Using Enterprise Modeling in Development of New Business Models

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Abstract: In the dynamic world of today, enterprises need to be innovative not only in their current line of products and services, but also in their business models. One of the challenges in Business Model Innovation (BMI) is to introduce radical changes in the current business model when entering new markets. Ideas for new models can come from various sources, however each such idea needs to be analysed from the sustainability and implementation perspectives. This paper evaluates whether enterprise modelling can help in analysis of hypotheses for radical changes of BMI. The evaluation is carried on a particular practice of an organization. Analysis of a new idea has been done using a so-called Fractal Enterprise Model (FEM). FEM ties various enterprise business processes together and connects them to enterprise assets (resources) that are used and/or are managed by the processes. FEM has been used to understand which new assets and processes should be acquired, and which existing ones can be reused when planning the implementation of a new business model.

1 INTRODUCTION

In the dynamic world of today, enterprises need to be innovative. The innovative power, however, cannot be focused only on the current lines of products and services. From time to time, companies need to revise who they are and what they do, which means innovate their Business Models (BM). This is needed in order to survive in the turbulent, technology driven business environment. For example, in the future, a traditional manufacturing company that both designs and manufactures their products may decide that they would better concentrate only on one aspect of their current business. The company then can become a manufacturer who produces goods based on somebody else's design, or a designer – designing goods to be manufactured by somebody else. This was the case in different companies where they changed their business model like LEGO (Robertson and Hjuler, 2009), TSMC (Su and Huang, 2006).

In light of the above, it is not a surprise that the topics of Business Model Generation and Business Model Innovation (BMI) have got attention from both practitioners and researchers. On the practical side, it is expressed by widespread usage of business model canvas (Osterwalder and Pigneur, 2014), and its numerous variations for communication and brainstorming purposes. The interest on the research side expresses itself in numerous research publications devoted to BMI, including books (Andreini and Bettinelli, 2017) and special issues of journals (Mangematin et al., 2017).

Roughly, the BMI process can be divided into two phases (Bider and Perjons, 2017): (I) generating hypotheses – new ideas on how the new BM could look like, and (II) assessing the hypotheses. The latter includes defining what existing resources/capabilities can be used in a new BMI, at what extent, and what needs to be acquired in addition to the existing resources. In this paper, we concentrate on the second phase – analysis, considering that the main idea of a new BM already exists.

Regarding the essence of BMI, we use the classification suggested in (Giesen et al., 2007) that differentiates three ways of innovating a BM:

1. Industry model innovation - which amounts to changing the position in the value chain, entering new markets, and/or other types of radical changes.
2. Revenue model innovation - which results in changes in how a company generates revenues, e.g. reconfiguring offerings and/or introducing new pricing models.
3. Enterprise model innovation – which involves innovating the structure of an enterprise, such as

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enterprise goals, business processes, products and/or services.

In this paper, we focus exclusively on the first type of BMI, i.e. industry model innovation. In addition, we are interested only in such an innovation that relies on the capabilities already existing in the organization. An example of such BMI is the case of Amazon Web Services where existing infrastructure was used to provide services to other organizations; this case was reconstructed in (Bider and Perjons, 2017). In comparison, we do not focus on industrial BMI cases where a new model concerns a completely new business activity, i.e. an activity not connected, whatsoever, with the current ones.

The objective of this paper is to investigate whether an enterprise model can be used for analysis of BMI hypotheses. Here, we try only one enterprise modelling type – Fractal Enterprise Model (FEM) from (Bider et al., 2017), and follow the ideas drafted in a general way in (Bider and Perjons, 2017). The choice of modelling technique is personal, as the first co-author of this work is part of the team engaged in FEM development.

The question will be answered based on applying FEM for analysis of a particular hypothesis generated in an organization. The organization in question is a real company to which the second co-author has been attached for some time.

The hypothesis that we analyse can be formulated as "becoming a provider of services that can predict the needs for maintenance of specific machines used in manufacturing lines". The idea itself is not completely new in nature as it was used by Rolls Royce in TotalCare (Rolls Royce, 2017) where customer responsibilities were taken at supplier end. However, the idea in our case is new in the sense that it may not belong to the core operations of an organization. The idea itself was created independently of current work and FEM. We applied FEM only to understand which existing assets and processes of the organization could be used in a new BM, which new assets and processes need to be added, and what challenges exist on the way of practically implementing the new BM.

