Process Modularization
A new approach for designing processes

Måns Ridzén
Abstract

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Modular product design has proven helpful in dealing with variance, while maintaining efficiency and quality. It allows companies to combine strategies that are otherwise difficult to combine, by decoupling product systems to allow parallel development and manufacturing. Applying modular design to business processes could help organizations in dealing with an increasing demand of flexibility, while maintaining or increasing efficiency. Since research on process modularity is scarce and that there are no methods for modularizing processes, this study has adapted a method for product modularization (Modular Function Deployment®) to be used for business processes.

A major issue in doing so has been to find the right framework for describing business processes. Their abstract nature makes it harder (then with a physical product) to envision possible divisions into modules. Structures and properties of business processes, which traditional process models cannot reveal, have been exposed by the unconventional use of the ARA-model (Håkansson & Snehota, 1989) as a tool for depicting business processes. That has brought the conclusion that activities and resources, belonging to a business process, are codependent and part of a bigger network of activities, resources and actors. Building on these ideas, the Modular Function Deployment® method has been adapted for business processes. A case process is used throughout the paper to show as an example and evidence of the findings. Even if not yet implemented within the organization, the proposed modularization of the process show great promise in improving the performance of the process, as well as further embodying the company strategy within its architecture.
Companies are facing an increasingly more complex and competitive environment as the world becomes more globalized and technological development accelerates. There is pressure to increase both efficiency and flexibility, but they have traditionally been seen as contradictory strategies which cannot be combined. Companies have dealt with that challenge by modularizing physical products so that different parts of the product can be developed and produced independently, and then assembled depending on the customer requirements. The same approach has been proposed for business processes, but there are no available methods for how processes should be modularized. Another issue that has been brought up is that models for depicting business processes do not reflect the true nature of business processes, which is a prerequisite for modularizing them.

This study has been carried out at a consultancy firm, called Modular Management, that focuses on product modularization, but wish to expand their services to include process modularization. One of Modular Management’s clients, a construction company, is engaged in improving one of their business processes. That process has worked as a case for this study and is referred to as the case process. By using a case, the ideas and methods presented in this paper could be tested and exemplified.

Instead of using traditional process models that present business processes as sequential activities, a network approach for depicting processes is proposed. That reveals that the case process is part of a larger network of activities, resources and actors. Properties that was not revealed by the initial mapping of the case process were then exposed and the practical challenges became clearer. The true nature of the process was that it was spread out through several organizational units, both within and without the construction company, and that it was entangled in other processes. The challenges of improving such a process goes beyond the activities and resources directly involved, as it has a strong interdependency with supporting activities and resources. Modularity aim to decouple parts of a system to control where the interdependency should be.

Since there are no methods for process modularization, a method for product modularization has been adapted so that it can be applied to processes. The method that has been adapted is called the Modular Function Deployment® method and uses matrices to divide a product into modules that represent different customer values. Internal strategies are also considered by assigning module drivers, that assigns different strategies for the modules. The method ends with defining the module interfaces, which dictates how the modules connect. Altogether five matrices from the Modular Function Deployment® method have been modified to fit the conditions of business processes and an additional matrix has been added to deal with the dependencies of activities.

The two main contributions of this study are the new approach for depicting processes as part of a network and the overall logic behind the modified version of the Modular Function Deployment® method. The method still need to be improved upon, but is a foundation for further discussions about the way forward within the field of process modularization.
ACKNOWLEDGEMENTS

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## DICTIONARY

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<th>Term</th>
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<tr>
<td>Modular</td>
<td>A property of a system that can be sub-divided into entities that can be replaced or changed without affecting the rest of the system.</td>
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<tr>
<td>Modularization</td>
<td>The process of changing a system to become modular, e.g. a product or a process.</td>
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<tr>
<td>Module</td>
<td>An abstract set of rules which dictates properties of a specific subset of a modular system.</td>
</tr>
<tr>
<td>Modular interface</td>
<td>A standardized interface which dictates how a module connect and interact with other modules.</td>
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<tr>
<td>Modular Variant</td>
<td>A subset of a system which belongs to, and therefore obey the rules of, a specific module. There can be several module variants that belong to the same module.</td>
</tr>
<tr>
<td>Product modularity</td>
<td>Field of research that investigates how products can and should be modularized.</td>
</tr>
<tr>
<td>Organizational Modularity</td>
<td>Field of research that investigates to which degree an organization is modular and how product modularity is mirrored in the organization.</td>
</tr>
<tr>
<td>Production system modularity</td>
<td>Field of research that investigates to which degree an inter- organizational production systems is modular. Focuses on outsourcing of activities.</td>
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1 Introduction

When I first approached Modular Management, the consultancy firm that has been the facilitator of this study, their representatives proposed process modularization as the topic of my Master’s thesis. Modular Management specializes in product modularization and wanted me to explore the possibilities of adopting the same ideas on processes. One of Modular Management’s clients, a construction company referred to as Company X, agreed to let me use them as a case for my study. Company X had initiated a development project with the aim of cutting costs and securing quality of their interior design process, also referred to as the case process. The case process consists of activities involved in planning, selecting and mounting the interior of each apartment that they deliver to their customers. The challenge of Company X, in redesigning the case process, is that each construction project has its own version of the interior design process that stretched over several organizational units and involved numerous suppliers and contractors. The process must be flexible enough to deal with the variance of input due to the different conditions of each project while being efficient.

These challenges, in combining flexibility with efficiency, are found in most industries and could be approach by modular process design. Unfortunately, there are little research available and there are no published methods sufficient for modularizing processes (Reijers & Mendling, 2008). Neither do traditional models for depicting processes capture the true nature of business processes, making it difficult to analyze them (Alotaibi, 2016). Given that there are no models or methods that are sufficient to neither depict the case process nor to modularize it, contributing to both these fields of research will have to be the first step towards a sufficient method that can be used by both scholars and practitioners to modularize business processes.

1.1 Research Problem

The idea of modular design was not invented by modern day researchers and engineers, but has been around for numerous years. To paraphrase one of the senior consultants at Modular Management:

“Modularization of products can be traced back long before the industrialized age; when the Chinese empire built the Terracotta army they used the same principles“.

Nevertheless, in an increasingly more complex and competitive world, these ideas are more relevant now than ever. Modular design allows for both organizational efficiency and flexibility by dividing a system into modules that can be independently produced, then combined, depending on the design requirements.

Research on modular design has traditionally focused on product design, but there is a growing body of research on both organizational- and production systems-modularity (see, e.g., Campognolo & Camuffo, 2010). A fourth field of modularity research deals with service modularity, which focus on the offering given to the customer and how a customized package can be combined by using different service modules (Tuunanen & Merisalo-Rantanen, 2012). Research on business process modularization relates to all these fields of research. None of the available process modularization research, regardless of their aim, offer a sufficient method or approach that can be used by practitioners to modularize a business process. This gap in research has been put into words by Reijers and Mendling (2008):
“Overall, the main focus of research on process modularization is of a conceptual nature. Clearly, there are no objective and explicit guidelines that modelers in practice can rely on.” (Reijers & Mendling, 2008)

Process modularization in the past has been constricted to process model modularization, rather than modularization of actual processes as they exist in organizations. Business processes are commonly described using different process modeling frameworks, which traditionally divides processes into modules by an ad-hoc grouping of activities into sub-processes (Reijers & Mendling, 2008). Reijers and Mendling (2008) argue that an ad-hoc division into modules entails that previous attempts of modularizing processes function as a means to create a hierarchical structure of sub-processes to increase the intelligibility of a process model. Valuable conceptual contributions have also been done by Tuunanen & Merisalo-Rantanen (2012) on service modularization, which closely relates to process modularization. They too ask for a holistic method for designing services and propose that the overall value creating process should be considered. Further they argue that not only the customer's perspective but the firms staff should be considered. The benefits of modular design are not fully utilized unless the logic that validates modular design is not fully incorporated during the initial design of a business process. Meaning that both internal strategic aspects, as well as external demands, should be considered in a method for process modularization.

Research on modular product design is more mature than research on process modularization and several methods for modularizing physical products has been developed and used in practice for decades. Methods for product modularization have different approaches and using matrices is one of them (Jose & Tollenaere, 2005). Modular Management uses such an approach that was developed during the 1990s by the founders of the company as they were involved in a research project at the Royal Institute of Technology in Sweden (Erixon, Erlandsson, Yxkull & Östgren, 1994; Erixon, 1998). The method was later trademarked as Modular Function Deployment® and has been further developed and improved. The method captures and integrates several important aspects of modular design into the product design using a set of matrices. The Modular Function Deployment® takes both external and internal demands on the product into account, which resonates with the demands for a holistic method for process modularization. Since the method is familiar to both Modular Management and its client, Company X, it further qualified as a good choice for the purpose of this study as it allowed for continuous discussions involving key concepts and how the method need to be adapted to fit business processes.

Nevertheless, developing methods for process modularization has little meaning if we fail to capture the true nature of the current process, as well as the process that are being designed. When modularizing a physical product, the need for a framework to depict the object being modularized is not as crucial as with processes. Processes are more abstract in their nature which entails that they need models to describe them, compared to physical products that can be described using their physical attributes. The gap between the true nature of the process and the model of the process can result in an inconsistency between theory and the real world. It has been suggested that available process models are insufficient to describe to true nature of business processes (e.g., Lindsay, Downs, & Lunn, 2003; Alotaibi, 2016). A process model most often describe one iteration of a process workflow, which in reality can flow differently depending on which organizational unit it travels through on different organizational levels. E.g. a business process that starts with activities at the head office, that then travel through a regional office, and finishes with activities close to a specific customer, will take different paths depending on variance in demands on the business process, including customer demands. The process might look the
same, with the same type of activities with each iteration, but traditional process modules will not
capture the structure of activities of several process iterations as they start at the head office, branch
out to different regional offices and then to different customers. Instead, traditional process models
would show the process as a set of sequential activities. In that sense, a process model often work as a
conceptual representation of an ideal process that an organization should work towards, rather than
representing how a business process is embodied in the business landscape. Processes most commonly
travel through several organizational units and its activities cannot be seen as isolated from the rest
of the organization. A process step that involve an organizational unit that is congested due to an increase
of input – that does not directly belong to the business – process might still affect its performance.

Since available process models often fail to capture the true nature of a process, we must look
elsewhere to find a framework to depict business processes. This study instead use a network
perspective, specifically the ARA-model, for depicting processes and their properties. The ARA-model
depicts the business landscape as a network of activities, resources and actors, thus revealing
the structure of the whole organization and how a process is embodied in the organization (Håkansson et
al., 2009). Further an ARA-analysis shows that resources are inseparable from both activities and actors,
making activities meaningless unless they are discussed in the context of resources and actors. A more
accurate model for depicting a business process is a prerequisite for a successful process modularization
that not only affect the conceptual domain, but help in improving operations in the real world.

