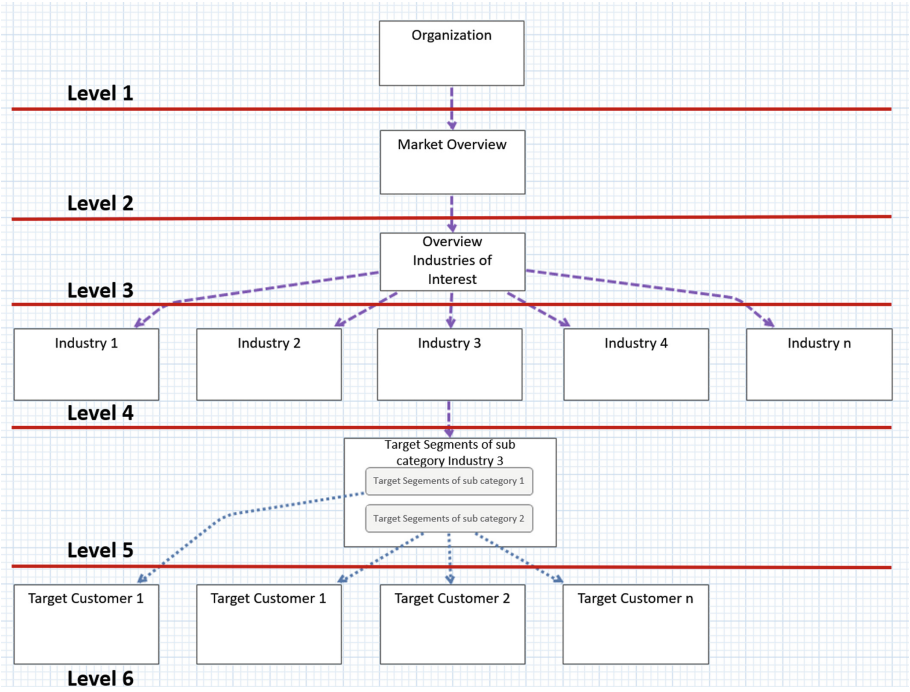

Fig. 1. GOLD tool overview with its 6 levels

3.1 GOLD Tool Application to the Case Study

The general structure of the tool and its diagrams will be described in parallel with its application to the case study, which shows (partially) instantiated diagrams, illustrating its concrete use.

Figure 2 in fact shows the full 6 level model hierarchy for a selection of the diagrams of the case study. Here we see that at each level the diagrams can include one or more purely descriptive fields (like in Level 1, Organization), depicted as light blue components, or also model diagrams, like e.g. the Market description (Level 2), that includes the Organization's main Market diagram, which is the Porter Five Forces diagram of Fig. 3.

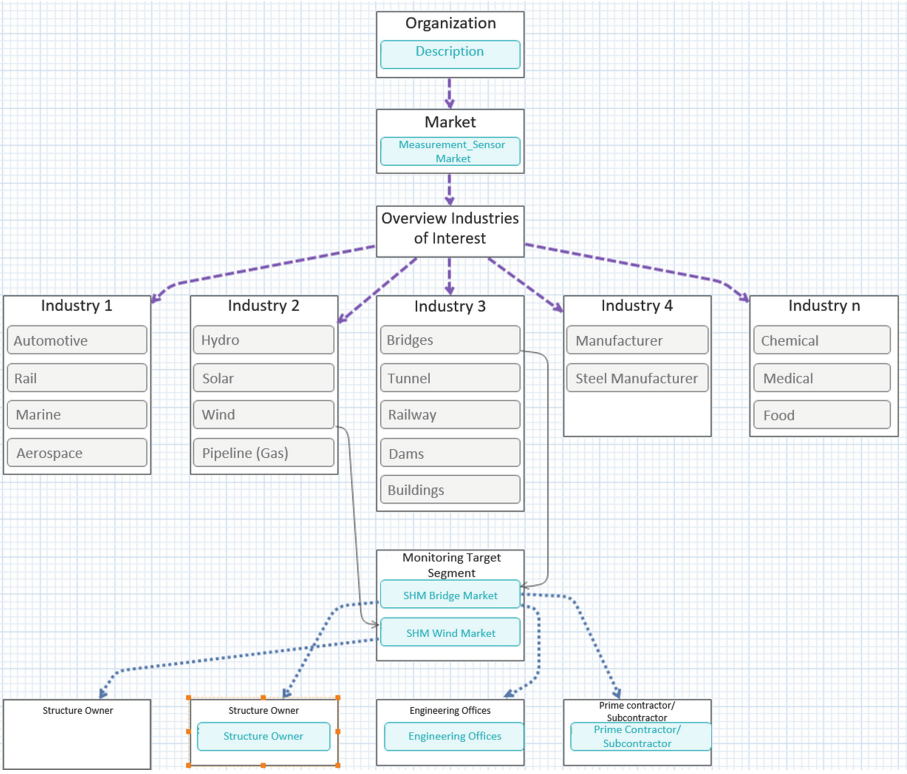

Fig. 2. Case study's 6 levels of the overview hierarchy in the GOLD tool (Color figure online)

Level 3 and 4 are in this case kept completely descriptive: they consist of the Industries of Interest diagram and of a description of each division of this company, matching their Industry categories (here kept anonymously). These are the branches for which this company produces its technologies, components, and systems. Each industry is subdivided in segments as depicted by the Sub-industry depiction.

Level 5 is instantiated in the case study only for the Monitoring Target Systems technology, which concerns Sub-industry C of Industry 2 and Sub-industry A of Industry 3. Both markets are subject to Infrastructure Monitoring, therefore there are specific diagrams for the Infrastructure Monitoring A market and the Infrastructure Monitoring B market.

For each of these markets, there are level 6 refinements concerning the specific target segments to that market. While Fig. 2 only depicts the Structure Owner segment for the Infrastructure Monitoring B market, addressing single owners, it shows three different target customers for the Infrastructure Monitoring A market: again the Structure Owners, but also Engineering Offices and Prime Contractor/Subcontractors, for which individual sub-diagrams exist.