The rest of the paper is structure in the following way. In section 2, we give an overview of FEM so that the reader does not need to go elsewhere to obtain this knowledge. In Section 3, we present the business case as it is, including parts that will be used for BMI in the next section. This section presents also a FEM for the important for our consideration part of the business. In Section 4, we present the main idea of BMI and build a FEM for a business-to-be. Then, we analyse the difference between the two FEMs, the current and the new one and discuss what could be used from the existing capabilities and what needs to be created from scratch. In section 5, we summarize our findings and discuss the difference of our approach to new BMs analysis from using the standard BM canvas, and draw plans for the future.

2 OVERVIEW OF FEM

The Fractal Enterprise Model (FEM) includes three types of elements: business processes, assets, and relationships between them, see Fig. 1 in which a fragment of a model is presented. The fragment is related to a business case considered in the next sections. Graphically, a process is represented by an oval; an asset is represented by a rectangle (box), while a relationship between a process and an asset is represented by an arrow. FEM differentiates two types of relationships. One type represents a relationship of a process "using" an asset; in this case, the arrow points from the asset to the process and has a solid line. The other type represents a relationship of a process changing the asset; in this case, the arrow points from the process to the asset and has a dashed line. These two types of relationships allow tying up processes and assets in a directed graph.

In FEM, a label inside an oval names the given process, and a label inside a rectangle names the given asset. Arrows are also labelled to show the types of relationships between the processes and assets. A label on an arrow pointing from an asset to a process identifies the role the given asset plays in the process, for example, *Workforce*, *Infrastructure*, etc. A label on an arrow pointing from a process to an asset identifies the way in which the process affects (i.e. changes) the asset. In FEM, an asset is considered as a pool of entities capable of playing a given role(s) in a given process(es). Labels leading into assets from supporting processes reflect the way the pool is affected, for example, a label *acquire* identifies that the process can/should increase the size of the pool.

Note that the same asset can be used in two different processes playing the same or different roles in them, which is reflected by labels on the corresponding arrows. It is also possible that the same asset can be used for more than one role in the same process; in this case, there can be more than one arrow between the asset and the process, however, with different labels. Similarly, the same process could affect different assets, each in the same or in different ways, which is represented by the corresponding labels on the arrows. Moreover, it is possible that the same process affects the same asset in different ways,