1.2 RESEARCH OBJECTIVE
The main objective of the study is to present a mock-up process modularization of the case process by
adapting the Modular Function Deployment®. There is no intent to build a complete model ready for
application, instead the aim is to contribute towards building such a method by offering suggestions on
which direction we should move. Before adapting and applying the Modular Function Deployment®, the
case process needs to be mapped with a sufficient model that depict the process and relevant process
properties as they are in the real world. The first objective of this study is therefore to see how the ARA-
model can contribute in creating a better model for depicting business processes. These two objectives
have been captured in the following two research questions:

- What additional information about the case process is revealed by depicting the process using
  the ARA-model?
- How must the Modular Function Deployment® method be adapted to work for business
  processes?

These questions will be answered by analyzing the case process using the ARA-model and then adapting
and applying the Modular Function Deployment® method. By answering these questions, this study will
contribute towards filling the gap in research on process models that depict business processes, as well
as the lack of a method for process modularization.
1.3 MODULAR MANAGEMENT
This study carried out with support from Modular Management, a consultancy firm with long experience of product modularization. The company was founded in the late 1990s by Arne Erlandsson, Gunnar Erixon and Alex von Yxkull, that were involved in a research project at the Royal Institute of Technology in Sweden. They used their findings from that research to further developed a method for modularizing products. Modular Management work with global companies to improve their productivity and help them grow their customer value. In comparison to their customers they remain a small organization. Their services focus on the modularization of physical products and they have developed sophisticated methods to evaluate potential gains from modularizing a product family as well as methods for modularizing product families. Their two main methods are called Modular Strategy and Potential Analysis™ (MSAP™) and Modular Function Deployment® (MFD®), but they also offer several additional services in supply chain management and other fields.

Some of Modular Management’s client are project based organizations, which entails that the distinction between service and product is ambiguous. One such client, a construction company, will provide as a good example and will be introduced further down. The company want to remain anonymous and will therefore be referred to as Company X. When Company X produce a residential house, it can either be seen as a service, or as delivering a product. Such organizations face different challenges than those of mass manufacturers, as each project requires its own temporary organization. Modular Management have experienced advantages with modularizing physical product and they believe that the same ideas can be applied to processes. Their expectations are that modularizing a process will give similar results as modularizing products, meaning an increase in both flexibility and efficiency. However, the lack of research on the topic makes it difficult to move forward and is why they asked me to investigate the possibilities with process modularization. Together with Modular Management, we decided that the best approach to explore the possibilities with process modularization was to study a process of one of their clients. They identified Company X as a good candidate, as Modular Management is already involved in their work with improving one of their business processes.

1.4 COMPANY X
Investigating how processes can be modularized could be done solely by reviewing literature and performing interviews. The use of a case process, however, gives me an opportunity to test my ideas against a real process, as well as presenting the reader with real examples of how modularization of processes could affect an organization. To provide me with a case process, Modular Management reviewed their projects and found up with one that was suitable.

The project involves several consultants at Modular Management and the client is a construction company that focus on residential housing projects and is referred to as Company X. Company X is divided into three organizations: Housing, Construction and Aftermarket. The Housing organization first buy a plot of land and develops the technical specifications for the planned building, that they then let the Construction organization build. The Aftermarket organization takes care of property management after the customers have moved in to their apartments. They are also considering additional services that they can offer the customer after the customer have moved in. Several external contractors and
consultants are involved in the construction process, like with most bigger companies within the construction industry.

The client agreed to let me use their company for my study on the premise that they could be anonymous, which is why they will be referred to as Company X. Modular Management is involved in several workflows within Company X that are investing in a wide array of improvement initiatives. All the workflows aim to improve the performance of the organization and prepare them for future growth. The workflows include modularizing the physical components (e.g. Kitchen), improve the interior design process and improve their IT-capability. My focus has been on the workflow that targets the Interior design process, which covers activities that contribute to the interior of the apartments. The interior design process has been identified as a potential candidate for improvement and is associated with big costs. One reason that it is such a time-consuming process is that the process has a high variance of inputs and conditions between projects. Another reason is the complexity entailed from that the customer can choose the interior of the apartment, such as floors, wallpapers, kitchen and bathroom design; all which must be coordinated with different actors both externally and internally. The initial aim of the interior design process workflow was to map the interior design process, which gave me an opportunity to study and learn more about the process. I participated in the workgroup that mapped the interior design process, as they carried out workshops at different regional offices. The group consist of employees of Company X and one senior consultant from Modular Management. A new project leader had just been employed at Company X when I joined the workgroup.

The case process is a sub-process to the overall construction process. The final output of the process is completed apartments that the customer can move into. The case process does not involve the design of the floor plan, but only the layers, kitchen, bathroom and everything else that is expected within an apartment. The construction process for Company X start when they acquire land on which they want to build. They then get the permits they need, design the building and finally erect the building. The apartments are put out for sale way before the building is completed, which allow for the customers to affect the production process. The interior design is what the customer mainly can affect, by making choices about floor, wallpapers, kitchen and bathroom. In the pre-study, performed by Modular Management, four phases of the process were identified. The four phases of the process identified in the pre-study are: the analysis phase, the productification phase, the visualization phase, the optional interior phase and the inspection phase. Mapping the activities of these phases has been the primary focus of the empirical part of the study.
2 Theory

In this chapter, relevant research and theoretical frameworks will be covered to give the reader enough background knowledge, the theoretical frameworks used will be presented, and the reasons for why those frameworks were chosen will be given.

Research on process modularity is limited and might sometimes not be called process modularity but something else. Researchers that have touched on the topic of dividing and grouping activities focus on inter-organizational production systems, while this study focuses on the of grouping activities both within and without the organization. There is little research on business process modularity, and no research on how to modularize a business process.

2.1 Choosing the Right Theories

As stated in the introduction, the research questions revolve around how business processes can be depicted as part of a networks and how methods on product modularity can be applied to business processes. A natural consequence of picking those research questions is that the theory can be divided into two main parts; research on depicting the business landscape as a network and research on modularization.

The network approach, the ARA-model in particular, has mainly been used to present the business landscape from a wider perspective and not to depict specific business processes. However, since business processes are part of the business landscape there should be no issues in doing so. Traditional models for describing business processes often target workflows, but they do not focus on how a process changes over time and space. Since the case process is part of a project oriented organization, the interior design process is carried out in (more or less) independent iterations. Every construction project has its own interior design process that looks a little bit different from project to project. On top of that, the effects of modularizing a process is likely to affect several stakeholders, including suppliers, customers and different organizational units. That means that the theoretical framework also need to allow for an inter-organizational analysis of activities, resources and how they relate to different stakeholders. One theoretical model that meet these requirements is the ARA-model, which is a model that sees the business landscape as a network of activities, resources and actors (ARA) (Håkansson et al., 2009). It states that all these three layers are interconnected and relate to each other, both within and without an organization. Further, modularity research and the ARA-model has in common that they both deal with the connection of entities, as well as their relationships and function, as part of a system.

When it comes to the field of modularity research, there is a lack of common definitions. Modular Management build its methods on research done by the founders (Erixon, Erlandsson & Yxkull, 1994). Using the concepts and definitions presented in their research will ease communication with both Modular Management and Company X throughout the study, as they are familiar with them. However, the broader field of modularity research will be partially reviewed to show the differences, progress and issues of modularity research. Later, when the Modular Function Deployment® is described in more detail, it will be apparent that the method starts with customer values, that are translated to product properties, which are connected to technical solutions, that can then be divided into modules. That means that the method already is prepared to take one important stakeholder into account: the
customer. Research on both modularity and business as a network will now be presented in more detail, starting with modularity.

2.2 MODULARITY

Modularity as a concept is not unique for management research. It is found in several fields of research, including biology and mathematics (Schilling, 2000). What seem to be the common denominator for how the concept of a module is used (in all fields), is that it describes something that is integral to a larger system, yet loosely coupled to other entities of that system. That entails that one part of the system can be replaced without affecting other parts of the system. Which means, from a business perspective, that a change in customer demands does not have to affect the whole product system, instead it only affects the part of the system that is related to that specific customer demand (Sanchez, 1995). A module as a loosely coupled integral of a larger system is a good first step towards defining a module, but if we want to talk about modularity we need a more comprehensive framework that we can rely on. In this chapter, research on modularity within the field of management research will be reviewed to show what has been achieved and where more work is needed. Excellent work has already been done by Campagnolo and Camuffo (2010), in reviewing and grouping modular research into three different categories. Their structure will be used to describe the field after giving a general introduction on modularity.

2.2.1 MODULARITY IN SHORT

Modularity is a wide concept that has been used in several fields of research. On a high, abstract level, modularity can be explained as follows:

“…it [Modularity] is a continuum describing the degree to which a system’s components can be separated and re-combined, and it refers both to the tightness of coupling between components and the degree to which the "rules" of the system architecture enable (or prohibit) the mixing and matching of components.”

Schilling, (2000)

In other words, modularity of a system is determined in how subsets of a system can be divided into entities that are interchangeable, meaning that one part can be replaced with a different variant of the same part without affect the rest of the system. The benefits, when applied to physical products, is that the product system can remain flexibility, in terms of the number of product configurations possible, while reducing the number of components needed by reusing modules within the same product family. Other advantages range from the possibility to develop specific modules variants without affecting the rest of the product system, for faster development times for new products, to strategic outsourcing of modules. To manage such a product system, containing many different modules, there must be rules that control the properties of the modules and their interfaces towards other modules. There is a lack of consistency in definitions within the field of modularity research. When Modular Management use the concept of a module, they do not refer to the physical component, but an abstract set of rules that regulates the properties and interface of the entity. The physical entity itself is referred to as a module variant. The interface between modules, or module variants, are referred to as module interface.
easiest way to explain product modularity, and how these concepts apply to a product, is to present fictional example of a made-up product, see Figure 1.

2.2.2 PRODUCT MODULARITY

Modularity within management research has its roots in product architecture. Flexibility combined with efficiency is often the argument for why an organization should introduce modular product system. Despite a significant number of articles and literature on the topic, there is still a lack of common definitions of what modular product design is, and no widely-spread methodology that can assist designers in implementing modularity to their organizations (Bonvoisin, Halstenberg, Buchert & Stark, 2016). Campagnolo and Camuffo (2010) identified three perspectives of research on product modularity. The first one they call *functional perspective* and is perhaps the most technical view of modularity. Each module is said to have a function that contribute to the overall value that the product delivers. The second perspective is called the *life-cycle perspective* and focus on modularity objectives rather than technical function. These ideas go beyond the function of the product itself and look at impacts of product modularity on stakeholders throughout its lifetime. Product development, manufacturing and recycling are among the factors that can motivate the introduction of modules to a production system, according to this school of modularity. The third and last perspective is a *mixed perspective* that look at both product architecture and technical functions of the product, as well as the process of modularizing a product. Researchers with this combined focus has tried to combine both previous perspectives. In trying to combine them, some shortcomings of the other two perspectives have been pointed out. They either lack function mapping or defined module interfaces (Sako, 2003). Without proper function mapping, each module is just a collection of components without a reason for why those components are grouped together. On the other side of the spectrum there is well-mapped functions for each module, but no module interfaces to allow for the benefits of reuse, recycle and parallel development of modules.