Already this overview level shows how such a hierarchy provides a robust structure, while simultaneously allowing customization in the choice of what to refine and how, e.g. by descriptions or with diagrams, and that it encourages the creation of an ontology capturing the terminology and the relations of the "things" (divisions, markets, technologies, segments, et cetera) that play a significant role in the organization's business and operations structure.

Levels 1 and 2 concern the corporate-level considerations of the organization, levels 3 and 4 describe the business-level of interest in the specific analysis, and levels 5 and 6 detail the project level specifics of the business model under discussion and the units involved in its realization.

Level 1: Organization

In Level 1, the description of the organization contains information on the organization's structure, including e.g. the number and location of its sites, the sites' tasks, the employees in charge of the different operations, its product portfolio and its competitive advantage.

Level 2: Market

On the Market level managers describe the market the organization is operating in. Initially they may limit themselves to those markets relevant to the current analysis (incremental modelling). The high-level market situation is appropriately described in its strategic context by means of Porters' Five Forces diagram. In fact, the Organization's main market(s) tile connects to such a diagram: in the GOLD Tool the navigation to sub-models happens by clicking on the blue tiles that refer to a new connected 'page', in this case Fig. 3.

At modelling time, the manager can simply select the Porter Five Forces tile, drag and drop it onto the canvas at the appropriate level (Level 2 in this case), and rename it to the specific market analysis of concern. By clicking on it, the overview of Porter's Five Forces model appears, showing the empty but structurally correct and complete model. The organization can use this predefined framework and fill it out at need, as shown in Fig. 3. E.g. for the case study the model was instantiated by the experts to reflect the situation of the market it is operating in.

Business-Level: Levels 3 (Industries of Interest) **and 4** (Specific Industry Description).

These levels define the industries the organization is doing business with, before describing specific target segments and target customers in Levels 5 and 6. The same Porter Five Forces diagram template can be used at the single industry level to get a more detailed overview of the organization's different fields of operation.

Obviously, managers may not be interested in filling out all different tiles by themselves and therefore it is envisioned to connect the tool with other tools, like e.g. proper modules of SAP, acting as extensive and important source of organizational and operational information. Further, if the organization has defined information at one 'place', this 'place' can be connected via edges to other 'places' on different 'pages' e.g. depicting different models and frameworks. Thus,

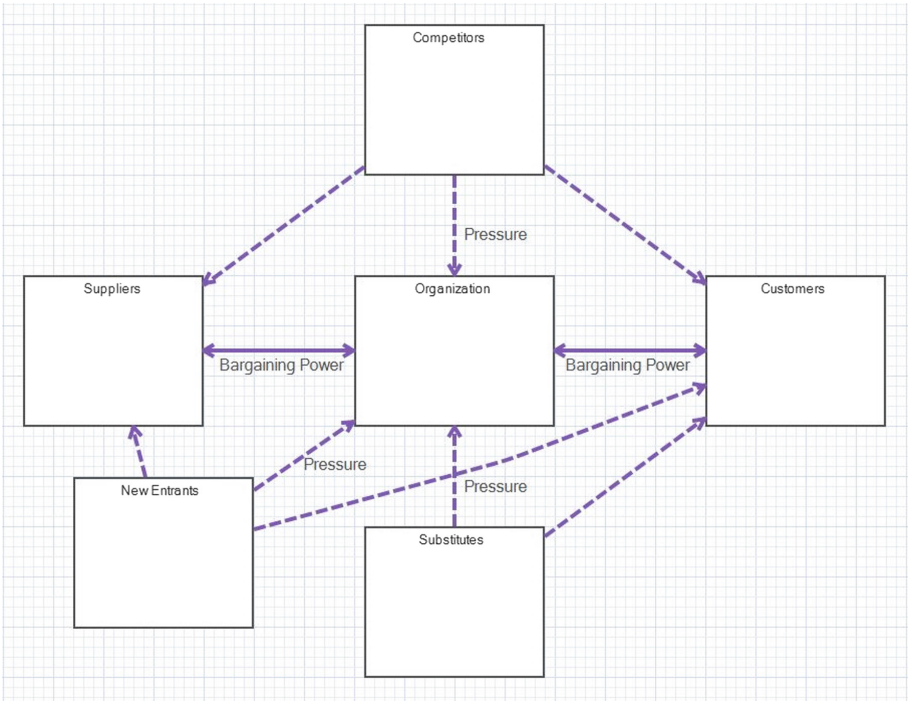

Fig. 3. Porter's five forces - market overview and power division (Color figure online)

among the connected 'places' alignment and up-to-datedness of information can be ensured.

In this case study, the company has simply described the areas in which it is active, basically providing a taxonomy of its broad and detailed areas of activity. For the specific question under consideration the analysis was concentrated on Levels 5 and 6, where we find again a wealth of diagrams.

Level 5: Target Segments

At Level 5, the target segments can be described in several different ways, depending on the kind of analysis and the degree of detail it requires. Here we see the power of the flexibility of the GOLD Framework coupled with the rigour of the GOLD Tool: while the framework provides a harness of top-down hierarchy and a methodology linked to a collection of models and diagrams, the tool manages the freedom to pick and choose the case-appropriate model for the specific analysis at hand. In case of need, it is also possible to design new models, as shown in the case study at this level.

Level 5 is instantiated in the case study only for the Monitoring Target Systems technology, which concerns Sub-industry C of Industry 2 and Sub-industry A of Industry 3. Both markets are subject to Infrastructure Monitoring,

therefore there are specific diagrams for the Infrastructure Monitoring A market and for the Infrastructure B market.