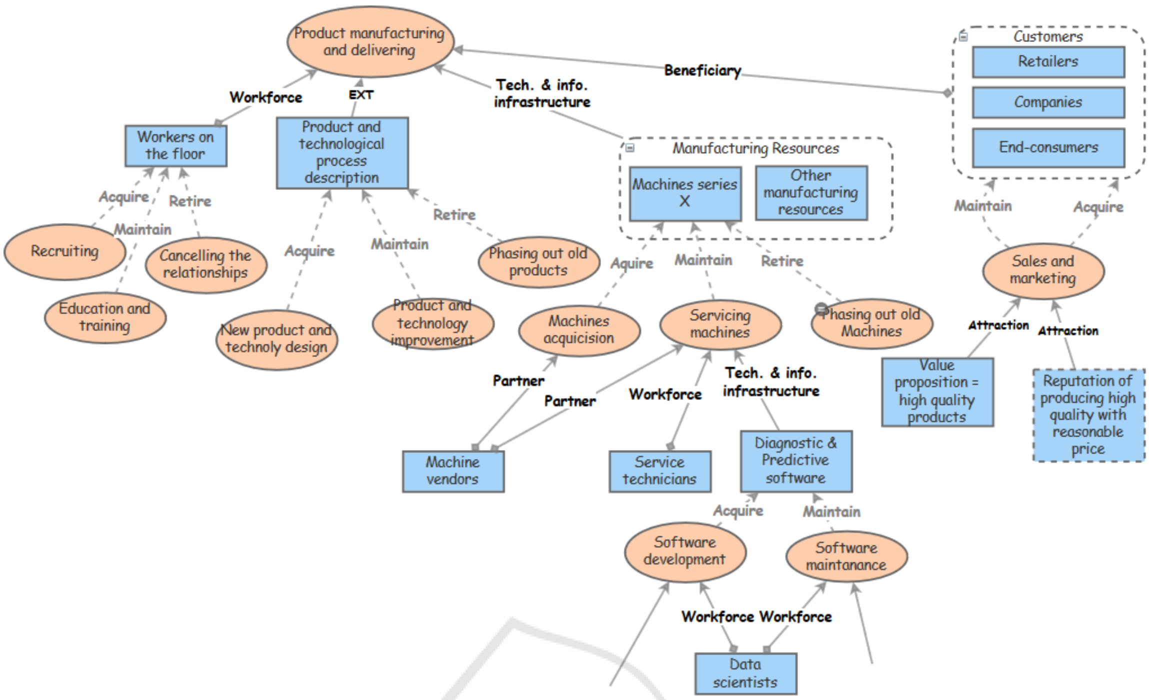

Figure 1: A fragment of FEM.

which is represented by having two or more arrows from the process to the asset, each with its own label.

In FEM, different styles can be used for shapes to group together different kinds of processes, assets, and/or relationships between them. Such styles can include using dashed or double lines, or lines of different thickness, or coloured lines and/or shapes. For example, a diamond start of an arrow from an asset to a process means that the asset is a stakeholder of the process (see the arrows *Workforce* in Fig. 1).

Labels inside ovals, which represent processes, and rectangles, which represent assets, are not standardized. They can be set according to the terminology accepted in the given domain, or be specific for a given organization. Labels on arrows, which represent the relationships between processes and assets, however, can be standardized. This is done by using a relatively abstract set of relationships, like, *workforce*, *acquire*, etc., which are clarified by the domain- and context-specific labels inside ovals and rectangles. Standardization improves the understandability of the models.

While there are a number of types of relationships that show how an asset is used in a process (see example in Fig. 1), there are only three types of relationships that show how an asset is managed by a process – *Acquire*, *Maintain* and *Retire*.

To make the work of building a fractal model more systematic, FEM uses archetypes (or patterns) for fragments from which a particular model can be built. An archetype is a template defined as a fragment of a model where labels inside ovals (processes) and rectangles (assets) are omitted, but arrows are labelled. Instantiating an archetype means putting the fragment inside the model and labelling ovals and rectangles; it is also possible to add elements absent in the archetype, or omit some elements that are present in the archetype.

FEM has two types of archetypes, process-assets archetypes and an asset-processes archetype. A process-assets archetype represents which kind of assets that can be used in a given category of processes. The asset-processes archetype shows which kinds of processes are aimed at changing the given category of assets.

3 BUSINESS CASE

3.1 Overview of the Current State

The case considered in this paper concerns a company that manufactures different lines of products. These products can be bought by companies, retailers or end-consumers for their usage. The company uses different machines for producing the products. In this paper, we focus on a particular machine that will be referred to as Machine X.

Fig. 1 presents a fragment of a fractal enterprise model of the current business activity. In the root of this model is a primary process of manufacturing and delivering products. Underneath of it, there are various assets that are needed for the process working smart-free. Under smart-free, we mean that instances of this process (production batches) are started with normal frequency. As shown in FEM in Fig.1, the process requires variety of assets such as workers on the flour (*Workforce*), manufacturing equipment (*Technical and informational infrastructure*) and customers (*Beneficiary*). Note that the FEM fragment in Fig.1 does not show all assets that are needed to run the primary process, for example, a stock of orders for producing product batches is not presented. The choice of what to present in Fig. 1 has been made based on the most important assets and assets that are of interest for BMI to be considered in the paper.

After the assets of the first level (underneath the primary process) are put in the model, the unfolding of FEM continues by applying the asset-processes archetype, which requires finding processes that manage the identified assets. These processes are connected with the asset(s) by three types of relationships: *Acquire*, *Maintain* and *Retire*. Dependent on the type of assets, the asset managing processes have different nature. For a workforce type of assets, they are hiring, training and retiring. For the infrastructure type of assets, they are acquisition, maintenance, and phasing out. For the execution template (EXT) type of assets, they are develop/design, maintain and phase out.

After the management processes are identified, assets that are needed to run them are identified using process-assets archetypes. For example, the customer asset needs sales and marketing for both acquiring new customers and keeping them attached to the company, so that they continue to add orders to the stock of orders. The equipment asset, e.g. machines X, needs a service/maintenance process (see Fig. 1).

