Does Fractal Enterprise Model Fit Operational Decision Making?

Victoria Klyukina[1], Ilia Bider[1,2] and Erik Perjons[1]
[1]DSV, Stockholm University, Stockholm, Sweden
[2]ICS, Tartu University, Tartu, Estonia

Keywords: Decision-making, Enterprise Modelling, Fractal Enterprise Model, FEM.

Abstract: The paper reports on testing suitability of using a so-called Fractal Enterprise Model (FEM) in operational decision making. The project in which the testing has been done aimed at identifying areas for cost reduction improvements in a support department of a European branch of an international high-tech concern. The idea was to use modeling of the department's operational activities on the intermediate level of details, just enough to identify the areas that need attention or provide an opportunity for cost reduction. FEM connects enterprise business processes with assets that are used in and are managed by these processes. It also allows to split a process into subprocesses in order to reach an intermediate level of details. The split is done by using a special type of assets called stock, which, for example, could be a stock of orders or a stock of parts to be used in an assembly process. The experience from the project shows that the level of details that has been achieved by using FEM is sufficient to understand the activities being completed by the department and identify possible ways for improvements. Furthermore, two generic patterns that can help to identify some areas of improvement have been established; these can be used in other projects.

1 INTRODUCTION

1.1 Motivation

According to (Hoverstadt, 2013) modern organizations have become so complex that no one in the management of an organization fully understand how it operates. The paper also states that for Enterprise Architecture to be taken seriously, it should provide the business with models that the management understands. As a model always simplify the reality, the type of models to be employed depends on the task at hand. More specifically, it depends on in what type of decision-making the model should be used, and in which decision-making phase. For example, a model that is suitable for a strategy decision, such as suggested in (Hoverstadt & Loh, 2017), might not be suitable for decision-making related to improvement of a particular process.

The need to have different models for different kind of business-related decision-making and their phases requires understanding of which modelling techniques are suitable for building models for these different purposes. There is a range of modelling techniques used in practice, like IDEF0 (NIST, 1993), BPMN (OMG, 2013) or ArchiMate (The open group, 2020), each of them focusing on some aspects of an organization, e.g. processes, resources, goals, while disregarding others. The decision of which technique to use is not always easy to make as the priorities of different stakeholders participating in the decision-making project may differ. For example, the modelers engaged in a project might insist on using a technique with which they are familiar, even if it might not constitute the best fit with the modelling purpose.

In theory, a fit can be checked by analysing whether a modelling technique has concepts important for a particular type of decision making. However, if a modelling technique employs high-level abstract concepts, such test might be positive for any purpose, but it would not guarantee suitability or usefulness for a specific purpose. The final test comes only from using a particular modelling technique in a real decision-making context. As the saying goes "the proof of the pudding is in the eating".

This paper is devoted to answering a particular question of whether a so-called fractal enterprise modelling (FEM) technique (Bider et al., 2017) is suitable for employing in operational decision-making. To answer this question, FEM was used in a business case that gave an opportunity to test this technique for the operational decision-making.

Klyukina, V., Bider, I. and Perjons, E.
Does Fractal Enterprise Model Fit Operational Decision Making?.
DOI: 10.5220/0010407306130624
In *Proceedings of the 23rd International Conference on Enterprise Information Systems (ICEIS 2021) - Volume 2*, pages 613-624
ISBN: 978-989-758-509-8

At the operational level, decisions are related to a short-term planning for the implementation of guidelines set by the upper planning levels, and they concern the preparation of detailed instructions for operational execution (Ayora et al., 2015). Models used in operation research, such as Process Diagrams, Mathematical models and Operational models, are focused on processes as subjects of investigation to capture relevant activities as detailed as they are needed for a particular task (Jacobs et al., 2011; Weske, 2007).

In this work, we concentrate on the operational decisions within the current business model, i.e. decisions that are not connected to changing what, how and for whom an enterprise creates value. Such operational decisions may include streamlining business processes, outsourcing or relocating some parts of the business operation, introducing more efficient/effective methods to complete operational activities, including changing equipment or software systems. Note that the operational decision-making includes various phases, one of which is finding potential areas where improvement can be made to produce the desirable effect. This work concerns only operational decision-making related to this phase.

1.2 Project Overview

The project aimed at investigating opportunities for improvement in an EMEA (i.e. Europe, Middle East and Africa) branch of an international high-tech business concern. The business concern provides test measurement products and related services to other high-tech organizations. The project started by a request from the department director of the internal Business Support and Services (BSS) department whose prime responsibility is sales support and managing supply chain activities. The BSS department is entrusted with the task of relieving sales and service departments from administrative work. Thereby, these departments could concentrate on their core businesses, i.e. increasing sales, and providing efficient high-quality calibration and repair of products. As a result, BSS completes the activities in business processes that belong to other departments, while having no total responsibility for these processes. The staff of the BSS department is distributed across several European countries residing in sales and services headquarters of these countries.

The background of the request that triggered the project is the exposure of EMEA branch to a significant economic decline that requires adjustment of the operational cost. Several alternatives to achieve cost reduction were considered, such as changing responsibility structure or relocating the staff to a lower-wage country. Our task has been to suggest a set of alternatives for organizational changes based on modeling of operational activities of the BSS department. We assumed that modelling of BSS's operational activities on an intermediate level of details would be reasonable for the task, i.e. sufficient for identifying opportunities for improvements. More details, which might be-needed for analysis of the opportunities and implementation of the final decision, could be added later.