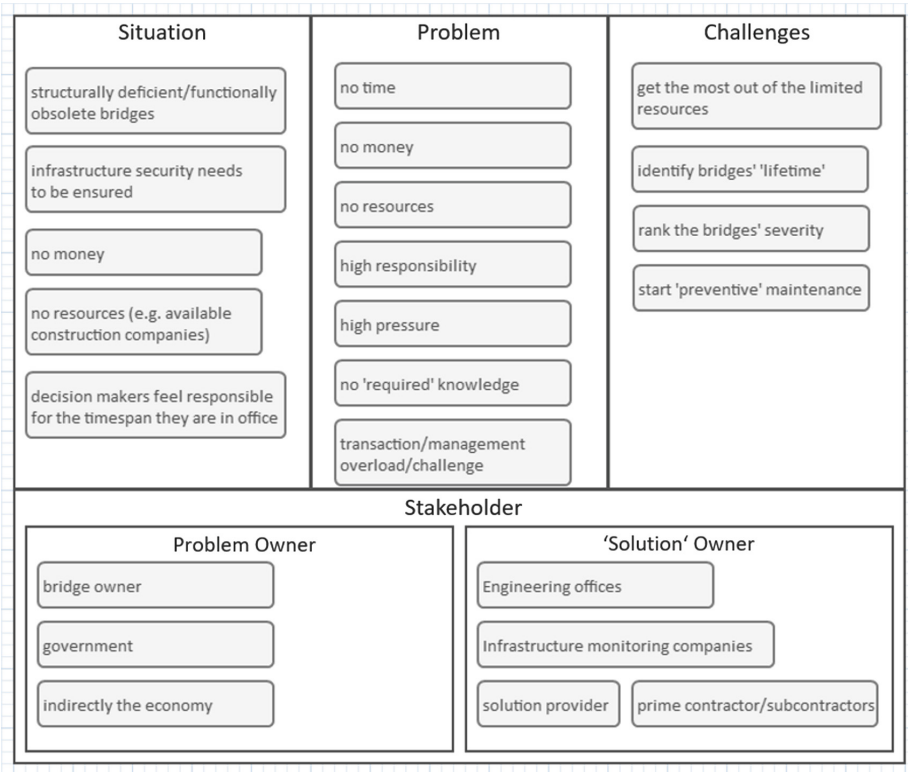

Fig. 4. Case study's infrastructure market overview (custom model type)

The Infrastructure Monitoring market description diagram is shown in Fig. 4. It is a new diagram custom-designed for the case study team. The organization was interested in a situational depiction of the characteristics of this specific market together with the potential opportunities for the company, with the aim of identifying untapped opportunities that may ideally be low hanging fruits or solvable with the use of more advanced IT. Working in a mind-set and layout similar to the various canvas models, the structure of this model arose from the needs discussed with the company experts: its 'What layer' (top) depicts the characteristics of this specific market (fields Situation, Problem and Challenge), and its 'How layer' (bottom) hints at the potential opportunities for the company (fields Problem Owner and Solution Owner). This new canvas model proved very effective in summarizing the necessary information, and useful as a communication basis for discussions with top-management and the engineering groups. The descriptions also contribute to the ontology of the case study.

Level 6: Individual Target Customers

For each of the Level 5 markets there are one or more level 6 refinements concerning the target segments specific to that market. The Infrastructure Monitoring B market consists in this example only of the Structure Owner segment, and it is not further refined. The Infrastructure Monitoring A market is the actual market under detailed analysis, and has multiple segments of target customers: again the Structure Owners, but also Engineering Offices and Prime Contractor/Subcontractors, for which there are individual sub-diagrams. Note that these target customers already appeared as "Solution Owners" in Fig. 4. The segment Infrastructure Monitoring Companies is not further considered as it comprises the company itself and its competitors, none of which is a target.

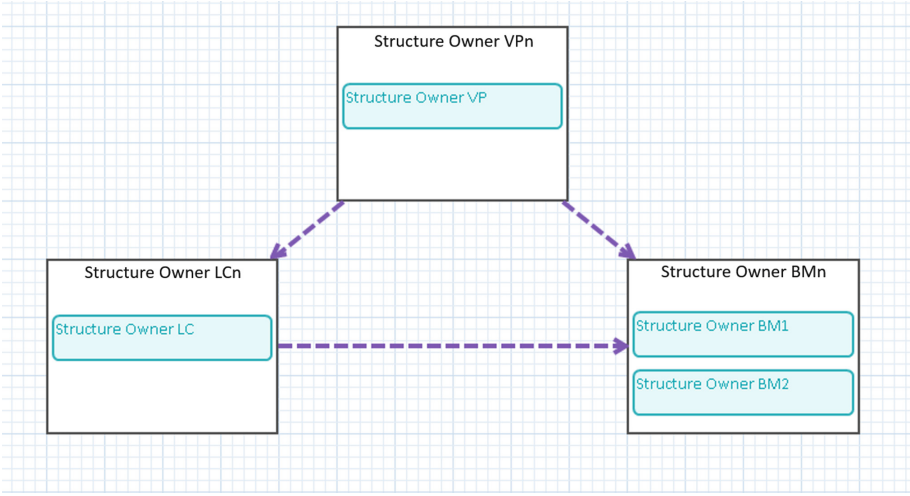

Fig. 5. Overview target customer - infrastructure monitoring a (custom model type) (Color figure online)

When clicking at the blue tile Structure Owner in Fig. 2, the model depicted in Fig. 5 pops up. Figure 5 is another self-created diagram. It provides an overview of the different information the organization possesses on a specific target customer segment, in this case the Infrastructure owners (Structure Owner). It connects information from the Value Proposition Canvas [18] with the Lean Canvas [16] and the BMC, all three materialized in corresponding models.