The process of unfolding of FEM can continue by applying the asset-processes archetype for newly identified assets. Thus, marketing and sales requires well-defined value proposition and reputation that backs it (see Fig. 1), as well as other assets (not identified in the figure), like sales executives. Machine X maintenance requires service technicians, machine process experts, machine providers (partners to provide spare parts, advice, etc.) and diagnostic tools. As machine diagnostic and prediction is in the focus of this work, we will look at this topic in more details in the next sub-section.

3.2 Machine Maintenance

In a manufacturing organization, production equipment - machines are very important resources for production. Different Key Performance Indicators (KPIs) related to manufacturing resources are used to ensure the optimal usage of the machines, such as OEE (Overall Equipment Efficiency) defined in ISO standard (ISO, 2014a; ISO, 2014b). A stoppage in production line due to machine failure costs a lot of money for an organization.

In the context of Industry 4.0, maintenance is an important area that has an enormous potential in terms of cost saving and resource efficiency. There are many use cases that come under the category "maintenance 4.0", like automatic maintenance order generation, notifications to stakeholders (users, other machines and mobile devices), predictive maintenance, flexible manufacturing, and support services (augmented reality).

Normally, in an organization, maintenance is counted as an overhead (however, a mandatory one) on the production. In order to avoid unpredictable costs, machines are serviced in regular intervals (sometimes according to manufacturer specifications). However, despite all regular services, sometimes unplanned maintenance also has to be carried out due to failure in machines or loss of quality in operations carried out by the machines. If a particular machine or its part is situated in a critical position in the line, it has a drastic impact on the whole production, as well as on the quality of products delivered to the customers; thus a failure in such an equipment affects the overall KPIs.

In a manufacturing organization, machines are used as long as they fit for the purpose, no matter how old they become. Several kinds of maintenance are carried out to keep the production lines running. These are briefly described below.

1. *Planned Maintenance*. The planned maintenance is carried out according to a specific plan like after completion of certain number of operating hours (e.g. 20,000 hours), or after certain cycles (e.g. 2,000,000 cycles). It is carried out regularly to avoid the unplanned (failure-based) maintenance in order to save costs. However, this planned maintenance is carried out sometime earlier than completion of the operating hours in order to avoid an extra stoppage in production when the production line is stopped for a different reason (like new software updates). However, an earlier planned maintenance affects negatively the costs of production for an organization, as shown in Fig. 2.

2. *Condition-based Maintenance*. In this kind of maintenance, certain machine parameters are actively monitored to get information about the health of the machine and to carry out the appropriate actions (reducing speed, load etc.) before situation gets out of control. This also applies to creating maintenance orders if necessary before a planned or unplanned maintenance (in case of a failure or production stoppage) occur.
3. Unplanned (problem-based) maintenance. In unplanned maintenance, as the name suggests, the maintenance is carried out when a problem occurs. In this case, normally, a notification is sent to the service team and a maintenance order is created in case of failure.

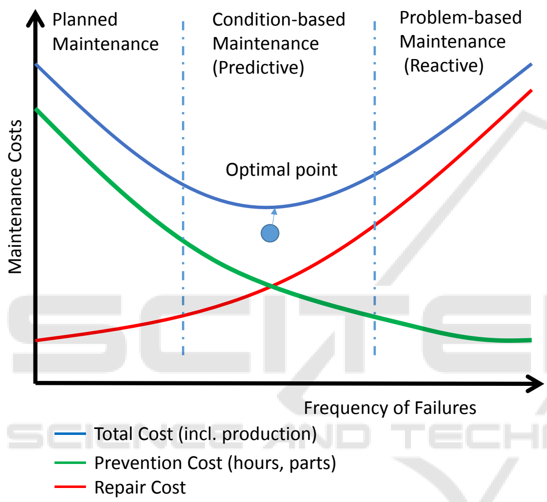

Figure 2: The impact of maintenance on costs; adapted from (Etia et al., 2006).

These three kinds of maintenance are common for all manufacturers. In any kind of maintenance above, in the first place, the internal service team is asked to complete the required service. If they cannot carried out the service, then the external resources are used. The goal of any organization is to avoid unplanned maintenances and run the production as continuously as possible.

3.3 Improving Effectiveness of Maintenance

As was discussed in the previous sub-section, machine maintenance costs, direct and indirect, are quite high. To reduce the cost of maintenance itself, and revenue lost from unexpected breakdowns, organizations look to applying the latest research results in several brunches of Computer Science, e.g. Internet of Things (IoT), data mining, machine learning and Artificial Intelligence, which might improve the maintenance process.