These three streams of ideas, on how to look at product modularity, show us that there are some differences in approaches. Voices has been raised about a lack of theory that include both the functional and the strategic aspects of product modularity. However, The Modular Function Deployment® method, do include both functional and strategic aspects of modularity. Modular Function Deployment® is one of the more conclusive framework, as it covers both the functional and strategic aspects of product modularity. To get an idea on how product modularity could work, with standardized module interfaces, take a look at Figure 1.
2.2.3 Production System Modularity

Research on production modularity often describe a perfect division of knowledge and resources between economic actors within the production system involved in producing a modular product (Campagnolo & Camuffo, 2010). The idea is that the production system is mirrored by the modular product, as tasks are divided in such a way so that they group around modules of the product. Campagnolo and Camuffo (2010) present two aspects of the research dealing with these ideas. First there is the outsourcing of activities and the correlation between outsourcing and modularity of products. It is called the Modularity and Task Management aspect of production system modularity. Second there is the Modularity and Networks perspective, which deal with organizational boundaries and inter-firm co-ordination. Campagnolo and Camuffo (2010) mention that several scholars argue that there is a ‘new’ common model of industrial organization, where major players focus on market control, market penetration and market defense, while they leave manufacturing to sub-contractors. One name for that type of industry is modular production network, a concept that has been used to describe the US electronics industry (Sturgeon, 2002). The concept of modular production network is of some interest to this study, as it is dealing with business processes, but on a macro level. The focal point of Sturgeons (2002) research differs from mine, as he is interested in the strategy of the process owner (as a controller of markets) rather than the logic and architecture of the modular system.

As Campagnolo and Camuffo (2010) mention, there are several researchers that have considered the connection between outsourcing and product modularity and weather there is a causal connection in any direction (Frigant and Talbot 2005; Galvin and Morkel 2001; Prencipe et al. 2003; Sako 2003; Sako and Murray 1999; Takeishi and Fujimoto 2003). They go on presenting that there are three ways that an organization can move from in-house manufacturing of integral products to outsourcing product modules, see Figure 2. Either an organization first modularizes their product and then move to outsource production of modules, or they first outsource production and then modularize the product. A third alternative is that they do both at the same time, together with a supplier. Nevertheless, there are research showing that production systems do not always mirror the modularity of the product. In complex industries, undergoing intense technological developing, production system modularity does

FIGURE 1. THE FIGURE SHOW HOW DIFFERENT MODULE VARIANTS CAN BE PUT TOGETHER TO CREATE PRODUCTS. MODULE VARIANTS THAT HAVE THE SAME COLOR BELONG TO THE SAME MODULE, MEANING THAT THEY OBEY THE SAME RULES. THE STANDARDIZED MODULE INTERFAZES ALLOW FOR DIFFERENT MODULE VARIANTS TO BE CONNECTED TO THE SAME. THIS FIGURE HAS BEEN TAKEN FROM MODULAR MANAGEMENT WITH THEIR PROMISION.
not keep up with the product modularity (Ernst, 2005). Different organizations are forces to communicate as conditions keep changing, counteracting the modularization of the production system.

As a rule of thumb, it seems that research on production systems believe that there is a correlation between product modularity and production system modularity. Even in cases where there is no clear correlation, the researchers believe that mirroring the product modularity in the production system is desirable. In the cases where there is a connection between product modularity and the production system, there is no clear direction of causality. Change can go both from modular product to modular production system and the other way around, or both at the same time.

![Diagram](image)

**FIGURE 2. PATHS TOWARDS MODULE OUTSOURCING. SOURCE: CAMPAGNOLO & CAMUFFO, (2010)**

### 2.2.4 Organizational Modularity

The third and last field of modularity research that Campagnolo and Camuffo (2010) present is relatively new. They start out by mentioning a publication by Daft and Levin (1993), which was the start of a new paradigm of research, which search for a new organizational form they called modular organization. The idea is to create autonomous, flexible, self-empowering units of people that would replace big, complex and bureaucratic organizations. Campagnolo and Camuffo (2010) divides organizational modularity research into two sub-fields. The first field focuses on how product modularity relates to the organizational structure of product development within an organization. While the second field cover the whole organizational structure, beyond product development.

The first sub-field is interested in how organizational structures mirrors that of modular products, much like the ideas about production systems mirroring modular products. The same articles can be found covering these different aspects of research, as those of production system mirroring modular products (Sanchez, 1995). Even if there are some research suggesting connections, there are still a shortage of empirical evidence supporting the claim that product architecture affect organizational architecture.

The second sub-field is interested in how the whole organization and says organizations must change their structure to meet future challenges. Baldwin and Clark (1997) argues that this is the only way for organizations to continue to be both responsive and pro-active in an increasingly complex environment that is subject to constant technological development. By using what they call “visible design rules”, the
integration problem of decentralized teams can be solved (Baldwin & Clark, 2003). Each team, they argue, should be grouped so that “all activities associated with specific aspects of the product . . . within one organizational unit – even if that organizational unit embodies multiple skill sets, disciplines or activities” (p. 14). Camuffo (2004) says that an organization is modular only if the modules have designed interfaces, which Campagnolo and Camuffo (2010) point out, is easy in theory but harder in practice. It has been suggested that a clear division of tasks between organizational units would facilitate the implementation of organizational module interfaces (Martin & Eisenhardt 2002; Sako, 2003).

2.2.5 Key Modularity Concepts

As mentioned before, there is no common definition of modularity concepts and a lot of researchers seem strangely contentable with ignoring the lack of clear definition and just using the concepts anyway, leaving the reader wondering what they are trying to say. The two quotes below are from articles on modularity and show how the authors seem aware that the concept of a “module” can mean two things, but then go on without dealing with the lack of clear definition. The confusion between the abstract “module” and the physical “module variant” can lead to misunderstandings and should be avoided. See below how two different articles seem aware, but then still make no effort in clarifying what they mean when they use the concept module.

“A module refers to a physical or conceptual grouping of components that share some characteristics.” (Jiao, Simpson & Siddique, 2007)

“Modules are physical or logical units in which one or more functions of the Functional Model are realized” (Erens & Verhulst, 1997)

Unless the context makes it obvious, this study uses the same definitions and framework that both Modular Management and their clients are used to, based on The Modular Function Deployment® (Erixon, 1998). An abstract set of rules is referred to when using module, and to a physical entity only when using the concept module variant. That applies to process modules as well, when referring to modules in the context of processes it is referred to an abstract set of rules, which can contain module variants that contain activities and resources. Part of the rules that make up the modules is its module interface. A module interface is, when talking about a product, how the module variants of one module connect to other module variants of another module. Most evident is the physical dimension of the module interface, that is, how the module variants of one module connects to those of another module. More than the physical, mechanical, aspects of the module interface, there might also be a transfer of energy or information between module variants. As the rules are set for the module, all module variants inherit the same logic. All these concepts are taken from Erixon (1998).

2.2.6 Modular Function Deployment®

Modular Function Deployment® (MFD) is a method for modularizing products and is the central method of Modular Management, which most of their work revolve around, and was first published by Erixon, Erlandsson and Yxkull in 1994. The method uses matrixes to connect customer segments with customer values, that are then translated into product properties. The product properties are then connected to technical solutions, that can be divided into module variants. The method has been developed by Modular Management since it was first published, but the cornerstones of the method are still the same.
that was presented over two decades ago and will now be presented, step by step. You can follow the steps in Figure 3 below.

![Modular Function Deployment Diagram](image)

**FIGURE 3.** THE FIGURE SHOW HOW THE MATRIX STRUCTURE OF THE MODULAR FUNCTION DEPLOYMENT METHOD LOOKS.

Like mentioned before, the MFD starts with identifying which customer segments are relevant and then connecting the values to each segment. It does that using a matrix called Customer Value Ranking (CVR). Usually, there are several customer segments that all have different demands on the product. Some demands might be shared by all customer segments, while others are unique for specific segments. If all customer had the same demands we could create just one product variant and satisfy all customers, the challenge here is that we want to create numerous product variants without holding off on efficiency. The customer segments are linked to different customer values using a matrix called Customer Value Rating, which also allow for weighing different values, see figure 3.

Since the customer values can be subjective and immeasurable, the next step is to translate the customer values to *product properties*. This is done using a simplified version of the Quality Function Deployment matrix (QFD), a well-spread matrix that has been used in product development for decades. The Quality Function Deployment matrix is a widespread tool used in customer-focused product development, but has also been used for services (Ramaswamy, 1996). Product properties should be empirically verifiable and contain target values. When defining product properties, it can be an advantage to avoid being specific in what kind of technical solution that will answer to that property. In the early stage, it is better to keep an open mind to which solution might be the answer to each product property. A good example of this is acceleration, if the product is a car. There might be several ways of increasing acceleration of a car, so by putting down *powerful motor* as a product property (when it is acceleration that your customer is after), you might lock out other possible options early in the process. A bigger motor might be one option, but better tires or a more efficient gear box might be alternative solutions. On the other hand, if the product is too general, it will be hard to find a technical solution that fits the property. As you can tell, there is no easy answers here and it all depends on the kind of products and customer segments that are relevant.

The next step of the Modular Function Deployment® is to take the product properties and translating them into technical solutions, this is when we start to get more specific. It is ideal if each technical solution only answers to one product property, as it makes it easier to modularize. One product
property can be connected to several technical solutions, if the technical solutions do not have other product properties tied to them as well. For example, a company producing mobile phones choose a technical solution which both has Bluetooth and Wi-Fi capabilities (integrated on the same circuit board). This means that if there are customer segments that want Wi-Fi and not Bluetooth, they still have to include Bluetooth. It might be that the option of including both is still the economically most viable approach, but there are plenty of examples where that would not be the case. Often, the organization has a good knowledge about the possible technical solutions. Some are no brainers that they certain they want to use, either because of the setup of manufacturing facilities or knowledge that one technical solution is superior over alternatives. To connect the product properties with technical solutions, the Design Property Matrix (DPM) is used. In an ideal situation, the connections between product properties and the technical solutions line up in a diagonal in the matrix (after rearranging them), meaning that each product property only connects to a one or a few technical solutions. This will be the first indication on how the technical solutions should be divided into modules and module variants. Technical solution that connect to the same product properties (which mirrors customer values) should be put in the same module.