Figure 6 depicts the Value Proposition Canvas, Fig. 7 shows the corresponding Lean Canvas and Fig. 8 the related BMC. It is suggested to use these three models in this specific order as the Value Proposition Canvas allows for an in-depth understanding of the customers, their problems the organization has to find a fitting solution for, by exploiting its unfair advantage and the specific jobs-to-be-done and the pains and gains customers are experiencing. This information is particularly interesting and crucial for hypothesizing the customers' main problems, which are the starting point for the Lean Canvas. In the Lean

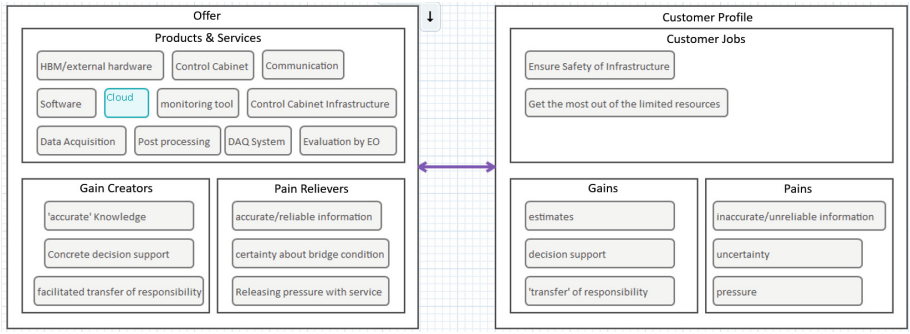

Fig. 6. Value proposition canvas - infrastructure monitoring a - market owners (Color figure online)

Canvas, based on the hypothesized customer problems the organization has to find a fitting solution, by exploiting its unfair advantage and developing a unique value proposition leading to a competitive advantage. Once the Lean Canvas is coherent, it is advised to develop several BMCs.

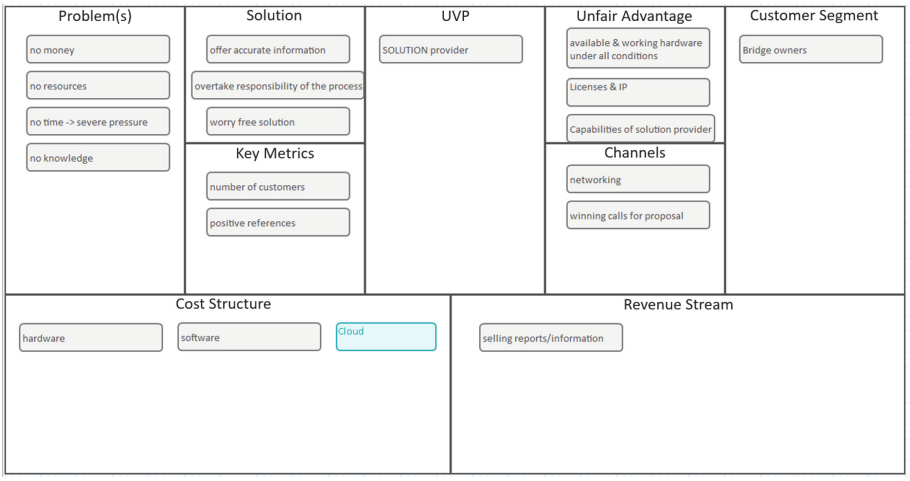

Fig. 7. Lean canvas - infrastructure monitoring a - market owners (Color figure online)

Most fields of the Lean Canvas and BMC are identical, as Maurya used the BMC as foundation for the Lean Canvas. Those fields of the BMCs will be in a future release automatically filled in by the GOLD Tool to ensure that all models of the framework are consistent. All changes made to 'things' that are identical (by copy or links) will be automatically kept aligned tool-wide. Further, the GOLD Tool will guide the user in filling out those frameworks correctly by making concrete suggestions of what to enter, using the ontology harvested in

previous models of the same organization or division. For example, if managers already defined the organization's key partnerships somewhere else, then such entries are re-proposed everywhere where key partnerships need to be defined. This reuse automatically prevents inconsistencies, avoids managing duplicates and ensures by design a higher coherence of the information in the organization's ontology.

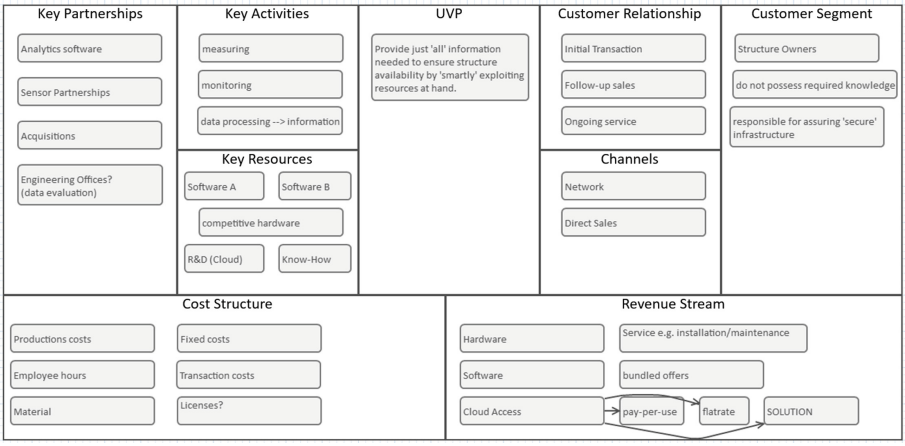

Fig. 8. Business model canvas - infrastructure monitoring a - market owners

3.2 GOLD Tool Outlook

Further, in future it is envisaged that some models will be connected with external tools, e.g. the Lean Canvas and BMC to be connected to cost models in Excel. This integration may allow changes throughout the business model developing process in the cost structure and revenue stream to trigger automatic updates and changes to the financial forecasts of the models. Later, if the organization starts to implement those models the actual data can be entered, this way enabling continuous target-performance comparisons.

The blue tiles represent a special way to ensure consistency: they refer directly to new models and, instantiated or not, they are 'standards' which can be used and re-used on any other page (no reuse is permitted in their own page: there is no self-inclusion of elements).

For example, we see the blue Cloud tile occur in both Figs. 6 and 7: they both open the Product Composition diagram in Fig. 9.