The goal of the project considered in this paper, was to develop a tool able to detect in advance when the machine is about to fail and take out appropriate measures, like appropriate production and maintenance planning. Several sub-goals were defined to achieve the main goal in a stepwise manner. The sub-goals included introducing monitoring the machine status and its parameters, and in case of deviation from the normal behaviour, automatically sending notification to the service technicians. Another sub-goal included analysis of the historical data and identification of the patterns that cause machine failure, and then using these patterns as a basis for predictive maintenance. The main idea of the project sub-goals is represented in graphical form in Fig. 3, which is based on material from (Davenport and Harris, 2007; Eckerson, 2007; Lustig et al., 2010). The direction, the project takes is to handle more complexity and get more business value from the effort.

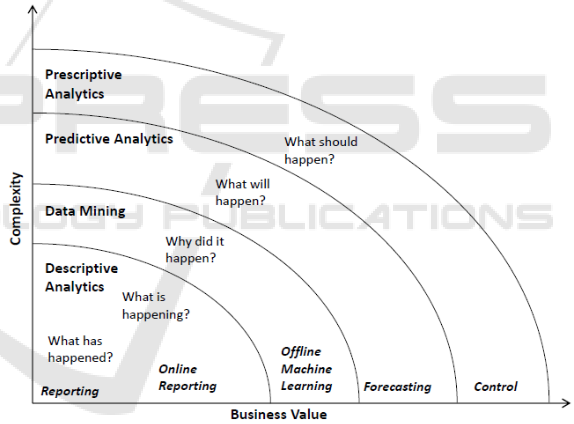

Figure 3: The goals of the project as a diagram.

3.4 Extending the Scope of Usage

The project described in the previous sub-section was started in one plant of the organization having a technical goal in mind, i.e. improving the maintenance effectiveness at this plant. However, when under the way, the project spawned the discussion of extending the scope of the usage of its results beyond the given plant and even beyond the whole company. This is understandable considering the costs of the project and the needs of establishing a permanent team that would deal with maintaining and further developing the software produced by the project. The latter is represented in Fig. 1 by the sub-tree starting from the asset node *Diagnostic &*

Predictive software. This asset is used as *Technical & Informational infrastructure* for the *Servicing machines* process in Fig. 1.

As any other asset, *Diagnostic & Predictive software* requires its managing processes, two of which, *Acquire* and *Maintain*, are represented in Fig. 1. Continuing unfolding of the FEM structure for the *Diagnostic & Predictive software* node, we will add assets needed for these management processes, such as *Workforce* represented in Fig.1. Furthermore, the *workforce* asset, i.e. *Data Scientists*, needs its own processes of hiring and training, etc.

As follows from the deliberation above, unfolding node *Diagnostic & Predictive software* reveals quite a complex structure that needs to be in place in order to use the results of the project described in Section 3.3 in practice. This explains the desire to extend the goal of the project from just improving the effectiveness of the maintenance in one plant to envisioning new BMs (Business Models) that could generate additional revenues for the company. The current discussion of extending the scope of usage ranges from providing maintenance services to other plants of the firm (remotely) to creating a separate business of licencing the diagnostic software to external companies. The latter example would be exploited in the next section.

4 ANALYZING A NEW BM

The most radical suggestion for a new business model based on the project was to open a new business of licensing diagnostic software to other manufacturers that uses the same type of machines, including the firm's competitors. To analyse the feasibility of introducing this BM, we drafted basic FEM model related to the new BM as presented in Fig. 4.

The primary process for the new BM becomes *Licensing of Predictive Software*. It needs certain assets to ensure that this process functions smart-free. The central asset for this process is *Diagnostic & Predictive Software* promoted from the old BM; in Fig. 4, the whole tree related to this asset is moved from FEM in Fig. 1. This asset serves as *Technical & information infrastructure* for the main process. Besides this asset, other assets are needed, in particular *Workforce* (*Installation & Configuration Engineers*) and *Beneficiary* (customers).

While comparing the beneficiary/customer assets in Fig. 1 and Fig. 4, it becomes clear that these two assets are completely different. In Fig. 1, the asset customers has nothing to do with manufacturing, in difference to Fig. 4. This difference becomes clearer if we compare value propositions for both processes. The difference means that a completely new set of managing processes need to be added to manage the new kind of customers. Two of such processes, *Sales and marketing* and *Customer support* are presented in Fig. 4. These processes and assets for them need to be developed separately from *Sales and marketing* in the current BM.