After the technical solutions have been chosen, and the first module candidates are starting to show, it is time to see how the module candidates mirror the strategy of the organization. Traditionally, product leadership, organizational excellence and customer closeness, are contradictory strategies; but with a modular product these three strategies can be combined. Underlying these three strategies are module drivers that can be seen as a means to reach the overlaying strategy, see Figure 4. These are strategic reasons for different modules. There are six main module drivers and six secondary module drivers. Once again, a matrix proves to be helpful in connecting technical solutions to module drivers. The Module Driver Matrix (MDM) lists module candidates (with underlying technical solution) on one side of the matrix and module drivers on a perpendicular side of the matrix. It might be that one technical solution is subject to more than one module driver, which might pose a problem if the drivers can be linked to different axes of the strategy diagram (Figure 4). A technical solution that is linked to both the “Planned development” and the “Common unit” driver will be under conflict in weather operational excellence or product leadership is most important for that component. If conflicts like these are discovered, the module might have to be broken up into two different modules. Other drivers go well together, such as “Carry over” and “Common Unit”. It is ideal if a module variant is both is used in all product variants and is not expected to change over the coming product generations. That kind of technical solutions could be part of a module with only one module variant that is always used, allowing for great operational excellence.
When the technical solutions are divided into different modules, it is time to look at how the modules will connect to each other. In the last matrix, modules are linked together by defining interfaces. There are several types of interfaces varying from physical connection to energy transfer. The result of this exercise is useful in understanding how the product is structured and can be assembled. There are two ideal structures from an assembly point of view: the “hamburger” assembly and the base unit assembly. In the first, on module is assembled on top of the other; and in the second structure, there is one module that serves as a chassis on which all other modules are assembled.

2.3 BUSINESS NETWORKS

We now move on to look at how processes can be depicted by using a network approach. The business network perspective focuses on interdependencies in the market, rather on the competitive nature of the market. It allows for both an inter- and intra-organizational analysis of businesses, and can help in understanding the structures of markets. The ARA-model is a well-known model of the business landscape, which claims that the outcomes of business interactions are three layers, consisting of activities, resources and actors, which all are codependent on each other. The ARA-model has been “summarized” as follows:

In ARA’s model main assumptions are (Hakansson, 1989, 1987) as follows: actors (namely, firms as a whole or individuals, groups, and departments within firms or even groups of firms) perform activities via deployment of directly and/or indirectly controlled resources (i.e., resources owned by the actor and/or resources accessed and explored via business relationships with other actors, respectively); all three substance layers of business relationships are interrelated, for instance, by strengthening actor bonds one obtains both stronger activity links and resource ties, or vice versa; and firms are “collective, purposeful actors,” “resource collections,” and “activity structures” deeply embedded in networks, which are in turn “webs of actors,” “resource constellations,” and “activity chains.”

Sousa’s (2010) 111-word sentence sums up the ARA model and show that actors can be both a group of people and an individual, that control resources and perform activities. However, the difference between Actors and Resources are not always obvious, as an organizational unit also is a resource. Depending on the aim of an analysis, whether an actor’s intent or its contribution to an activity is the focus of analysis, a person (or group of people) can be seen as an actor or a resource. Using the ARA-model as a framework for analyzing and depicting processes, will reveal the activities, resources and actors involved, affecting, and being affected by, the process that is the focus of analysis. On top of that, there are some concepts that will help us discuss a process as a collection of smaller groups of activities, and how those groups interact with each other, which will be presented shortly.

Out of the three layers of the ARA-model, the activities layer is probably the layer most associated with processes. They create value by generating knowledge as well as refining and combining resources. If there were only actors and resources, nothing would happen, or as Håkansson et al. (2009) put it:

“Activities bring life to a network: Goods are produced, delivered and displayed; services are provided, accounts are calculated and bills are paid.” (Håkansson et al., 2009)

Activities has gotten an increased focus within Industrial Marketing and Purchasing (IMP) research and they have been acknowledged to be an integral part of the output of the business network (Håkansson et. al., 2009). Without activities, the flow of resources and the transformation of resources would be static. Activities in networks were first used by describing activity links between counterparts in different companies. In those early studies, the activities within an organization were grouped together into clusters that linked to activity clusters in other organizations (Håkansson, 1982). In later publications, activities have been used to describe activities both within and without organizations, enabling an intra-organizational activity analysis. That entails that a process that move in-between and within organizations can be analyzed on a detailed level.

Two ideas from ARA-research are of special interest to this study, as they involve the division of activities into groups and how activities relate to each other. First, there is the concept of activity interdependency, which is closely connected to the concept of activity patterns. Depending on how activities depend on each other, there will be different activity patterns among a group of activities. There are three types of interdependencies between activities: serial interdependency, dyadic interdependence and joint interdependence (Håkansson et. al., 2009). Serial interdependency is one way dependence, traditionally found in production lines, where one activity follows another. If the dependence is two ways, it is called dyadic interdependence. Activities were there is a need for continuous feedback or customer input, is a good example of that kind of dependence. Last there is the joint dependence, which means that two activities both depend on output from a third activity. Second, there is the concept of an activity configuration, which is a group of activities that are contributing to the same service or product within an organization, at the same time as it is part of the overall activity pattern of the organization or industry. The idea with activity configurations will be of interest, as it shows how a process is a subset of all the activities involved in an organization, or a cluster of organizations. The same activity can be part of several activity configurations, meaning that depending on which process within an organization you are looking at, a specific activity will be seen from different perspective. An emic account of an activity, given by one employee, might be different than the account of another, since they might be active in different activity configurations within the overall activity pattern.
Going too much into detail can be avoided by finding the right activity resolution. The concept of activity resolution is a new concept that is introduced here to give us a more comprehensive vocabulary when talking about activity networks. There is no sufficient concept within the ARA-framework that otherwise deal with such activity properties. Activity resolution hereby defined as a property of a network, that tells us on which level activities are defined. A high activity resolution means that every step of a process is described in detail. Low activity resolution means that activities are grouped together and only described on a higher level. E.g. “planning” could be defined as one activity or as a group of activities, see Figure 5. Bringing us to the fuzzy line between activity clusters and activities.

The concepts activity and activity cluster are used in a liberal manner in this study. As the concepts of activities and activity clusters are used within ARA-research, the difference between them is not always obvious. Depending on the activity resolution, an activity can often be broken down into smaller components. For instance, the activity of billing a customer was, during the workshops at Company X, marked as one activity. However, the activity “billing a customer” can probably be broken down into sub-activities such as filling out the customer information form, sending the invoice and documenting that is has been sent. This means that an activity and an activity cluster could be the same thing, depending on how we choose to define them. Trying to find one objectively “true” definition of an activity (as compared to activity clusters) will most likely be both hard and very impractical, instead it makes sense to talk about different activity resolutions. There is no reason to initially break down activities into more detail than needed. If greater detail is needed, it is always possible to go into more detail at a later stage. For that reason, an intuitive and hands on division of activities by using a top down approach seem appropriate. A good rule of thumb is to see at what level the process is defined.

FIGURE 5. THE NUMBER OF ACTIVITIES DEPEND ON WHICH LEVEL OF A PROCESS ACTIVITIES ARE DESCRIBED. IF DEALING WITH A PROJECT BASED ORGANIZATION, THE ACTIVITIES OF A PROCESS CAN BE DESCRIBED AT DIFFERENT LEVELS. THE RESOLUTION OF THE ACTIVITY PATTERN DEPENDS ON HOW DETAILED THE PROCESS IS DESCRIBED.
today and then start there or at lower resolution. The specific module variants and definitions of activities will take place at a later state of the process design and will not be dealt with in this paper.

As it comes to resources, the ARA-model show how they are linked together to create value by different resource combinations, but to get clearer definitions, another model can be of help. The 4R-model is a closely related model and a good complement to the ARA-model (Håkansson et al., 2009). The 4R-model divide resources into four categories: products, organizational relationships, production facilities and organizational units. All these categories of resources are integral to modularizing a process, since they all can work as enablers for allowing activities to be executed.

There is one layer left to describe: actors. Actors are defined as someone with intent. This distinction is important since it does not simply imply that a person is an actor just because it is a human being. From the perspective of the ARA-model, it is when someone has an intent that they become an actor. So, a person could be both an actor and a resource by the definitions of the ARA-model. Why it might be important to include the actor level of the network is that people have the power to affect the network on all three levels (actors, resources and activities). By mapping the actors of a business landscape, the opinions, intents and power of people involved in the network is revealed. My suspicions are that this will be an important integral to succeeding in modularizing a process. If activities are grouped in such a way so that they are interfering with the intent of an agent with a lot of power, that agent will prove to interfere with the modularization of the process, as it is affecting the agents’ interests. An actor network can be mapped either by creating typical actors that represent the interests of someone with a specific role within an organization, or by mapping actual people and both their professional and personal interests.

2.3.1 Background of the Network Model

The network model was first developed as an alternative way of describing and analyzing the business landscape, which focuses on interaction and interdependencies rather than competitiveness. As Håkansson et al. (2009) points out, the business landscape is often portrayed as a jungle, were individual businesses must fight for their survival in a hostile environment. These ideas are not new and, by drawing parallels to Darwin’s theory of evolution and survival of the fittest, the ideas have been given legitimacy (Polyanyi, 1944). The idea of individual businesses as competitors among others has persisted until today and is still present in contemporary literature. Porter (1990) argued that a small competitive advantage, in either price or quality, will result in an immediate gain of customer base. There is a narrative that dictates that the task of a business is to analyze its competitors to create a competitive advantage in relation to other companies in the market (Marglin, 2008). There is no doubt that competition and self-interest is an important integral in doing business and something business practitioners must relate to. However, this view does not always give an accurate description reality, in which companies are interdependent and where business processes often stretches outside the organizational borders of an individual organization. Collaboration for mutual gain, rather than competition, is more common than what is reflected in research. Outsourcing creates an interdependence between organizations that rather coexist than compete. Håkansson et. al. (2009) offers an alternative to the jungle metaphor that they believe better mirror the reality of business. They portray the business landscape as rainforest, where there are no autonomous entities, but rather an interdependence which link them together.
2.4 CHALLENGES FACING THE CONSTRUCTION INDUSTRY

The construction industry has been said to combat high production costs because of lagging behind other industries in terms of productivity and only a few years ago, it seemed like most authors agreed that the construction industry would do better by adopting practices used in other industries (Dubois & Gadde, 2002). However, that standpoint as changed since then, as the different conditions and challenges of the construction industry has been acknowledged. Analyzing the structure of the construction industry in comparison to other industries show how different entities couple differently between industries. The construction industry differs from the manufacturing industry in that it is almost entirely project based, rather than orbiting around continuous processes. One paper that deals with this phenomenon is Dubois and Gabbes (2002) article “The construction industry as a loosely coupled system: implications for productivity and innovation”, in which they analyze how the construction industry is coupled (project focused) and what implications that brings. They come back to these issues in a more recent article, where they also study partnering as a way of dealing with the structure of the construction industry (Dubois & Gadde, 2010). There has also been articles about the implication that the structure of the construction industry has on supply chain management (Bankvall et. al., 2010). Within projects, there are strong connections between actors and activities, but the connection between different projects are weak, even within the same firm. Dubois and Gadde (2002) argue that the reasons for why the structure of loose and tight couplings look like they do can be derived as a mean to deal with the complexity of the construction industry. Arguments has been made that the construction industry is among the most complex industries and that it continues to increase in complexity (Winch, 1987; Gidado, 1996). To deal with the complexity, from both uncertainty and interdependence of activities, the construction industry has decentralized its organizations to empower local project teams. That enables them to be more familiar with local conditions and to make quick adaptations to changes in the environment without following a centralized, general, process (Dubois & Gadde, 2010). Given that the arguments are correct, that the construction industry is more complex than other industries, Dubois and Gadde (2010) conclude that it might not be as easy as to simply apply techniques used in other industries to the construction industry. Similar arguments have been made by Jørgensen and Emmitt (2008), arguing that the Lean philosophy has its roots in mass manufacturing and that the uniqueness of each project (within the construction industry) very much differs compared to the mass production of cars. Their paper deals with the concept of Lean Construction and how there is a lack of critical research looking at how Lean has been adopted from the manufacturing industry to the construction industry.