Fractal Enterprise Model (FEM) (Bider et al., 2017) has a form of a directed graph with two types of nodes, *processes* and *assets*, where the arrows (edges) from assets to processes show which assets are used in which processes and arrows from processes to assets show which processes help to have specific assets in "healthy" and working order. The arrows are labeled with meta-tags that show in what way a given asset is used, e.g. as *workforce*, *reputation*, *infrastructure*, etc., or in what way a given process helps to have the given assets "in order", i.e. *acquire*, *maintain* or *retire*.

FEM is aimed at showing the relationships between business processes through different types of assets used in the processes. It does not have means for representing individual activities in the process and their detailed sequence as is the custom for the workflow-based notations, e.g. BPMN (OMG, 2013). Nevertheless, FEM allows to represent a business process as a set of subprocesses through using a special type of assets called *stock*. A typical stock asset is a stock of parts that are used in an assembly process. Other examples of stock assets are a list of orders or customer complaints that need to be handled. Hence, a stock asset differs from other types of assets used in a process in it being depleted by instances (runs) of the process. Each process instance consumes one or more entities from the stock, thus the stock needs to be constantly filled with new entities by some other business process(es). The latter process(es) is connected with the stock asset by a relation of type *acquire*. Using *acquire-asset-stock* chain we can connect casually related (sub)processes based on the result from one (sub)process being used in another (sub)process.

The decomposition of the company's business processes into subprocess helped us to identify and understand subprocesses completed by the BSS department. In particular, we could identify which particular subprocesses the BSS department is carrying out within business processes controlled by other departments. These subprocesses could be analyzed without further decomposing them into individual activities.

During the analysis of decompositions, we have identified two patterns of recurring situations that points to areas for potential improvement. One pattern is a subprocess that deals exclusively with virtual information. In such a situation, the members of staff who handle the subprocess have no explicit connection to a physical location, as they can do it from any place on the earth. The handling of the subprocesses could be moved to another location, and even outsourced. This type of situations constitutes our first pattern for identifying opportunities for organizational change that might lead to cost reduction improvements.

Another pattern that has emerged is a subprocess that converts a virtual document from one form into another and includes the usage of a diverse set of IT tools. This situation gives an indication of interoperability issues that require attention. Either the IT tools need to be integrated, or a new integrated IT system should be employed, so that the tasks of manually moving information from one system into another become automated.

Based on the analysis of detailed FEM model, the management was presented with a set of potential areas for improvement, which are currently under consideration. On the whole, our experience of using FEM for analysis of operational activities to identify potential areas for improvement could be considered as positive. We could get the level of detail that is needed for our purpose without diving too deep in how the processes are conducted. We have also identified some patterns of areas for improvement that can be used in other projects of a similar kind. Based on the results achieved in the project, we can give a positive answer to the question posed in Section 1.1 and in the title of this paper.

The rest of the paper is structured in the following way. In Section 2, we give an overview of FEM, so that the reader does not need to look for it in other works. In addition, we position the project inside a wider research program, of which the project is a part. In Section 3, we give an overview of the company and business activities of the support department. In Section 4, we present examples of models that decompose the company's business processes in subprocesses connected via *acquire-asset-stock* chains. In Section 5, we use these models for identifying potential areas of improvement. In Section 6, we summarize our experience and present lessons learned. In Section 7, we discuss our findings. Section 8 includes concluding remarks and areas for future research.