To analyse which other existing assets could be used in the new BM, we put two FEM fragments from Fig. 1 and Fig. 4 side by side, see Fig. 5, and continue deliberation. To start with, we can decide that service technicians can serve as installation and configuration engineers on one hand and as customer support staff

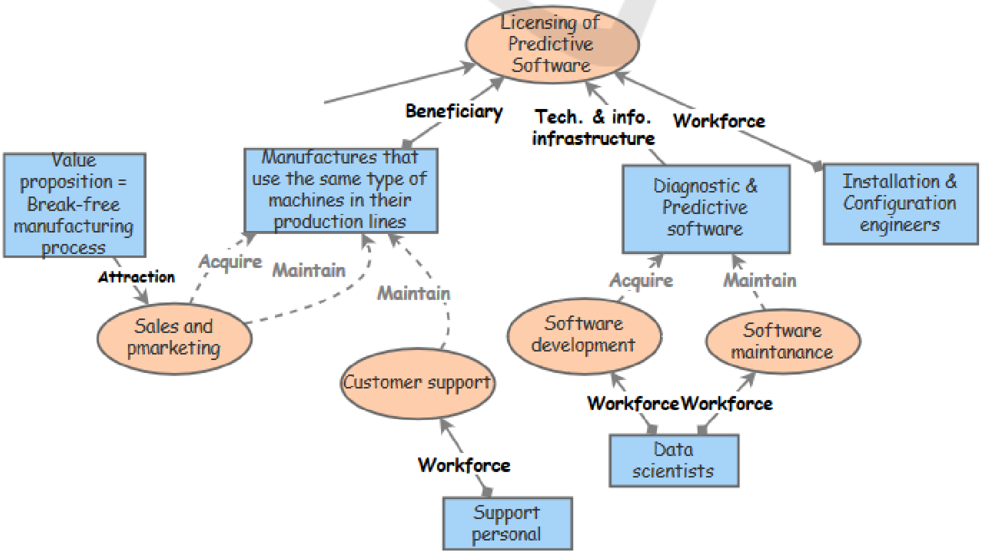

Figure 4: A FEM fragment for the new BM.