Lean is one of the widest spread methods and/or philosophies, practiced by several industries, and has its roots in the Toyota manufacturing system (Roos, Womack & Jones, 1991). It was during the Second World War that the lack of resources drove Toyota to practice a culture of waste reduction, low stock and short lead times, which was characterized by a pull process rather than a push process. Their practices have since been studied, documented and spread to several industries. In its core, Lean mean that you identify waste and value within a process and then try to eliminate all waste (Womack & Jones, 1996). When Lean was first popularized as a concept, it was implied that one was talking about Lean Manufacturing, but Lean as concept has now spread and is now used in several areas outside mass manufacturing. New Lean concepts include Lean Design, Lean Startup and Lean Construction, which all to some degree use some of the core principles of Lean Manufacturing. However, even if Lean Construction share principles with Lean Manufacturing, there is a lack of common systematic methodology in how someone go about to implement Lean to the construction industry (Jørgensen &
Therefore, Lean Construction is more like a gathering of principles and ideas, one could call it a philosophy, than it is a method for improving a business process.

Some of these tools are considered Lean tools and one of the more central ones is Value Stream Mapping (VSM). VSM is central in implementing Lean to a process, since it is the tool used to map the process and to identify the different activities and whether they add value or not. It also includes creating a future – desired – process, that can be used as a target in the work to transform the process. The VSM is a qualitative tool than can be very powerful if used correctly (Pepper& Spedding, 2010). It can be compared with the Six Sigma methodology, which is more of a quantitative tool that uses statistics to evaluate and improve process performance, based on carefully chosen metrics. Pepper and Spedding (2010) compare the two approaches and argue that they are complementary in their different focuses, one being a wide and qualitative tool or philosophy, and the other being a precise tool that do not have much room for interpretation in terms of what activities gives value or not (given that the right metrics been chosen). Both tools have in common that they have an origin in mass production and that they have a hard time dealing with a wide variety of products in small volumes. One of the main reasons for why implementing Lean in job-shops like businesses tend to be unsuccessful is that they usually have a wide array of products that result in difficulties to standardize their operations (Bamber & Dale, 2000). The same properties can be said to apply for construction companies, as each project is unique and, compared to many other industries, the volumes are low.

Even if there are some obvious differences between the construction industry and the manufacturing industry, Lean has still been implemented and many reports that they did so with success. Even if there is a lack of standardization and a huge overall variation between projects, Lean still seems to be a useful tool, at least according to its advocates. Many of the activities, integer to sub-processes that are part of the overall construction process, are still similar or identical between different projects. Therefore, even if there are variations on a higher level, there are still sub-processes and activities that are candidates for improvement by using approaches such as Lean and other tools and/or philosophies that have an origin in mass production. One aspect that has been improved using Lean is workflow on construction sites, by reducing input variance (Ballard & Howell, 1994). Having work teams wait for deliveries or tools is a source of waste and by synchronizing deliveries of both material and tools necessary to perform certain activities the work force can be fully utilized to obtain optimal workflows. Another means of reducing waste on the construction site, by decreasing input variation, is to move activities from the construction site upstream the supply-chain by pre-fabricating sections of the building in factories (Vrijhoef & Koskela, 2010).

Beyond the input variance, or perhaps behind it, is the issue of interdependence between different actors involved within construction projects. In an early phase, there are usually several consultancy firms involved in developing the documents, including blueprints, necessary to produce a building. Architects, structural designers, pluming engineers and many others all must contribute with their expertise, without always understanding how their different designs affects the work of the others. At a later stage, in the production of the building itself, there is a similar situation where many different professions work both in parallel and in sequence to raise the building step by step, as well as the involvement of several suppliers. One person’s work will inevitably affect the work of others. Partnering and collaboration between actors has been on the agenda for long within the industry, as a response to this interdependence. One concrete way of reaching this aim is to include Integrated Concurrent Engineering (ICE) meeting within the planning phase of the construction process. These ICE meetings
gather decision makers in one place at the same time to solve all issues during one day, rather than letting an issue circulate for weeks by emails and phone calls.

Nevertheless, the biggest challenge of the construction industry is the immense complexity of interdependency between activities and variance of input. The industry has adopted tools from other industries that are applicable to some of the activities and have had some success in reducing the variance in some areas, both by better planning and by moving activities upstream in the supply chain. To deal with the high level of interdependence, that is said to be unique for the construction industry, collaboration initiatives has helped in achieving shorter decision cycles. However, there still seem to be lack of tools and theories that deal with the overall architecture and logic of the processes involved. Traditional theories argue that a business process can be either flexible or efficient, which is explained using the Efficient Frontier Theory, see Figure 6 below (Slack, Chambers & Johnston, 2009). Modularity has been found to solve similar challenges with complexity of product systems and might be the path foreword, but it is unexplored territory and one must be careful in applying theories from one industry to another.

![Efficient Frontier Theory](image.png)

**FIGURE 6.** THE EFFICIENT FRONTIER PUT FLEXIBILITY AND EFFICIENCY AS CONTRADICTORY STRATEGIES, A COMPANY HAS TO CHOOSE WHERE ON THE FRONTIER THEY WANT TO PLACE THEMSELVES (SLACK, CHAMBERS & JOHNSTON, 2009).
3 METHODOLOGY

The course of the study can be divided into three stages, first there was the gathering of empirical data, followed by two steps of analysis. Parallel with the gathering of empirical data, there was a search for appropriate theory that could be used for the first and second tier analysis, see Figure 7 below. The empirical data was gathered by observing and participating as part of a workgroup set up by Company X with the main goal of mapping the current interior design process. A search was conducted to find models for depicting the case process and methods for modularizing the case process in parallel with participating in the workgroup. As new insights were made, models and methods were pursued and discarded, using systematic combining (Dubois & Gadde, 2002), until a satisfying model for depicting the case process was found (the ARA-model). No satisfying method for process modularization was found, which is why the Modular Function Deployment® method was picked. Part of the work applying it to the case process was therefore adapting the method for process modularization.

![Diagram](image.png)

FIGURE 7. THE THREE STAGES OF THE STUDY. INVOLVING GATHERING AND SEARCHING FOR A THEORETICAL FRAMEWORK, FIRST TIER ANALYSIS, AND SECOND TIER ANALYSIS.

The data collection resulted in an emic account of the case process that was then analyzed and depicted using the ARA-model at the second stage of the study. That revealed a more accurate etic account of the case process, compared to the one performed by Company X using traditional process models. Since the interior design process proved to be extensive, some parts of the process were left out to make the analysis more comprehensible for the reader.

PARTICIPANT OBSERVATION

Studying organizations through field work involve some type of observation. One of the challenges is to gain access to the organization and to get acceptance from the people involved. Participating in the daily activities can help in both gaining access and acceptance (Myers, 2013). As part of a team, the researcher will get an inside perspective of the operations which might prove hard to achieve from interviews and non-participating observations alone. Working together with people towards a common goal creates trust which make people open up and reveal details that would otherwise gone unnoticed.

Empirical data, both about the case process and about Company X was collected by a participant observation. As part of a team at Company X that was mapping the case process I participated and contributed in the planning and execution of three workshops. Additional knowledge about the case process and Company X was absorbed from casual conversations had with members of the workgroup on flights and in-between workshop sessions.
DOCUMENTS

It is not uncommon that researchers use documents as a source of data when organizations or business phenomenon are studied. Documents should be “out there” for the researcher to collect and not specifically produced for the sake of the study (Bryman & Bell, 2015). If they are not public, permission to use the documents must be given by the document owner. Representatives of Company X agreed to share documents that had been produced before the study, as well as documents that were produced during the workshops. The documents varied from presentation slides to process descriptions.

VALIDITY, RELIABILITY, REPLICABILITY AND SAMPLING

Validity is a measurement of how relevant the object of observation is and reliability measure how precise the method of gathering data is (Bryman & Bell, 2015). Validity is often high in qualitative studies like this one, while reliability is low because of the subjective nature of observations. The replicability of the study very much depends on how well the method of gathering data and performing analysis is described when published. There have been efforts to describe the method of this study, both in this chapter and in the stages of analysis, to assist researchers that might want to try and replicate the same results. However, the nature of qualitative research entail that each case is unique which makes it impossible to control every variable. Instead the uniqueness of each case must be embraced and described so that it becomes clear for the reader why certain measure were taken in that specific case. Sampling for this study was very much a question of available projects that Modular Management had to offer. Among the projects that they were working with, the project involving Company X had the best fit, both in time and scope.

3.1 A SYSTEMATIC COMBINING

It was decided early that there would not be no time or resources for, nor would it be helpful, to conduct a quantitative study within the boundaries of this study. The research problems and research questions stated earlier, call for innovative use of theory and creative, iterative, theory building. That leaves qualitative research methodologies as the only practical approach. As my experience on the topic was limited, and the supply of articles on the topic was scarce, it was hard to predict the direction that the study would take. That is why the Systematic Combining approach was suitable, which allow for more flexibility in terms of choosing theoretical framework.

The work of mapping the case process had just started at Company X when the main study started, which forced me to jump straight into the empirical gathering of data. However, the search for useful theoretical frameworks continued in parallel with the field study. As I started to get a clearer image of the case process, and formed ideas on how such a process are comparable to products, I saw the need for theories that filled the gap between product modularity theories and what I experienced in the field. The process of gathering data empirically, in parallel with literature review, and redirecting the focus depending on the path of which the study takes, is what Dubois and Gadde (2002) calls Systematic Combining. In comparison to positivist approaches, Systematic Combining grants the researcher more flexibility as it allows for faster iterations. The theoretical frameworks can be picked and discarded as knowledge accumulate and data is gathered, rather than forcing data to fit into the framework that you have chosen.
Supporters of the positivist approach argue that more is more, that the replicability of a case study will give more credibility to a theory than a single case study. But, as others have argued, that means that we must deduct the uniqueness of the case studied, in benefit for what is general and common with other cases (Dubois & Gadde, 2014). That is illustrated in Figure 8, showing that only the global commons aspects of a case will found if the study is to be replicated. Using a case allows the researcher to dig deeper into this specific case, rather than only touching on that which might be general for all similar cases. However, properties that can be generalized are still of interest and it is my belief that much of the results from this study will be applicable to other types of processes. Beyond contributing to the research community, the result of this study will be of help to both Company X, in their search for better operations, and to Modular Management, in their search for methods to improve other client’s businesses in the future.