2 BACKGROUND

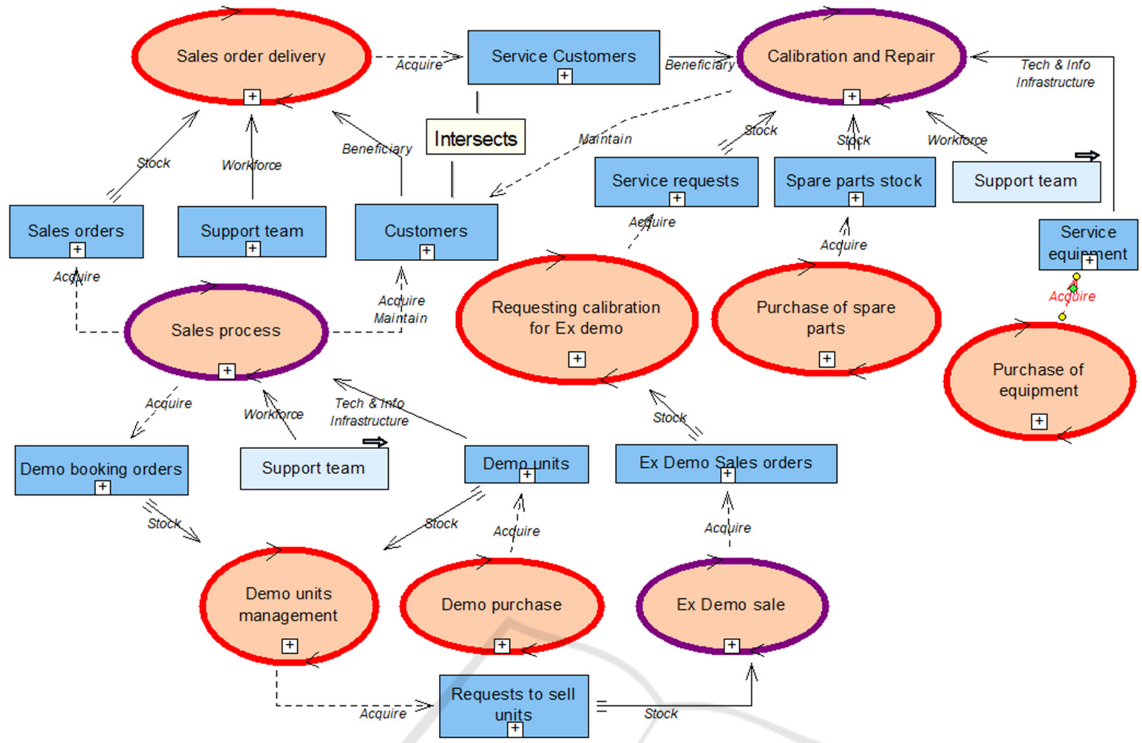
2.1 Overview of FEM

In this section, we repeat the main principles of building Fractal Enterprise Models (FEM) already published in a number of other works, especially in (Bider et al., 2017). FEM includes three types of elements: business processes (more exactly, business process types), assets, and relationships between them, see Fig. 1 in which a fragment of a model is presented. The fragment is related to the business case analyzed in this paper, and it will be explained in detail later. In this section, Fig. 1 is used for illustrating the FEM concepts. Note that processes in FEM can be presented on different levels of granularity. For example, on the highest level the whole company can be presented as one process. In Fig.1, an intermediate level of granularity has been chosen.

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. We differentiate two types of relationships in the fractal model. 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 labeled to show the type 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*, and *infrastructure*. 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 in a given process. Labels leading into assets from processes reflect the way the pool is affected, for example, the label *acquire* identifies that the process can/should increase the pool size.

Note that the same asset can be used in multiple processes playing the same or different roles in them,



Agenda for border coloring: **Red** – BSS is responsible for the process; **Purple** – another department of EMEA is responsible for the process; **Black** - a third party is responsible for the process.

Figure 1: A fragment of a FEM for the business case.

which is reflected by labels on the corresponding arrows. It is also possible that the same asset plays multiple roles in the same process. In this case, several labels can be placed on the arrow between the asset and the process. Similarly, a process could affect multiple assets, each in the same or in different ways, which is represented by the corresponding labels on the arrows. Moreover, it is possible that a single process affects a single asset in multiple ways, which is represented by having two or more labels on the corresponding arrow.

When there are too many arrows leading to the same process or asset, several copies can be created for this process or asset in the diagram. In this case, the shapes for copies have a bleaker color than the original, see asset Support team in Fig. 1 that appears in three places.

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 dashed or double lines, or lines of different thickness, or colored lines and/or shapes. For example, a special start of an arrow notifies that the relation is of the stock type (see the arrows in Fig. 1). Another example of styles used in this project, is the color of borders of processes and assets which identify which department is responsible for each process and asset.

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) are standardized. This is done by using a relatively limited set of abstract relations, such as, *workforce* or *acquire*, 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 describe 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 the kinds of assets that can be used in a given category of processes. The asset-processes archetype shows the kinds of processes that are aimed at changing the given category of assets. The whole FEM graph can be built by alternative application of these two archetypes in a recursive manner representing self-similar patterns on different scales, fractals. The term *fractal* in the name of our modelling technique points to the *recursive* nature of the model

Hereby, we finish a short overview of the standard FEM. The reader who wants to know more about the model and why it is called fractal are referred to (Bider et al., 2017) and the later works related to FEM.

2.2 Research Approach

The research presented in this paper belongs to the Design Science (DS) paradigm (Hevner et al., 2004; Bider et al., 2013), which focuses on looking for generic solutions for problems. These problems could be known, or unknown. The result of a DS research project can be a solution of a problem in terminology of (Bider et al., 2013), or artifact in terminology of (Hevner et al., 2004); alternatively, the result can be in form of "negative knowledge" stating that a certain approach is not appropriate for solving certain kind of problems (Bider et al., 2013). Note that from the knowledge acquisition perspective, it does not really matter whether the answer on the question posed in the previous section would be positive or negative.

This research is part of a broader undertaking connected to FEM. Initially, FEM has been developed as a means for finding all or the majority of the processes that exist in an organization. The result of this research produced more than a solution to the original problem, as FEM includes not only relations between the processes, but produces a map of assets usage and management in the organization. Therefore, it became clear that it would be worthwhile to look for other problems/challenges that could be solved using FEM while extending FEM when necessary. One example of a specific application of FEM is using FEM for business model innovation, which belong to the area of strategic decision-making, see, for example, (Bider & Perjons, 2018).

From the point of view of classification of DS opportunities introduced in (Anderson et al., 2012) and adopted in (Bider et al., 2013), see Fig. 2, we use exaptation (in terminology of (Anderson et al., 2012)) or transfer (in terminology of (Bider et al., 2013)), which amounts to extending the known solutions to new problems, including adapting solutions from the other fields/domains. According to both (Bider et al., 2013) and (Anderson et al., 2012), exaptation provides a research opportunity.

As far as this particular project is concerned, it can be classified as a practitioner reflections project. (Mott, 1996). In this project, the authors functioned as practitioners, i.e. business analysts. The research conclusions when answering the question from Introduction are based on the reflection from own practice.

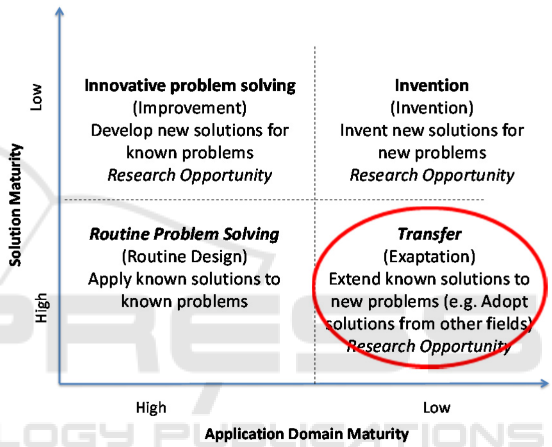


Figure 2: The Application Domain Maturity/Solution Maturity matrix adopted from (Anderson et al., 2012).