This diagram summarizes the product offerings envisioned by the company's team as a consequence of their analysis. Based on different cloud platforms, on different levels of processor power, storage dimensions, versions of a visualization app, and the possible add-on of an analytics engine, different packaged

products were defined, whereby only the offer on Project-Report-Basis includes the Analytics Software service.

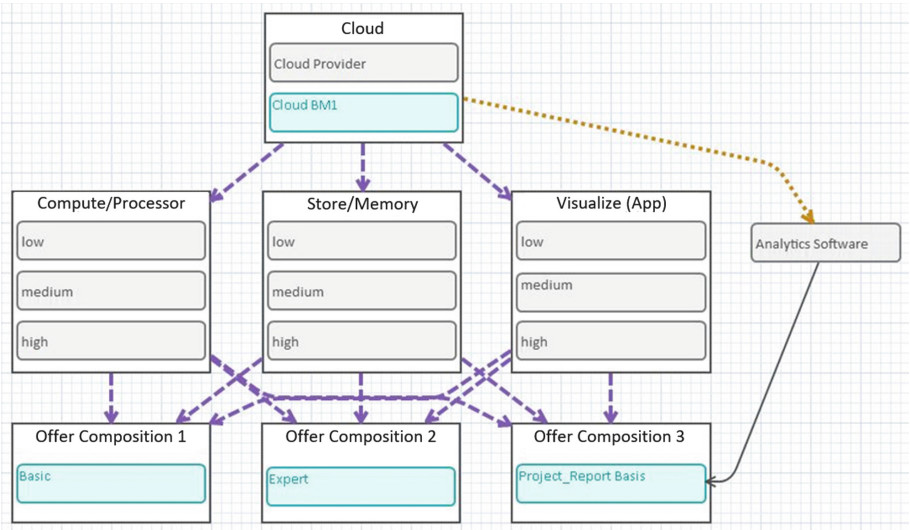

Fig. 9. Case study's cloud idea/service overview (Color figure online)

Over time the GOLD Tool will become a quite extensive analysis suite comprising all of the organization's main information and knowledge. A role-based view will be implemented to prevent overwhelming employees with too much information and/or them getting access to information they do not possess the clearance for. This role-based view approach will provide every employee with access to exactly the information and knowledge needed to perform their tasks. Additionally, it will be possible to show the information at different levels of abstraction, with different levels of aggregation in the reporting. The top-management is mostly just interested in overviews of all the key data of their different branches. They can explore 'the deeper level' of information and knowledge by data drill down, as all data is linked, however they are not distracted by it in first instance. The middle managers will have as default view a constant overview of the business units and projects they are responsible for, while the employees will have direct access to all the 'raw data' with which they work daily.

4 Technical Perspective

The development of a software product to support something as tangible as business modeling touches many aspects. Modeling guidance by means of predefined components and applicable rules are one thing. Being able to apply model

analysis and comparison is another crucial factor, particularly in supporting business model innovation. In this section we focus on the requirements mainly from a technological perspective towards a simplicity-driven, structured approach to domain-specific business modeling that has been conceived to overcome the drawbacks of the mere generic solutions currently available.

The current version of the GOLD tool, i.e. the implementation of a software product supporting the GOLD framework, is developed with the *CINCO SCCE Meta Tooling Framework* [17] that facilitates the development of domain-specific graphical modeling tools in a rigorous model-driven fashion. Following the XMDD paradigm (*Extreme Model-Driven Design*) [15] the development process puts the domain expert (typically a non-programmer) in the center of the development process. Though the GOLD tool is significantly more sophisticated, its development benefits from the achievements made so far with the development of the Business Model Developer [1]. The focus during development lies on simplicity for the user, as the notion of simplicity has been identified as a driving paradigm in information system development [14].

In the following, both the already implemented as well as the envisioned features of the GOLD tool are broken down into specific aspects of tool development.

4.1 Domain-Specific Modeling

Models in general consist of components that represent entities from the respective area of application. In terms of business models these are business-related entities that make up the terminology of the "things" that play a significant role in the organization's business and operations structure. In the following, these "things" will be referred to as "business items". The type of these business items heavily depends on the actual application domain. As an example, business models related to hospitals address very different business items compared to models related to car manufacturing. Although both domains might be served by means of generic components, a domain-specific modeling environment significantly improves the modeling efficiency by serving the respective modeler with well-known concepts, i.e. the terminology they are used to. This typically results in effective support in the creation of meaningful models.

Structure via Taxonomies. Currently, there are virtually no domain-specific solutions that guide the creation of business models for specific business fields or application domains. Instead, available tools pursue a mere generic approach based on unspecific model components. As an example, the actual components to fill the Business Model Canvas are generic notepads that hold textual labels manually created by the modeler. We argue that this is not to be excused by arguments regarding design freedom or boosting creativity. Even the most simple drawing programs provide shapes and powerful editing tools instead of leaving the user with only a freehand tool, a blank canvas and some good advice on how to succeed. We argue that useful components and editing tools rather push

effectiveness instead of limiting creativity and domain-specific solutions in the context of business modeling would cause the same positive effect.

In contrast to a generic approach, we facilitate a domain-specific setup of the modeling environment by means of building a taxonomy of modeling components. This taxonomy is achieved by collecting and characterizing the business items derived from the concepts in the organization's terminology. It can be created and maintained in different ways.

- In a distinct customization step typically preceding the actual model design phase. Different stakeholders with different disciplinary backgrounds might be involved, spanning domain experts, application experts, business strategists, etc.
- Manually in the modeling environment by means of extending and maintaining the taxonomy on demand.
- Automatically, by means of collecting items that are used throughout the different models and presenting them to the modeler in a live-updated view.

The latter option might additionally make use of knowledge discovery techniques and this way may become a very powerful tool, especially if the GOLD framework grows, e.g. towards a multi-user, multi-organization platform. In such an environment the automatic discovery of modeling components can enable reasonable recommendations tailored towards the specific domain to enhance the overall modeling experience. But even a manually maintained taxonomy of business items would mean a huge achievement in enhancing organization-wide knowledge management.