![Figure 8: The figure show that some of the conclusions from this case study are likely to be applicable to other cases, while other aspects are unique to this case. Each new case will demand some degree of further analysis and adoption of the contributions of this study, as they will all have some aspects that are unique for that case.](image)

3.2 The Path of Systematic Combining

Since the systematic combining approach has been used, there is no linear research process to be described beyond the three stages described above. Instead the iterative and exploratory procedure, seen from the researcher’s perspective, will be described. Several theoretical paths were evaluated and discarded along the way.

When I first started the empirical fieldwork I soon got familiar with the overall purpose of the case process as a mean for the company to deliver customer specific apartments. The fieldwork had to be coordinated with the workgroup at Company X, that had two goals with their work. The first goal was to reduce the immediate and more acute problems to come up with quick solutions to some of the problems that where driving waste and affecting their customer satisfaction index. The second goal was, and still is as I’m writing this text, to come up with a future, ideal process, to work towards. My interest was mostly aligned with their second goal of designing an ideal process.

Their methodology was already decided as I joined their workgroup, and something that I had to relate to in my own work. Their first step was to map the current process and problems associated with it, to understand the process and identify how procedures differed between regions. To do so, they planned three workshops, one at each regional office, and one that everybody attended in the end. They had
already had one workshop at their eastern regional office by the time I joined them. Employees with different roles within the interior design process attended the workshops, where they put up yellow post-it notes representing activities and pink post-it notes representing problems connected to those activities. They also added some ideas for improvement represented by green post-it notes. All post-it notes were put on big sheets of paper that were then brought to the remaining workshops.

Two more regional workshops were carried out after I joined the team, one at the western regional office and one at the southern regional office. The same procedure was carried out there, as had been used in the first workshop, to ensure that each region got a chance to give input. The yellow post-it notes, which represented activities, were marked with which role that was responsible for that activity at each region. Some activities were specific for just one or two regions, while other activities where the same for the whole organization. As the discussions took place at the workshops, it became clear that the process routines where not only region specific, but project specific. Some activities were said to go fine if working with some people, and other times caused problems depending on who was involved in the project. I mostly took the role as an observer and I focused on understanding the process, but I did participate in assisting the workgroup with some activities.

In parallel with these workshops there were a discussion with my academic supervisor at the University about a suitable theoretical approach. As Company X portrayed the case process as a linear process, and as the project leader of the group had extensive experience in working with Lean Manufacturing, it seemed like using the Lean Manufacturing theories might be the right approach. However, this path only led me away from modularity, since Lean Manufacturing tries to create a continuous flow, rather than breaking up activities into modules. I reasoned whether it be possible to compare Lean Manufacturing with Modularity, but soon realized that there were no process modularity theories to compare with.

I then went back to reviewing research on modularity, realizing that there were some articles on modularization of organizations and production systems already. As I presented this research earlier in this paper, I will not go into details on the research here, but after reviewing it I realized that there was no research that I could find that offered a method for modularizing a process. That took me back to the Modular Function Deployment® method, which is where I first started and perhaps what I been looking for all along.

The Modular Function Deployment® method has a compelling logic of translating the customer values to properties, which are used to find technical solutions, that are then ran past the module drivers (the “voice of the company”), to end up with modules and module variants that can be put together into customer specific products. As I took a closer look at the Modular Function Deployment® methodology, I immediately saw some aspects that were likely to be transferable to processes, other parts were uncertain. One of the issues that I struggled with was that the Modular Function Deployment® method deals with technical solutions, and I was not sure what the equivalent of technical solutions would be in a process. Looking back, I realize that this was the turning point of the study, as I went from asking what process modularity was to asking what a process was in relation to modularity. I soon realized that a process is dependent on more than just activities, there are people, tools, materials and other resources involved in a process. Part of this realization was gained from discussions with senior consultants at Modular Management, who were involved in a different project where they tried to mix activities into modules, as they build a configurator for another company. The configurator was intended to improve
the client’s response time to tenders, and, as a project based organization, they wanted to be fast to decide which components and activities that had to be included to finalize delivery.

I started looking for a theory that would allow me to look at a process as more than activities and I came across the ARA-model. It proposes that the business landscape is a network of activities, resources and actors that all connect and combine in certain structures. In includes concepts such as loosely coupled activity clusters and tightly coupled activity clusters, which could be used to described a modular system. Traditionally the ARA-model is used for analysis on a wider perspective, looking at whole industries, but the ARA-model has been used to look at intra-organizational structures as well, even the construction industry (Dubois & Gadde, 2002). I could start the second stage of the study, analyzing the case process with the assistance of the ARA-model. This opened my eyes, as I saw the case process from a different perspective, stretching over different projects, organizational units, as well as external organizations. I could see that activities, resources and actors were all linked together, and the ARA-model gave me tools to portrait those structures. Instead of sitting with my nose down a book trying to describe the process activity by activity, I could now raise my head and see the landscape of the process with all its dimensions. The limitations of showing the case process as a linear process, visualized in Figure 6, was now taken away and I could start seeing patterns of how activities, resources and actors where coupled together. However, there were still some questions on how to group the activities and resources, and how the actors connected to the two. That part of the study has mostly been trying ideas on paper, seeing what works, and then improving on them. My supervisor at Modular Management, as well as their consultants, has been of help in developing, discarding and improving on ideas that I have had. As there are limited time and resources, evaluating the potential benefits or risks with modularizing a process must be done mostly using deductive reasoning. All my final ideas have been shown to senior consultants at Modular Management, as well as members of the workgroup that is working with the case process at Company X, to give their verdict of the conclusions made, and in doing so, giving credibility to the results.

RESEARCH ETHIC

Before moving forward, some ethical questions that need to be dealt with will be raised. As with studies of this kind, there will be an obvious dilemma in what my intentions with the study might be. Since this study is part of a Master’s thesis and conducted in collaboration with a company, one could question whether the researcher (me, the student) might feel pressured to present the company and the results in such a way so that it will not portray them in an uncomplimentary manner. When Modular Management first agreed to collaborate on this study and take me in as a student writing my Master’s thesis, they clearly stated that there would not be any pressure for me to deliver or contribute to their business in any other means than the result from the study. They went on to ensure that they, as a company, are interested in an objective analysis of the results, and that they themselves has grown out of university research and therefore see the value in scientific inquiries. When it comes to Company X, the client of Modular Management, they have agreed to the same terms. Both Modular Management and Company X have, however, asked to review the final report before publishing, to ensure that no critical information that could hurt their businesses might be revealed. No information critical to the study has been excluded.
All that being said, it is upon me as a researcher to ensure that this study is carried out in accordance to ethical guidelines provided by Uppsala University and that possible ethical consequences of the results of this study are considered and discussed. All people encountered during my study has been informed that I am there in the role of a researcher, conducting my Master’s thesis study. All names will be made anonymous and the final report will be reviewed by my supervisor to ensure that it upholds the ethical requirements.
4 MAPPING THE CASE PROCESS

In this chapter, the empirical data will first be presented from an emic perspective, which is a representation of how the team at Company X depicted the case process; then from an etic perspective, which is a representation of the case process seen from the ARA-perspective.

4.1 EMIC ACCOUNT OF THE CASE PROCESS

As described above, the empirical focus has been on what has been described as the interior design process, also referred to as the case process, at Company X. As part of the work group at Company X that was assigned to map the interior design process, I observed and learned about the process as well as the organization. The raw data from the empirical phase consist of observations supported by notes, data supplied by Company X and the results from the workshops. The most important results from the workshops is the mapping of the interior design process, which was first documented in with Post-It notes and then visualized in Microsoft Visio, see Figure 3. Parallel to the early stages of the case process, there is the design process of the building itself. It was added as a separate sheet of paper during the workshops, were activities belonging to the design process of the building (but affecting the case process) were placed. All these results represent the emic account of the case process and will be described in this chapter, the etic account (using the ARA-model) will follow.

The work of mapping the case process involved three regional offices and several employees with different roles within the case process. Since the procedures involved in the case process varies between regions and projects, the mapped process represents a mix of several variants of the process, which are visualized on the same canvas. After visiting the eastern, western and southern regional offices, the mapped case process had 50 activities, 5 documents, 11 boxes of additional information and 102 problems, which can be seen in Figure 9. The activities represent process steps, while the documents are products of those activities. Both the information boxes and the problems are linked to different activities and show descriptive information or problems that are associated to those activities in today’s process. Information connected to an activity can be about whom might be present on a meeting or a more extensive explanation of an activity. The problems are there to document what issues the actors involved in the process perceive. All the shapes in the canvas are tagged with which regions that are associated with that activity, problem or document. Some activities might only be carried out by one region and not by others, while other activities are the same for all regions.

The activities will not be described in detail, instead the process phases will be discussed and specific activities will only be mentioned if they prove as good examples. The same goes for the problems, which are too specific and numerous to give real value for this study. However, a presentation of the main themes among the problems will be more helpful, as it will provide a picture of the character of the issues related to the current state of the case process.

As mentioned before, Company X is divided into subsidiaries, three of them are directly involved in the case process. First, there is the Housing Organization of Company X, which plans, buys lots and designs the buildings. Then there is the Construction Organization of Company X, which builds houses that the Housing Organization order to be built. Finally, there is the Aftermarket Organization, which take care of the building after it been built. The whole interior design process was identified as having four phases during the pre-study (performed by Modular Management consultants), during the workshops, a fifth one was added to cover activities in the early stage of the process, called analysis. Altogether, the five phases of the case process were defined as: analysis phase, productification phase, visualization phase,
optional interior phase and the inspection phase. The first phase, the analysis phase, is when Company X has acquired land and decides the scope of the project, as well as what the customer segment should be. This phase includes activities such as a startup-meeting and a review of interior fittings, where the initial floor plans are reviewed and decisions on which types of kitchens and bathrooms should be used for the considered project. This gives input to the next phase, productification, which contains activities that aim to decide the standard interior fittings (that are included in price of the apartments) and which are optional. The final activity of this phase is to specify the prices for the optional interior fittings. With this output, the next phase is started, visualization. This phase is about visualizing the product that has been defined in the previous phase. The output of this phase is the interior fittings catalog, which is sent to the customers (the future residents of the apartments) during the next phase, the optional interior phase. The optional interior phase is the most activity dense phase with over 15 activities, dragging out over several months. This phase is also different from earlier phases; in that it includes a lot of contact with the customer. After some preparations, the customers are invited to a meeting where they are informed of what is included in the base price of the apartment and what can be added as additional options. After the meeting the customers can make their choices. That part of the processes differs from region to region; some use external consultants to assist them while others use internal resources. Once the choices have been made the customer signs a contract with Company X. The customers are billed part of the total price (of the optional additions) early on, and the remaining amount just before they get access to the apartment. In the fifth and final phase, the inspection phase, the interior fittings of all apartments are controlled (in various degrees depending on which region) to ensure that the apartments have the right interior fittings.