3 BUSINESS CASE

Our project has been conducted in an international high-tech business concern. The business concern produces and sells test measurement equipment to their clients, most of which are teleoperators or providers of equipment for teleoperators. The business concern also provides services related to the test measurement equipment. There are three major branches of the global organizations: USA, Asia and EMEA (Europe/Middle East/Africa). These days, EMEA, which has been in the center of our investigation, is challenged by the competitive environment. It has been exposed to a significant economic decline and urgently needs a solution that will help retaining a leading position in the industry. In particular, the question of how to minimize the operational costs

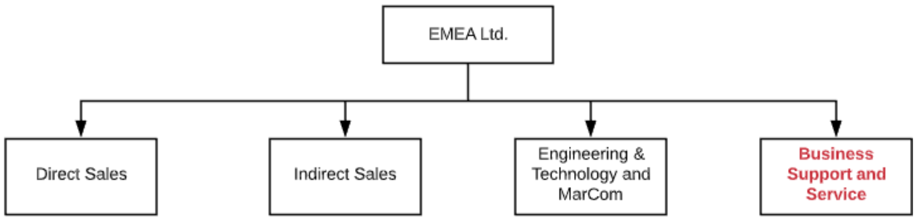


Figure 3: EMEA structure in relation to BSS.

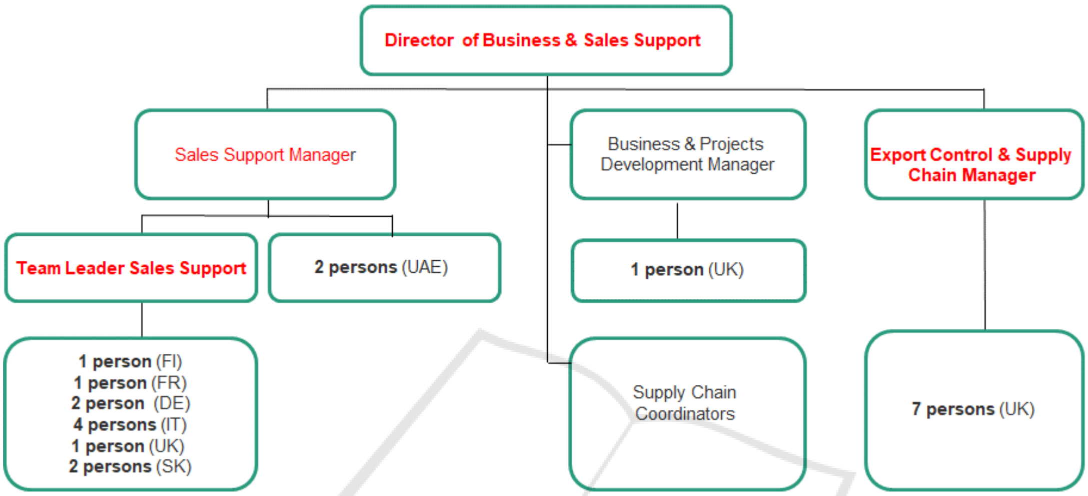


Figure 4: BSS formal organization (from the case documentation).

while maintaining the quality of service of the EMEA Business Support and Service (BSS) department has been raised.

The core activities of EMEA related to our project are presented in the form of four boxes in Fig. 3. The last box is marked with a red font to highlight activities that are entrusted to the BSS department, the department with which we have cooperated during our project. Some examples of activities included in this box, according to EMEA documentation, are as follows:

- Sales and Service Support. This activity is aimed at unloading sales staff and technical service personal from paperwork and other formalities related to the customer orders for equipment and service. It ensures that other departments (i.e. the Sales and the Service departments) can concentrate on their primary activities, e.g. generating customer orders or performing service and calibration. This activity includes Purchasing of products from the factories (see the next activity) and Customer Support as its parts.
- Purchasing. The activity takes care of any purchase within the company, such as products for customers, equipment, spare parts, etc. It includes Export Control and Shipping as its parts.
- Export Control and Shipping (i.e. Supply Chain). This activity is aimed at ensuring export and import compliance with the government regulations and smooth physical movement of products and equipment between relevant parties, e.g. production plants, country offices, customers.
- Demo and Loan. This activity is aimed at supplying sales with demonstration units of company products to be tested by customers, and later can be sold to customer with reduced prices. It includes paper work and Purchasing and Export Control and Shipping as its parts.

The formal organization of BSS is presented in Fig. 4, which also shows that the staff of BSS is distributed through the whole Europe. The red font in Fig 3 identifies managers with whom we cooperated during the project.

Considering the range of activities completed by BSS and their interweaving with the activities of other departments, choosing what to change and the scale of changes have become a challenge for the management team. Our project was started in an attempt to assist their decision-making. Beside the authors of the paper, the BSS director and other key employees of BSS participated in the project. The latter included Export Control and Supply Chain manager, Sales Support manager and team leader. The project lasted over the period of 8 months (September 2019 - April 2020) and included multiple detailed interviews with key persons based on which the models of BSS activities were built.

The goal of the project was to assist the BSS management with operational decision making by suggesting alternatives for restructuring that might lead to cost reduction.