The taxonomy of modeling components, i.e. the outcome of the domain-specific setup, is going to be referred to as the library of "building blocks". That they are well-structured by means of characterization paves the way for many of the envisaged features of the GOLD framework, as this characterization can be interpreted as static types from a programming perspective.

Modeling Guidance. Available solutions in the field of business modeling, both pen-and-paper-based approaches as well as software-based model editors, lack support for the model design process itself. These tools provide a blank canvas to start with but do not convey the required knowledge on how to actually fill it. Step-by-step guides that put design steps in a meaningful order are outsourced to theoretical training courses or not to be found at all. This means an initial hurdle in terms of investment upfront before creating the first model, although many modeling tools have been conceived with brainstorming and innovation in mind. However, attending courses might extend the mindset of the participants but does not add guidance to the modeling tool of choice.

The GOLD tool comes with canvas-specific guidance by means of a wizard that guides through useful, ordered steps to fill the respective canvas in a meaningful manner. We have already introduced this feature with the Business Model Developer on a per-canvas basis. We now envisage to integrate and extend it by means of supporting hierarchical models, thereby relying on the per-canvas solution on each respective hierarchy level.

4.2 Canvas Customization

Besides the tailoring of the modeling environment towards a specific domain by the creation of building blocks the layout of the canvas is another aspect that might be domain-specific. Applying our modeling tool in practice and evaluating the feedback we experienced that business professionals are really interested in re-designing the canvas they work with. Hence, the further development of the GOLD tool introduces custom canvases. This not only allows the user to rename or move specific tiles but also to delete them or invent completely new ones from scratch. As various communities have created custom canvases for specific purposes, already, we provide them with explicit tool support for integrating their ideas to build a comprehensive modeling environment.

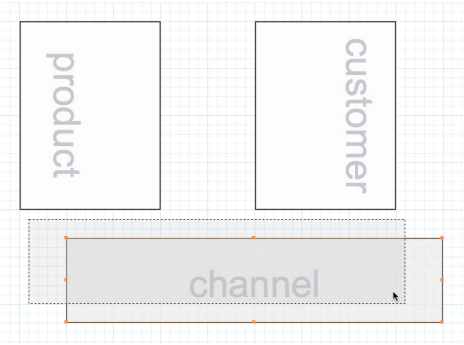

Fig. 10. Tile arrangement for a custom canvas (from [1])

Tile Arrangement. The crafting skills that are needed to build a custom layout are rather little sophisticated as it all comes down to arranging tiles and giving them a name. Therefore, the model editor supports the creation of various shapes, reaching from rectangles over circles or ellipses to complex polygonal shapes (cf. Fig. 12). Figure 10 shows a screenshot of a simple arrangement of tiles in the creation process of a custom canvas layout.

Building a custom layout is an activity that is not typically part of the actual business design process but rather takes place in a preceding customization phase, along with the initial definition of building blocks to create a domain-specific setup. It is more like creating the meta model of a specific canvas to be added to the modeling environment. We might even consider a dedicated role in the overall design process to lead the customization process. However, as there is no specific reason for not adding a custom canvas on demand, the GOLD tool is envisaged to support both possible approaches.

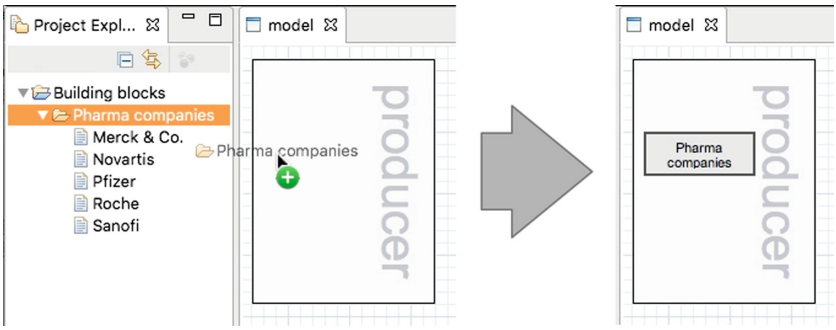

Fig. 11. Definition of containment rules (from [1])

Templating. Having created and properly arranged the tiles to form a custom layout, it will be available for the business modelers to utilize it. However, its creator might be particularly interested in defining what is allowed to be inside each respective tile of the canvas. To do so, they can make use of the structure that arises from the library of building blocks that are part of the domain-specific setup. In order to allow or forbid the usage of specific building blocks, their type (i.e. the classification within the respective taxonomy) can be linked to the specific tiles of the canvas that should be constrained. The editor of the GOLD tool makes this a specifically simple task as the type of building blocks can be dragged to the canvas and dropped on the respective tile. This triggers the creation of a node in the tile that represents this exact type. Figure 11 shows a screenshot with an example, in which a collection of building blocks (in this case companies) is linked to a tile labeled "producer". The created node is interpreted as a containment rule, which specifies that all building blocks inside the referenced collection can be used to fill the respective tile at model design time.

The creation of custom canvases along with the specification of containment rules results in the definition of so-called "templates". This action is typically not part of the actual business model design, but rather takes place in a preceding customization phase. At runtime, the model editor of the GOLD tool is capable of providing a modeling environment based on the template definition. With this, users are able to create business models based on the respective template (generally referred to as "instantiation") and fill the provisioned tiles with building blocks according to the specified containment rules. These rules either become part of the general canvas validation, i.e. error and warning messages are generated in case of rule violation, or they can even be enforced by means of suppressing the creation of forbidden nodes completely. This supports the modeler in two ways, through the enforcement of structural correctness of the models as well as through additional guidance for the modeler by means of validating the model semantics. The latter helps at avoiding models that, even though structurally correct, lack soundness or are just not meaningful.