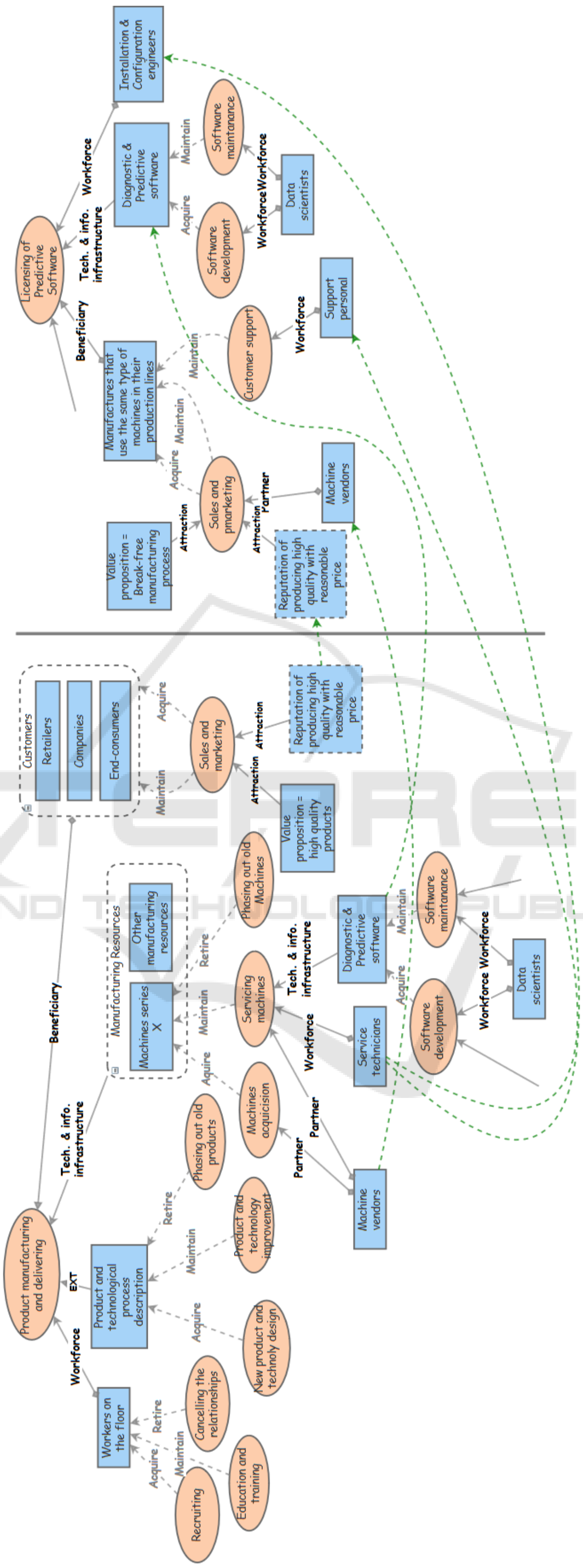

Figure 5: Comparing two FEM fragments.

on the other hand, which is shown by green arrow lines drawn between these assets in Fig 5. The experience of the service technicians in using the software would enable them to function in another capacity as well. However, this may help only in the beginning, if the new BM starts producing more customers, more *Workforce* will need to be hired.

The next step would be to use existing reputation on high-level quality as an attraction in the new BM. As many of the new customers will belong to the company's competitors, this reputation can be used in advertising by pointing out that the software to be licensed is used internally in the organization. This gives us a possibility to move asset *Reputation of producing high quality with reasonable price* to the new fragment of FEM in Fig. 5 and connect it with the one in the old FEM fragment with a green arrow line.

In the next step, we can consider using the machine vendor as a partner for sales and marketing activities, as the vendor has access to all companies who use the machine. In Fig. 5, the machine vendor is moved to the new FEM fragment and connected to the one in the old FEM fragment with a green arrow line.

The analysis above shows that some existing assets could be used in a new BM, however, introducing it still requires considerable efforts, e.g. in creating different kind of sales and marketing, and support, as well as increasing the size of some existing assets. The latter will mean increasing the capacity of the processes that manage these assets, e.g. hiring and training new members of staff.

5 CONCLUSION

As follows from Section 1, the stated goal of this paper was to investigate whether an enterprise model could help in analysing new BM hypothesis. The fractal enterprise model (Bider et al., 2017) was chosen for testing; the test itself followed the guidelines from (Bider and Perjons, 2017). The main difference from discussion in (Bider and Perjons, 2017) and this work is that the former considered a hypothetical scenario, while this work considers a real business scenario. Another difference is that the main asset chosen for building a new business (*Diagnostic software*) is positioned on a much deeper level of the FEM structure compared to the example in (Bider et al., 2017).

The discussion in Section 4 demonstrates that using FEM helps to detect which assets are needed for introducing a new BM, and which ones could be reused from the old BM. As the central asset of a new BMI is positioned quite deep in the FEM structure, using a standard BM canvas (Osterwalder and Pigneur, 2014) would not be possible. Most of the assets that could be reused in the new BM would be outside the scope of the BM canvas, thus making it difficult to use the canvas for deliberation.

Note that our example shows FEM advantages only for the implementation phase of a new BM. It does not help much in investigating whether a new service or product will be accepted in the market place. Other means need to be employed that can include Business Model Canvas, SWOT, etc. This is a limitation of FEM in relation to the BMI tasks.

The next step in this particular project would be to deepen the analysis completed in Section 4, e.g. by quantifying the parameters of introducing the new model, e.g. calculating the size of assets and capacity of processes to be introduced, at least in the beginning. Another direction is to present the analysis to the company management and get feedback. As far as more general goal is concerned, we are working to find other examples to test the idea of using enterprise modelling in BMI.

In this, and previous examples of applying FEM for practical tasks, we used *InsightMaker* (Give Team, 2014) for drawing models. Though this tool is not designed for FEM, it was sufficient for our cases. For more broad use, however, a more suitable tool should be found. Several alternatives are being explored right now for solving this problem. One is developing a specialized tool, for example, based on the *ADOxx* meta-tool (ADOxx.org, 2017). This alternative has an advantage in that it will allow including special means for generating new BM hypothesis from transformational patterns (Bider and Perjons, 2018), and for their analysis. Another alternative would be using some general diagramming tool, like *Archimate*.

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