4 UNDERSTANDING BSS ACTIVITIES

4.1 Processes in Which BSS Participates

Fig. 1 presents a partial model of EMEA business activities in which BSS participate. That part includes two primary processes, that is, processes that deliver value to customers, *Sales order delivery* and *Calibration and Repair*, and assets that are needed for the process instances of this processes to run smoothly. In addition, Fig. 1 features a number of management processes aimed at having the assets in order. The most important of these processes is *Sales process* that provides *Sales order delivery* with both new *Customers* and new *Sale orders*. This process in its own turn require assets, one of which is *Demo units,* which are examples of the company products that can be borrowed by customers for testing. These need to be sold after half a year in order to renew the stock of demo units. This is done by a special sales process called *Ex Demo sale*.

Fig.1 uses a special coloring scheme to show for which processes BSS is responsible. The red border means that BSS is responsible for the process that has this border color. The purple border means that some other EMEA department is responsible for the process. The processes in which BSS participate, but might not be responsible for, are identified by asset *Support team* being used in it. As follows from Fig. 1, BSS is responsible for one primary process, *Sales order delivery*, and participates in two other important processes, *Calibration and Repair process* (a primary process), and *Sales process*. Besides, BSS is responsible for many supporting processes, some of them being depicted in Fig. 1.

While Fig. 1 provides a good picture of the diversity of tasks completed by BSS it does not provide a more detailed picture of what BSS does in each process and whether the same kind of tasks are present in many processes in which the BSS staff is engaged on the daily basis. To better understand these issues, we have decomposed many of the EMEA business process into subprocess. The examples of such decompositions will be presented in the next sections.

4.2 Examples of Decomposition of BSS Processes

Fig. 5 presents a simplified FEM model of decomposition of business process *Sales order delivery* from Fig. 1. Simplification has been made to illustrate the idea of decomposition without burdening the reader with too many details. A more detailed model of this process will be presented in the next section.

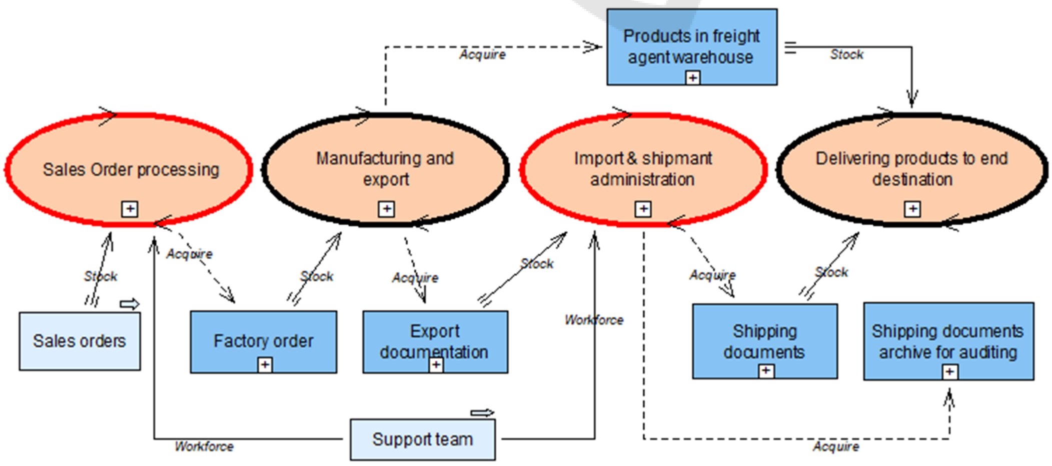
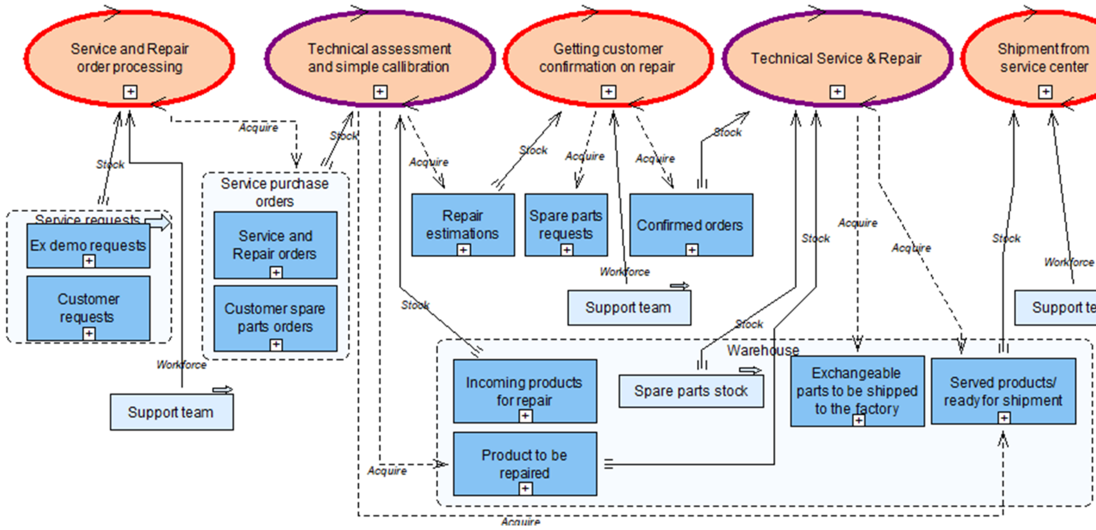


Figure 5: Decomposition of *Sales order delivery.*



Agenda for border coloring: **Red** – BSS is responsible for the process; **Purple** – another department of EMEA is responsible for the process; **Black** - a third party is responsible for the process.