![Diagram](image)

**FIGURE 9.** THE FIGURE SHOW THE RESULT OF COMING OUT FROM THE THREE WORKSHOPS. DARK YELLOW BOXES INDICATE ACTIVITIES, BRIGHT YELLOW BOXES INDICATE INFORMATION, BROWN BOXES INDICATE DOCUMENTS AND THE PURPLE BOXES ARE PROBLEMS ASSOCIATED WITH THE ACTIVITIES THAT THEY ARE UNDER. ABOVE THE BOXES THE DIFFERENT PHASES OF THE PROCESS ARE VIZULIZED.

All together there were 102 problems identified, all connected to an activity. They will not be mentioned in detail, but there are some themes that are worth mentioning. Out of the 102 problems, almost 30
were connected to one of the activities, which involved the reviewing of Company X’s internal product list. Their product list was introduced to make sure that every project chose the same product (e.g. kitchen sinks, toilet seats etc.) when possible, to improve supply chain management. Other problem areas were: invoicing issues, digital signing of contracts, kitchen related issues and wrong fittings at site.

Even if the emic account of the case process will give us a comprehensive view of the case process, as to which activities are involved, there are certain limitations in displaying the process as it is above in Figure 9. That way of visualizing the process gives us an idea that the process is linear, when in fact, it is not. When modular design was first applied to the case process, as it can be seen in Figure 9, it was difficult to see which activities would go together with which, and why, since it seemed strange to divide them in non-sequential manner. If some sequential activities were grouped together, followed by another group of sequential activities, it would only serve as a division of the process into process steps. Instead, I realized that there was a need for another approach to depicting the case process that revealed the complex codependence of activities. The etic account uses the ARA-model to both help present the case process in a more context based notion, as well as to introduce some new concepts that will help in the division of activities.

4.2 ETIC ACCOUNT OF THE CASE PROCESS

After presenting the emic perspective of the case process, the etic account will now be presented with the help of the ARA-model and related concepts. The emic account for the case process presented us with a linear view of the process which seemed straight forward. As you will notice, changing perspective and seeing the process through the framework of the ARA-model will mix things up.

The activity layer of the case process was in focus during the mapping of the process, so identifying the activities within Company X has been straight forward. The emic account does, however, give the sensation that all activities take place within the organization and that they all follow a linear pattern. According to the ARA-model (Håkansson & Snehota, 1989), activities are interlinked cross organizational borders even if it is not always obvious at first. To make it easier to identify activities across the organizations of Company X as well as other actors, the concept activity configuration was used. An activity configuration is a set of activities that all contribute to the same service or product (Håkansson et. Al., 2009). The concept is used to talk about different activity configurations within the overall activity pattern of Company X. That reveals that one activity can be part of several activity configurations, and that each activity configuration has its own actors with an intent for that configuration, meaning that several actors can have different intent for the same activity. Since there is so many actors involved in the construction process, the discussions will be limited to only include the kitchen supplier and the customer as external actors. Internally, within Company X, there are three subsidiaries that will be included.

The activity pattern in Figure 10 show an example of how activities, belonging to a regional division of Company X that have three construction projects, might look. It shows the overall activity pattern of the organization and highlights the activities involved in the interior design process by showing them in black. There are more projects going in reality, but for the sake of this paper only three projects are represented to make it more comprehensible. First, each organization within Company X has its own activity configuration with its own goals, shown by the dotted circles. The housing organization buys and
develops land, the construction organization builds houses and the aftermarket organization provides services after a building is completed. Within the construction organization, each construction site can be said to be its own activity configuration with a goal of erecting a building, also shown by three dotted circles. Outside of Company X, the kitchen supplier has its own activity configuration which focuses on manufacturing and selling kitchens. The customer has his/her own activity configuration for finding new accommodation.

The case process is spread out over all these activity configurations, where each activity that is involved is interconnected to other activities outside of the case process. The kitchen cannot be planned before there has been a decision on which customer segment the overall project is going after. Neither can it be mounted in the apartment before the electrician has installed the right connections. The same goes for activities that involve external actors outside of Company X. The kitchen cannot be delivered before the kitchen supplier has performed certain activities in its own activity configuration. See Figure 10 below for a good overview of the overall activity pattern, its different activity configurations, and how the case process is spread out over these activity configurations.
As mentioned before, people can be both a resource and an actor. If we are interested in their intent we decide to see them as an actor and if we are interested in how they contribute and enable activities we see them as a resource. An actor is usually a group of people or an institution (e.g. an organization) that has an intent for activities and resources that are affecting their interests. So, when identifying actors involved in the case process, it makes sense to identify actors that have a clear impact on resources and activities involved in the process. To some extent, every person involved in the process will have influence over, and intent with, the case process. However, it will be unsustainable to involve every individual, which is why propose that the relevant actors should reflect the different activity configurations. A few different groups of actors that are crucial to the case process were identified, which reflect the different activity configurations seen in Figure 10. The customer is the first actor, which is involved in several activities in the process and who is contributing with resources that are financing the process. Each customer segment can be seen as its own actor, or one can see them all as one actor, depending on the purpose of analysis. The same goes for other actors, which includes suppliers, subcontractors and partners, that all can be seen as individual actors, depending on the purpose of analysis.

When people are seen as a resource, there are some other groups that should be included. Since activities are carried out by different people, they will act as enabling resources for that activity. As mentioned in the emic account of the case process, each activity that was mapped during the workshops were marked with a functional role within the organization that was responsible for each activity. Those functional roles can be seen as different resources, as each functional role represent a group of people with certain skills within the organization. A certain activity will need someone with the right competence to carry out the activity. For instance, the activity of creating the sales brochure need a sales person that designs it. However, not all the resources involved in activities were documented on the same level during the workshops. All activities, which were carried out by employees under the construction organization of Company X, were grouped together. Meaning that several professions were grouped under one label. Other types of resources were mentioned to a certain degree during the workshops, such as the software that Company X uses for keeping track of the interior design choices. Other resources include the physical component that are to be installed in the apartments (kitchen, bathroom and wallpapers etc.). The construction site is also a resource as it is a temporary production facility which also enables activities. Activities that need the resource “construction site”, are bound to be carried out on the construction site, while other activities might not be bound to a specific geographical location.

Activities belonging to the case process were often grouped in heterogeneous collection of activities, as some activities can be clearly connected to customer values, while others cannot. Many of the meetings mapped in the case process are not clearly giving value to the customer, but rather helping Company X in planning and strategizing their work. Internal billing between organizational units and activities associated with suppliers are both examples of activities that do not reflect customer values directly. So, it seems that when working with processes, it is preferable to take the stakeholder perspective rather than only looking at the customer’s demand. A stakeholder is another word for an actor that has a stake in the process. To some extent, the mapping of the case process had a stakeholder perspective, but it was limited to internal stakeholders involved in the case process. The perspectives and opinions of the different internal stakeholders were aired during the discussions at the workshops and, as expected, people involved with certain activities were more familiar with those activities than other activities and therefore lifted important issues related to them. In the case process, people involved with the internal
design software (used to document and assist the customers in their choice of interior fittings) were concerned with limitations in the software that affected both the customer experience and resulted in extra work internally. Their insights come from a unique perspective of a specific part of the process, as they are more involved and engaged than any other person can be of that process step. That could make them an important stakeholder, as their supervisors and people with other roles within the organization where not as familiar with the software as they were. They would therefore be able to present demands on the process which no one else might think of at first, customers and management included. However, the opinions and knowledge of the different actors were never gathered structurally, analyzed or presented, and some of the important stakeholders of the process were not included (e.g. suppliers). These other actors did not get to be part of the workshops and was therefore left out. This should be considered as the mapped process will be portrayed from an internal perspective, seeing the process with the eyes of Company X. Some of the activities that were mapped include meetings with the architect to ensure that the floor plan works with the chosen kitchen. This imply that the architect might have some demands on information from the interior design process to be able to deliver a passable floor plan which work together with chosen kitchens. Another activity, which might not seem time consuming at first, is getting a tender from the kitchen supplier. The activities performed by the kitchen supplier are hidden as the process is portrayed from an internal perspective, but the cost of these activities will be included in the price of the kitchens they deliver. A housing project that include several hundred apartments, where each customer should be able to choose their kitchens, will produce a significant number of activities at the kitchen suppliers end. The activities involved in first producing an offer and then (later in the process) package and deliver all kitchens is significant. By including the kitchen supplier’s perspective and demands on the process, one can create a more efficient process flow both internally and externally. All these actors have different demands on the process and are therefore stakeholders in the process. If they are not included in an early phase of process design, their needs might be overlooked and the process not designed to meet their demands. These demands should of course go both ways, as it should be expected to get something back if their job is made easier. The important point I am trying to make here, is that there are a lot of things happening outside the organization that is directly affected by the design of the process. So, by not limiting the scope of analysis within the organizational borders, savings can be made working together with external partners, suppliers and perhaps customers.

Different organizational units, customer segments, suppliers and institutions are all examples of stakeholders that wish for certain outputs from a process. So, when modularizing a process, it makes sense to start with which demands that are put on the process, that is, which values it should create for its stakeholders and which stakeholders that matters. A significant difference between a physical product and a business process, in terms of value creation, is that a process more often has more than one “customer”. So instead of only focusing on creating value for the end customers, all stakeholders should be involved.

Even if the resource layer in terms of human resources has been partly covered before, there are still resources belonging and connecting to the actors and activities mentioned that have not been covered in the empirical collection of data. It became evident during the discussions at the workshops, that the activities involved in the case process are very much dependent on the resources that enable them. IT-systems, production facilities and business relationships are closely codependent on all activities and cannot be treated as isolated from activities. An activity involving an IT-system will very much depend on the functionality, performance and interface of that IT-system. If it was to be exchanged, the activity
would also change in character or perhaps become obsolete. A full resource analysis of the case process has not been possible because of lack of time and other resources, but the conclusion that activities and resources are inseparable will be taken into account during the next chapter.
The ideas presented in this chapter are the result from studying the etic account of the case process and adapting the Modular Function Deployment® method to fit its conditions. Since the method originates from product modularity, there will be parallels drawn to products to see how the logic compare with a more familiar and less abstract object of focus. Examples from the case process will be used to show how the tools and ideas presented can be applied. However, the modularization of the case process should be seen as a mock-up and will work as an example. There have not been enough resources assigned to this study to perform the following steps of analysis in collaboration with Company X. That entails that some assumptions that has been made have not been verified. However, they are not essential for the results presented. Figure 11 below, shows the traditional Modular Function Deployment® (Erixon, 1998) next to the modified version. As each matrix dealt with, effort has been taken to be as clear as possible in regards to what is taken from Erixon (1998), and what is my own ideas. Figure 11 will be referred to along the way, to show what step of the method that is dealt with and to point out the modifications that have been done.