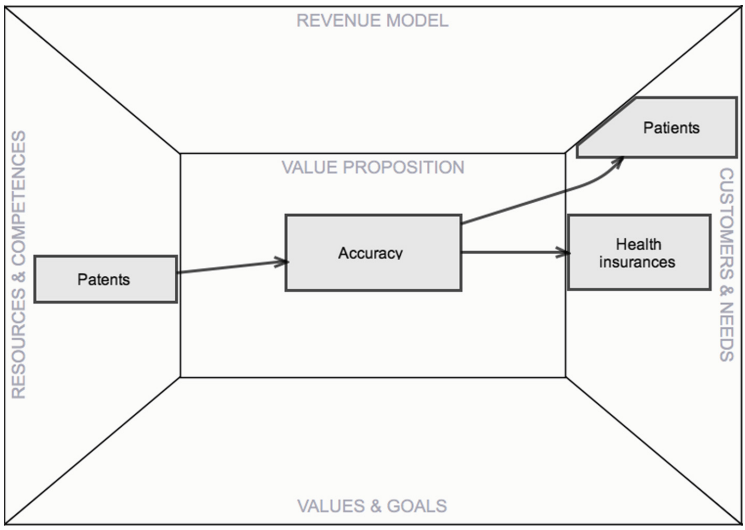

Fig. 12. Example of a custom canvas (from [1])

Scenario Validation. With the overall templating approach, sophisticated canvas layouts can be defined already. Figure 12 shows a layout based on polygonal shapes. However, in terms of constraining the use of the template in terms of how it is to be filled, we have just scratched the surface. We recently established a scenario-based approach with extended containment constraints by means of, for example, cardinalities as well as attribute value checks. Users can link templates with so-called "scenarios" that represent a specific instantiation of the template that is intended to either be enforced or avoided. Scenarios are created using the items as well as their types from available taxonomies, i.e. the library of building blocks.

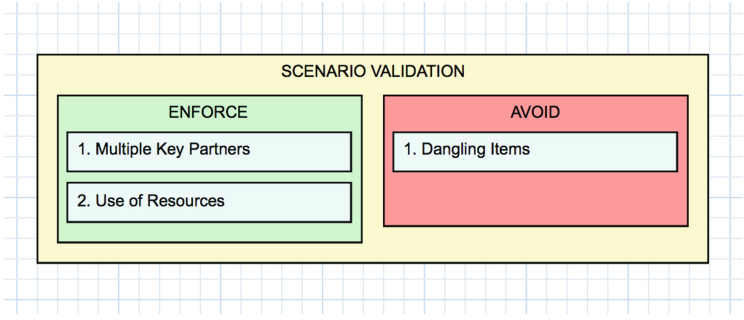

Fig. 13. Scenarios to be enforced or avoided

Figure 13 shows how easy scenarios are linked with a specific template. The graphical model of a template contains a dedicated validation area. This is where those files from the workspace that contain the scenario descriptions are dragged to in order to link it with the current template. Both types of scenarios, those to be enforced as well as those to be avoided, are interpreted as rules to be validated at the runtime of the canvas editor. This means warnings and errors are generated during the design of models based on the respective template in case of rule violation.

4.3 Aggregated Views

As the complexity of the GOLD Tool grows, the integration of the support for different views on the models becomes mandatory. The multi-level approach of the GOLD Framework naturally involves various stakeholders in the design process, each of them having different skills, knowledge, roles and responsibilities within the organization. Some information might only be relevant for a few users, or even for a single user. We strive to integrate the concept of personalized, aggregated views to the GOLD Tool, in multiple variations. On the one hand, the visibility of information and data held by a specific model might be customized towards specific user roles. On the other hand, information from submodels can be collected and displayed in the parent model in an aggregated fashion. Parts of one model might even be filled with information from submodels. However, the data is to be updated in a live fashion as the models evolve. That way, information and data is kept accurate and visualized for those users that really want or need to see it.

The definition of views is facilitated by the rigorously structured approach of the GOLD Tool, based on determined model layouts filled with well-defined building blocks. Additionally, the realization of a model interface concept can help to define exactly which information is provided by a specific type of model to be read externally and used from, for example, parent models. The final step is to integrate a role concept in order to leverage role-based views, up to real personalization.

5 Summary and Outlook

SMEs adopting Industry 4.0 must develop a global organizational strategy paving the way for successful business models. They are struggling to couple their ‘manufacturing’ core competences with the enabling IT technology to a compelling and incontestable unfair advantage that allows for unique value propositions that successfully address the customer segments they are serving (illustrated on the left-hand side of Fig. 14). This silo-driven approach must be bridged internally allowing for a more in-depth customer understanding. The GOLD Framework and Tool are envisioned to guide and support the organization in bridging the gap between the silos of manufacturing, IT and business (see the GOLD Effect shown at the right-hand side of Fig. 14). GOLD’s global

approach of analyzing the external and internal world of the organization in a controlled and ordered manner allows for finding and defining coherent and consistent strategies, processes and business models. It aims at guiding all the involved stakeholders via hierarchical collections of analyses from different perspectives to converge on an organization-wide aligned business strategy. Only with this internally and externally driven orientation and alignment will SMEs be able to master the Industry 4.0 adoption and translate it into a competitive advantage.

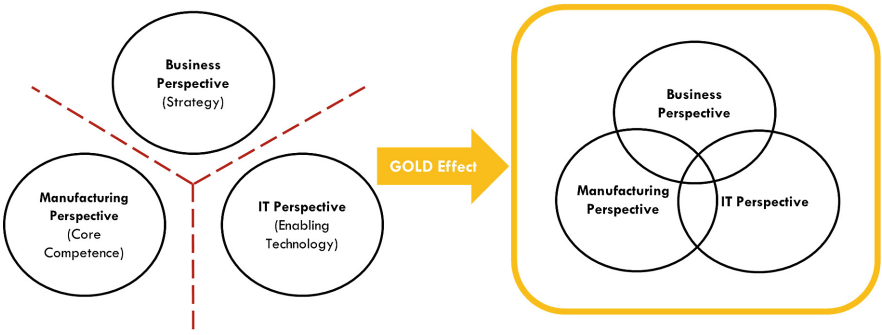

Fig. 14. Envisioned GOLD effect

The impact of the proposed GOLD Framework and Tool has the potential to go far beyond the mere design phase for competitive business models. In fact, once the strategic direction is set, the envisaged GOLD Tool with its established transparent global perspective can significantly reduce the risk of misconceptions, communication errors, and failing assumptions by functioning as an early warning system e.g. based on systematic target-performance comparisons.