Figure 6: Decomposition of *Calibration and Repair.*

The decomposition features four subprocesses, two of which are handled by BSS – they have red colored borders, while the other two are handled by parties outside EMEA – they have black colored borders (see "Agenda for border coloring" in Fig. 1). The subprocess *Manufacturing and export* is handled by one of the factories of the concern, while *Delivering products to end destination* is handled by a shipping agent. The connection between the subprocesses is done through *acquire-asset-stock* chains. For example, subprocesses *Sales Order processing* and *Manufacturing and export* are connected via the asset *Factory order*, more precisely via the first subprocess *acquiring Factory order* that serve as a *stock* for the second subprocess.

A more complex, but still simplified, model presented in Fig. 6 decomposes process *Calibration and Repair* from Fig. 1. The subprocesses in the model in Fig. 6 are connected to each other in the same way as in Fig. 5. In this model subprocesses for which BSS is responsible (red colored border), are intervened with the subprocesses for which the EMEA product service department is responsible which have purple border coloring.

As we can see from models in Fig. 5 and 6, activities completed by the BSS team are:

- Interwoven with activities completed by others, i.e. other departments or external partners
- Of administrative nature, mostly processing information/documents. The larger part of this information resides in various IT systems, but it can also be in the form of PDF documents sent and received by email.

5 ANALYZING BSS ACTIVITIES

To better understand the business activities of BSS and identify the possible areas for improvement, the models of the type presented in Fig. 5 and 6 were extended by adding more details. In particular, a more detailed information on technical and information infrastructure has been added to the models. This is illustrated in the example of the enhanced model from Fig. 5, part of which is presented in Fig. 7.

In Fig. 7, the subprocess *Sales order processing* is enriched with the groups of assets belonging to *Information sources/Databases* and *IT tools* that are used by the process participants when managing process instances. By visually representing all systems and information sources used in the process, Fig. 7 highlights the complexity of the process of translating entities from the asset *Sales orders* into entities of the asset *Factory orders*.

Databases and other information sources provide such information as prices of products and services, and they also include various types of forms to enable the transformation of a sales order into a factory order. To such sources belong Customer profile form, Customer screening form, Purchase order screening form, Incoterms, Customer credits, Price lists, Quote, etc. First, all documentation related to a factory order is created and shared internally using an IT system called SBO (provided by SAP). Then, these documents must be shared/uploaded into IT systems used in a business concern's production organization, one of which is situated in Japan and another one in US. The Japan production uses systems CP, MXE and R3, and the US production uses systems QAD and Tradesphere. Besides these systems, email and customer portals are often involved in communicating the information related to a factory order.

The primary cause for complexity of this process is the employment of multiple disjoint IT systems, which are not easy to use and which require manually transferring of information from one system into another. Looking at the model in Fig. 7, it becomes clearer why the BSS department has been created in EMEA. Sales people have no time and no desire to learn and handle all this information sources and IT systems. They want to concentrate their efforts at getting new orders and new customers, especially, considering that their salary is based on commission from sales.

The fragment presented in Fig. 7 is repeated with some modification in other BSS processes, such as *Purchase of spare parts* and *Demo purchase* from Fig. 1. To make *Sales order processing* less complex something should be done to eliminate manual operations included in it, especially the ones that consists of manually moving information from one system into another. This can be done by integrating systems employed in the process, in the simplest way by introducing robot integration (e.g. robotic process automation). An alternative could be acquiring one integrated system which is easy to use. In addition, automation of some operations, such as translation of the sales order in a country language into English, could be considered.

A situation presented in Fig. 7 gave rise to a pattern for potential improvement, which was present in several BSS processes. This pattern can be defined in a following manner. If there is a process/subprocess that:

— Converts some virtual information/documents from one form to another without much communication with the external world,

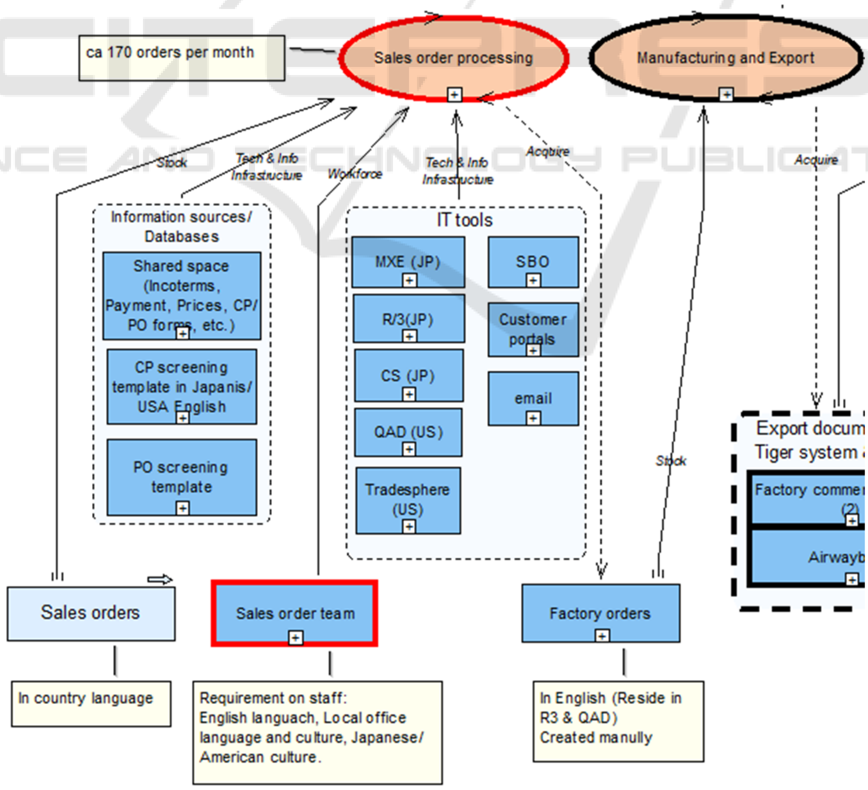


Figure 7: Part of the enhanced model of *Sales order delivery.*

- And it employs a lot of disjoint IT systems and other type of tech and information infrastructure, especially when it is not user friendly and difficult to handle,
- And, possibly, it includes manual movement of information from one system to another,

Then, there is a potential gain to either integrate the systems, or substantially reduce their number while automating manual operations, at least partially, during this process.

For all BSS processes that fitted this pattern, we suggested the BSS management to have a closer look on them and see whether something could be done. For some of such processes BSS has no control, and the suggestions would need a decision on the higher level. For others, BSS could decide on the measures on their own.

Another pattern that could be derived from Fig. 7 concerns the physical placement of the *Sales order team* which is part of the *Support team* from Fig. 1. As we can see from the model, they deal with virtual documents and use IT resources that are available remotely. This means that the team can operate from any location, as long as its members satisfies the requirements listed in the note attached to *Sales order team* in Fig. 7.

For all BSS processes that fitted the second pattern, we suggested the BSS management to have a closer look on them and see whether they would want to relocate the teams.

6 REFLECTIONS

The following lessons could be drawn from our experience regarding the usage of FEM in operational decision-making:

1. FEM is an effective tool for understanding activities performed by a particular business department. For this purpose, modelling starts with drawing of a high-level FEM that includes all processes that the department participates, without showing much of details, as it is done in Fig. 1. Then, the processes in which the department participate are decomposed using *acquire-asset-stock* chains. This method is especially suitable for departments such as BSS, which performed a set of diverse administrative activities.
2. Intermediate level of details obtained via FEM during decomposition seems to be sufficient for identifying areas that need attention and present opportunities for improving efficiency or reducing costs. However, more granulated analysis may be required for assessing the opportunities, and for this purpose, a different modeling technique(s) could be more suitable.
3. FEM is useful for identifying patterns of situations that require attention and present opportunities for improvement. Two such patterns have been identified during the project. One pattern concerns IT integration/automation. The other one concerns physical relocation of teams, and, possibly, outsourcing. We believe that more patterns can be identified in the frame of other projects that have a similar goal to ours.

In the project, we also tested a newly developed tool for FEM modelling implemented using ADOxx toolkit (ADOxx.org, 2017), (Bork et al., 2019). Generally, we were satisfied with the functionality of the tool but encountered some opportunities for enhancements. In particular, it would be beneficial to subclass assets and processes according to various dimensions. For example, assets could be classified in three categories: tangible, intangible and human. Subclasses could have different background and/or border colors. The subclassing needs to be flexible, so that each modeling project could define its own subclasses and its own visual way of presenting them. In the version of the tool we used, it was possible to visualize subclasses, but this required manual adjustment of colors for each asset and/or process.

The subclassing enhancement has been successfully introduced in the next version of the tool, and the tool has been made available for the public (Fractal Enterprise Model, 2020).

7 DISCUSSION

Summarizing our reflections from Section 6, we can give a positive answer to the question posed in Introduction of whether FEM is suitable for employing in operational decision-making. However, we need to add some limitations on the fitness of FEM for operational decision-making. Firstly, the use of FEM was limited to finding areas for potential improvement. When such area is detected, a more detailed investigation needs to be completed to assess the feasibility and costs of the suggested change. To what extent FEM could be useful for such investigation is not clear at this stage. For example, if a detailed analysis of the activities involved in the area is required for decision, then another technique might be more suitable.

The second limitation concerns a different dimension of fitness. Besides being suitable for performing modeling tasks, we need to consider the team engaged in building the model. In our project, the modelers where acquainted with FEM, thus the challenge associated with learning and applying new tool was not present in the project. Based on the lessons learned, we may conclude that for business analysts who have experience of using FEM, this technique could be successfully used in operational decision-making.

What other modelling techniques could be used in the context similar to our project and whether they are more or less suitable for this task than FEM is an open question. Answering it is outside the scope of this paper. As we have mentioned in Section 1, answering such a question usually requires testing of each technique in a real project. Nevertheless, some presumptions can be made based on the logical analysis. For example, business process modelling techniques, such as BPMN, may not be suitable, as they are aimed at depicting details on activities completed and their ordering, rather than depicting all assets (resources) used in a process/subprocess. IDEF0 might also be less suitable than FEM, but in a different way. As it has been shown in (Bider et al., 2019), there are some similarities between FEM and IDFE0 which allow transformation of a FEM model into an IDEF0 model and vice versa. However, IDEF0 can represent less types of assets, and, what is more substantial, it presents them graphically as arrows, which could be difficult to overview and analyse.

Other general enterprise modelling techniques, such as ArchiMate (The open group, 2020), could be suitable, especially for the modelers that have experience of the techniques. Still they need to be tested in an appropriate context, i.e. similar to the one we had in our project to provide with a more definite answer.