To our knowledge the GOLD approach is the first systematic attempt to go beyond the known perspective-specific frameworks and tools to establish a coherent, tool-supported multi-perspective decision support system. In a sense, this is achieved at the meta level, as the GOLD Framework and Tool can be regarded as orchestrators of already existing frameworks as colorfully illustrated in Chap. 3 Preliminary Results. In fact, adequately linking well-known frameworks allowed to aggregate global knowledge for the top-management to take informed decisions regarding the organization's short-term and long-term strategic direction.

The results found in this work clearly show limitations in size, scope and depth, especially regarding the validation of the GOLD Framework and GOLD Tool. This paper explored a global flavor of the current situation in the manufacturing industry in the context of Industry 4.0. This context could be successfully established as a source of knowledge to deduce requirements for the GOLD Framework and GOLD Tool. This broad perspective inevitably leaves room for further investigation in three main dimensions:

– to validate the general need and usability of the framework and tool in small scale proof-of-concepts **(Technology and Industry)**,
– to elaborate on the technological potential via a running prototype implementation and user feedback at several organizations **(Technology and Scale)**.

A careful analysis of this potential requires a fully established setup at some organization and has therefore to wait until an installation at some adequate early adaptor has reached the required state.

References

1. Boßelmann, S., Margaria, T.: Domain-specific business modeling with the business model developer. In: Margaria, T., Steffen, B. (eds.) ISoLA 2014. LNCS, vol. 8803, pp. 545–560. Springer, Heidelberg (2014). https://doi.org/10.1007/978-3-662-45231-8_45
2. Brettel, M., Friederichsen, N., Keller, M., Rosenberg, M.: How virtualization, decentralization and network building change the manufacturing landscape: an industry 4.0 perspective. Int. J. Mech. Aerosp. Ind. Mechatron. Eng. **8**(1), 37–44 (2014)
3. Consulting, C.: Industry 4.0 - the capgemini consulting view - sharpening the picture beyond the hype. Accessed 22 Sept 2018
4. Davies, R.: Industry 4.0 Digitalization for productivity and growth. WGMB GmbH (2017)
5. Digital, M.: Industry 4.0 how to navigate digitization of the manufacturing sector. https://www.mckinsey.com/business-functions/operations/our-insights/industry-four-point-o-how-to-navigae-the-digitization-of-the-manufacturing-sector. Accessed 22 Sept 2018
6. Drath, R., Horch, A.: Industrie 4.0: Hit or hype? [industry forum]. IEEE Ind. Electron. Mag. **8**(2), 56–58 (2014). https://doi.org/10.1109/MIE.2014.2312079
7. E Porter, M.: The five competitive forces that shape strategy **86**, 23–41 (2008)
8. Evanschitzky, H., Wangenheim, F., Woisetschläger, D.: Service & solution innovation: overview and research agenda introduction **40**, 657–660 (2011)
9. Faller, C., Feldmüller, D.: Industry 4.0 learning factory for regional SMEs. Procedia CIRP **32**, 88–91 (2015). https://doi.org/10.1016/j.procir.2015.02.117. 5th Conference on Learning Factories
10. Fink, D., Knoblach, B.: Von disruptiven geschäftsmodellen zur digitalen transformation (2017)
11. Fließ, S.: Kundenintegration, pp. 223–247. Springer Fachmedien Wiesbaden, Wiesbaden (2015). https://doi.org/10.1007/978-3-8349-4681-2
12. Hildebrand, V.G.: Individualisierung als strategische Option der Marktbearbeitung. Deutscher Universitätsverlag, Springer Fachmedien Wiesbaden (1997). https://doi.org/10.1007/978-3-663-01519-2
13. Jacob, F., Kleinaltenkamp, M.: Leistungsindividualisierung und -standardisierung, pp. 601–623. Gabler Verlag, Wiesbaden (2004). https://doi.org/10.1007/978-3-322-91260-2
14. Margaria, T., Steffen, B.: Simplicity as a driver for agile innovation. Computer **43**(6), 90–92 (2010). https://doi.org/10.1109/MC.2010.177
15. Margaria, T., Steffen, B.: Service-orientation: conquering complexity with XMDD. In: Hinchey, M., Coyle, L. (eds.) Conquering Complexity, pp. 217–236. Springer, London (2012). https://doi.org/10.1007/978-1-4471-2297-5

16. Maurya, A.: Running Lean: Iterate from Plan A to a Plan That Works, 2nd edn. O'Reilly Media Inc., Sebastopol (2012)
17. Naujokat, S., Lybecait, M., Kopetzki, D., Steffen, B.: CINCO: a simplicity-driven approach to full generation of domain-specific graphical modeling tools. Softw. Tools Technol. Transf. (2017). https://doi.org/10.1007/s10009-017-0453-6
18. Osterwalder, A., Pigneur, Y., Bernarda, G., Smith, A., Papadakos, T.: Value Proposition Design: How to Create Products and Services Customers Want. Business Planning. Wiley, Hoboken (2014)
19. Osterwalder, A., Pigneur, Y.: Business Model Generation (2013)
20. Sharma, A., Iyer, G.R.: Are pricing policies an impediment to the success of customer solutions? Ind. Mark. Manag. **40**(5), 723–729 (2011). https://doi.org/10.1016/j.indmarman.2011.06.002. Service and Solution Innovation
21. Weiber, R., Ferreira, K.: Transaktions- versus Geschäftsbeziehungsmarketing, pp. 121–146. Springer Fachmedien Wiesbaden, Wiesbaden (2015). https://doi.org/10.1007/978-3-8349-4681-2