8 CONCLUDING REMARKS AND PLANS FOR THE FUTURE

As it was explained in Section 1, the research goal of the project was to test whether FEM can be used in operational decision-making. Besides the research goal, the project has a practical objection to analyse a challenging business situation and produce recommendations. Therefore, the research team was prepared to abandon FEM if it proved not to be suitable for the practical goal.

The possibility of decomposing business processes into subprocesses using *acquire-asset-stock* chains allowed us to proceed with FEM in the project. This possibility has been suggested already in (Bider et al., 2017), but it has never been tested in practice before. Such decomposition should now be considered as useful for certain contexts and goals since it has proved to be useful in the presented project. At the beginning of the research we were overwhelmed with the diversity of the activities performed by BSS. Understanding what the department does and why has been a challenge. Building an overview model, as presented in Fig. 1, and decomposing processes in which BSS participated helped us to comprehend the complexity, and identify patterns of recurrent situations related to the BSS business activities.

Note that the concept of stock used in this work is consistent with the business terminology, e.g. *stock of orders,* and with the usage of the term in other modelling techniques, e.g. System Dynamics (Richardson & Pugh III, 1981), where any kind of reservoir for storage is modelled as a stock.

The project has identified the needs to extend the capabilities of our modeling tool in order to provide a more convenient environment for modelers. Desired features concern easy to grasp visual presentation of decomposition, and classification of assets and processes according to various dimensions. As was mentioned in Section 6, these features have been implemented in the new version of the tool.

Other directions of our work on using FEM in operational decision-making include conducting more case studies, and starting working on a library of patterns, two of which were identified in the project.

ACKNOWLEDGEMENTS

The authors are grateful to the BSS management team who spent a lot of time describing their activities and answering numerous questions. We are also in debts to Dominik Bork who has created the first version of the FEM modeling tool and continues helping us in the further development of the tool.

The work of the second author was partly supported by the Estonian Research Council (grant PRG1226).

REFERENCES

ADOxx.org, 2017. *ADOxx*. [Online] Available at: https://www.adoxx.org [Accessed March 2019].

Anderson, J., Donnellan, B. & Hevner, A.R., 2012. Exploring the Relationship between Design Science Research and Innovation: A Case Study of Innovation at Chevron. In *Communications in Computer and Information Science, 286*. Springer, pp.116-31.

Ayora, C. et al., 2015. VIVACE: A framework for the systematic evaluation of variability support in process-aware information systems. *Information and Software Technology*, 57, pp.248–76.

Bider, I., Johannesson, P. & Perjons, E., 2013. Design science research as movement between individual and generic situation-problem-solution spaces. In Baskerville, R., De Marco, M. & and Spagnoletti, P. *Organizational Systems. An Interdisciplinary Discourse*. Springer. pp.35-61.

Bider, I. & Perjons, E., 2018. Defining Transformational Patterns for Business Model Innovation. In *Perspectives in Business Informatics Research: 17th International Conference, BIR 2018, Stockholm, Sweden, LNBIP*. Springer, pp.81-95.

Bider, I., Perjons, E., Elias, M. & Johannesson, P., 2017. A fractal enterprise model and its application for business development. *SoSyM*, 16(3), pp.663–89.

Bider, I., Perjons, E. & Johannesson, P., 2019. Using Ontologies for Comparing Modeling Techniques: Experience Report. In *Advances in Conceptual Modeling*. Springer, LNSC, Vol. 11787, pp.180-90.

Bork, D. et al., 2019. An Open Platform for Modeling Method Conceptualization: The OMiLAB Digital Ecosystem. *Communications of the Association for Information Systems*, 44.

Fractal Enterprise Model, 2020. *FEM toolkit*. [Online] fractalmodel.org Available at: https://www.fractalmodel.org/fem-toolkit/ [Accessed 27 February 2021].

Hevner, A.R., March, S.T. & and, P.J., 2004. Design Science in Information Systems Research. *MIS Quarterly*, 28(1), pp.75-105.

Hoverstadt, P., 2013. Why Business should take Enterprise Architecture seriously. In J. Gøtze & A. Jensen-Waud, eds. *Beyond alignment, Systems Volume 3*. College publishing. pp.55-166.

Hoverstadt, P. & Loh, L., 2017. *Patterns of Strategy*. Taylor & Francis.

Jacobs, F.R., Berry, W.L., Whybark, D.C. & Vollmann, T.E., 2011. *Manufacturing planning and control for supply chain management: APICS/CPIM Certification Edition*. McGraw-Hill Education.

Mott, V., 1996. Knowledge comes from practice: Reflective theory building in practice. In R.W. Rowden, ed. *Workplace learning: Debating five critical questions of theory and practice*. San Francisco, CA: Jossey-Bass. pp.57-63.

NIST, 1993. *Integration definition for function modeling (IDEF0), Draft Federal Information Processing Standards, Publication 183, 1993*. [Online] Available at: https://www.idef.com/idefo-function_modeling_method/ [Accessed 30 October 2020].

OMG, 2013. *Business Process Model and Notation (BPMN), Version 2.0.2, Object Management Group (OMG), Document formal/2013-12-09, December 2013*. [Online] OMG Available at: http://www.omg.org/spec/BPMN/2.0.2/PDF [Accessed February 2015].

Richardson, G.P. & Pugh III, A.L., 1981. *Introduction to System Dynamics Modeling*.

The open group, 2020. *ArchiMate® 3.0.1 Specification*. [Online] Available at: https://publications.opengroup.org/standards/archimate/specifications/c179 [Accessed 30 October 2020].

Weske, M., 2007. *Business process management: concepts, methods, technology*. Springer-Verlag.