![Diagram of Modular Function Deployment](image)

![Diagram of Process Modular Function Deployment](image)

**FIGURE 11.** THE MODULAR FUNCTION DEPLOYMENT® METHOD, COMPARED WITH THE MODIFIED VERSION. THE PROCESS MODULAR FUNCTION DEPLOYMENT® IS A BIT DIFFERENT. FIRST, IT HAS ANOTHER MATRIX, SECOND, THERE HAS BEEN SOME MODIFICATION TO THE EXISTING MATRICES.
A business process has some aspects which make it different from a product, but they have in common that they both try to create value for its stakeholders. Processes differ in that they have more dimensions than physical products. Time, location and flow of resources must be considered when designing the architecture of a process, while physical properties are in focus for product modularity. These additional, more abstract, aspects of processes put pressure on the conceptual framework. The three layers of process components (activities, resources and actors), all have to be considered when modularizing a process. Modularizing activities without taking the other two layers into consideration can lead to process modules (group of activities) that seem decoupled from other modules, but are indeed coupled through resources or actors. Resources enable activities and can therefore put certain constraints on how activities are grouped together. Actors (people) have power over both activities and resources, so grouping activities and resources that are affected by different actors together might create unwanted couplings. In modularizing a process, all three layers must be analyzed together and their relationship understood. Only modularizing activities without taking resources into account will create unwanted dependencies between activities by common dependencies to resources. If an activity is performed by the same resource, e.g. a person, they will not be independent from each other as they share a finite resource. If a person performing one activity experience problems that causes time delay, that will also affect the second activity. All this can be concluded by using the ARA-model, but it does not help us in where to move from the current state, the current activity and resource pattern, towards a more efficient and flexible pattern. That is when the Modular Function Deployment® method will help, as it gives us the logic for how to divide the process.

5.1 Stakeholder Values
When modularizing a product, using the Function Deployment® methodology, one starts with customer values (Erixon, 1998). Studying the etic account of the case process show that some activities and resources are not directly linked to the end customer, instead, they connect to other stakeholders that are affecting (and being affected by) the process. The term stakeholder is self-explanatory, as it implies that it refers to someone which holds a “stake” in the process. It seems appropriate to incorporate all the stakeholders, rather than only the end customer, into the modularization process. The stakeholders represent the actor layer of the process and their relation to activities and resources within the case process will be mapped by using the Modular Function Deployment®.

Identifying which stakeholders drive variance of activities and resources in a process can be challenging if a bottom up analysis is used. It is better to, instead of analyzing the current activities and resources used, ask which stakeholders should be able to affect the process. To make the process more comprehensive for the sake of this study, only some of the stakeholders involved in the process have been included. The external stakeholders that have been included in the analysis is the end customer and the kitchen supplier; the internal stakeholders that have been included is the housing organization, the construction organization and the aftermarket organization. Their activity configurations are shown in Figure 10. These stakeholders have certain values (that they are expecting from the case process) in common, and other values are unique for specific stakeholders. How the stakeholder values are linked to different stakeholders is shown in a modified Customer Value Ranking matrix, see Figure 11. The name has been changed to Stakeholder Value Ranking to avoid confusion between how the Customer Value Ranking is traditionally used. Ranking the different values depending on how many stakeholders find them important can be done just like with the Customer Value Ranking. Since there was no time or
resources to investigate the actual stakeholder values, by performing a stakeholder survey, the values are estimates of what different stakeholders might hold as important. The stakeholder values are, however, grounded in empirical observations during the workshops at Company X.

![Stakeholder Value Ranking Matrix](image)

**FIGURE 12. THE STAKEHOLDER VALUE RANKING MATRIX SHOW HOW DIFFERENT STAKEHOLDER VALUES ARE IMPORTANT TO DIFFERENT STAKEHOLDERS. NOT SURPRISING, THE INTERNAL STAKEHOLDERS HAVE SEVERAL STAKEHOLDER VALUES IN COMMON, EVEN IF THEY RATE THEM DIFFERENT.**

All stakeholder values are ranked, depending on how important they are to different stakeholders, just how customer values are ranked when the traditional Customer Value Ranking matrix is applied. That gives a picture of which values that are important to which stakeholders. Some of the values are precise and objectively verifiable, such as “See/Feel materials”, which means that customers value that they can see the wallpapers, kitchen cabinets, floor styles etc. in person, before they make their decisions about what interior they want. Other stakeholder values are fuzzier, such as “Flexible kitchen supplier”. Since some of them are fuzzy, they need to be translated into process properties that are empirically verifiable. That will be done next, using the Quality Function Deployment matrix.

### 5.2 Process Properties

As mentioned earlier, stakeholder values are sometimes fuzzy. If a stakeholder (let say a supplier) has a demand that is “Fewer points of contact”, then the measurable property will be “the number of points of contact”. A fuzzier stakeholder demand might be “understandable invoices”, which might translate into two different process properties. The properties reflecting that value might be “even sums in invoices” and “same format for invoices and sales material”, which would make it easier for the customer to see how their choices of optional interiors are reflected in the invoice. These are examples of suggestions that arose during the workshops, after it was clear that customers had a hard time understanding their invoices. Both these properties can be empirically checked to see if they are reflected in the process, which means that they are measurable. At the same time, they do not say anything about how to practically embody those properties into the process, which is preferred at this stage of the modularization process. That allows for an evaluation of different solutions that could meet these demands, without committing to one solution early in the design of a process. These ideas are directly taken from the Modular Management, and how they use product properties. Instead of the
Quality Function Deployment method to identify product properties, I have used it to identify process properties, see Figure 13.

**FIGURE 13. THE QUALITY FUNCTION DEPLOYMENT LINKS PROCESS PROPERTIES WITH CUSTOMER VALUES.**

With physical products, the product properties are often physical attributes, while process properties can have several types of attributes. Here too, can we take advantage by the ARA-model to understand what properties are likely for a business process. Since activities and resources are linked together, and that they change over time and space, the structure of activities, and the change of activities and activity structures of time, as well as space, are possible process properties. In Figure 13 above, I have transferred the stakeholder values from the Stakeholder Value Ranking, and connected them with different process properties. Depending on how many stakeholders that will be affected, the connections are weighted differently. This will give an indication to which properties that will drive variance within the process. Before we move on, have a look at Figure 11 to see where the Process Modular Function Deployment® is in comparison to the Modular Function Deployment®. So far, they are not that different.

### 5.3 PROCESS SOLUTIONS

After performing the Quality Function Deployment, the process properties are defined. The next step is to find process solutions that embody those properties. Inspired by the Modular Function Deployment®, which uses a Design Property Matrix to link the properties with technical solutions, a similar approach has been used to link process properties with activities and resources (see Figure 14). Instead of technical solutions, a process has activities and resources as solutions, according to the ARA-model. Some organizations might have well defined processes in terms of activities, while other organizations might not. Depending on the starting point, activities either have to be defined from scratch or they can be gathered from the existing process definitions. However, existing activities should only work as inspiration and, as with any creative exercise, it is important to think outside of the existing framework. Defining the process solutions is a very important step that will make one of the biggest impacts on the process design. There might be a risk of getting stuck on specific activities rather than the wider
perspective. Getting too deep into details makes you unable to see the big picture, use the right activity resolutions to avoid this problem, see Figure 5.

Not only activities have to be included, as resources are crucial to a process as well. Resources can include production facilities, organizational units, products, tools, knowledge or whatever might hold value for the process. They are crucial as enablers of activities, e.g. both laborers and kitchen modules are needed for the activity of installing kitchen. If resources are not included, the division of activities into modules would be meaningless, as they might be restricted by some resources. If an activity is enabled by a facility, it should not be grouped together with an activity which is enabled by another facility at a completely different geographical location.

Figure 14 shows the Design Property Matrix, different symbols connects the process properties with the process solutions. Just like with the Quality Function Deployment, the different symbols are there to weigh the technical solutions depending on which of them will be subject to variance and therefore need several module variants. In the example presented in Figure 14, there are not much variance driving the different solutions. That is in part because I decided to exclude most aspects of the process, to make it easier to take in. All physical components except for the kitchen was excluded, making it less complex. If all other components would have been included, such as floor, toilet, washing machine and doors; there might have been a process solution was called “physical modules”, for which there were several variants required. The same goes for the laborer (seen as a resource), there each type of laborer might drive one process module variant.

FIGURE 14. SHOW THE DESIGN PROPERTY MATRIX THAT SHOW THE RELATIONS BETWEEN PROCESS PROPERTIES AND SOLUTIONS. SOLUTIONS CAN BE BOTH RESOURCES AND ACTIVITIES THAT IS PART OF THE PROCESS AND IS FULFILLING THE PROPERTIES THAT THEY CONNECT TO.

Using this matrix in industry would allow practitioners to evaluate what resources and activities should be part of a process as solutions to the value it will have to create for its stakeholders. It can also be
used to see how different resources are affecting what activities are needed, several activities can be automated by technological resources, such as IT-systems or robots. In Figure 14 you can see that there is a resource called Kitchen Configurator. A configurator is a IT-tool which can put together defined module variants so that it optimizes towards target goals that is given as input. Company X will develop such a configurator to replace much of the manual activities that are involved in planning and designing the interior of the apartments today.

After the activities and resources have been defined and linked to process properties, the first module candidates should start to reveal themselves as some solutions connect to specific properties. Process solutions that connect to the same process properties should be grouped together as they are affected by the same drivers for variance.

5.4 Activity Interdependency

The ARA-model has been a necessary tool to reveal the case process in all its dimensions, as compared to the emic account of the case process, which showed it as linear. However, even if the ARA-model has proven helpful in identifying stakeholders, understanding process properties and defining process solutions, the next step of modularizing the process is directly related to the IMP-paradigm research (research that focuses on relations and networks), and an all-new addition to the Modular Function Deployment® method. The Design Property Matrix aim to group entities together depending on which properties they answer to, but there is no inherent logic within the Modular Function Deployment® which allow for grouping of entities depending on the relation of entities in space and time. For a product, that is not a problem, since a final product exist as a system in one point of time and in one location. Processes however, are spread out over both time and space, meaning that the interdependence of activities over time and space must be considered.

Some process properties might not necessarily connect to specific activities, instead they relate to the structure formed by several activities together. During the workshops at Company X, I learned that the architect sometimes has to make changes to the floorplan after the kitchen has been chosen, as the floorplan does not go together with the kitchen dimensions. The process property does not say anything about how a specific activity should be performed, instead it gives us information about how the activities involved in producing a floorplan and the activities involved in choosing kitchens for a project relate to each other. One cluster of activities must come before the other cluster of activities.

Building on the ideas of Håkansson et al (2009), I propose that activity interdependencies can be mapped using an Activity Interdependency Matrix. As mentioned in the theory chapter, activities have three types of interdependencies: serial interdependency, dyadic interdependence and joint interdependence. These different types of interdependencies can be represented by different symbols and placed in a matrix that connects the activities that was mapped using the Design Property Matrix. In Figure 15, I have done so by using four types of arrow symbols, two which represent serial interdependence in either direction, one for dyadic interdependence, and one for joint dependence.
A serial interdependence means that one activity must come before another activity, dyadic interdependence means that two activities must have continuous and close interaction, while joint interdependency means that two activities both depend on a third activity. Most crucial is to look at the dyadic interdependencies, as they show activities that most likely should not be divided into different process modules. Serial interdependence on the other hand, tells us something about how the structure of activities should be, and how module interfaces should be designed at a later stage. Activities that have joint interdependencies are candidates for sharing the same module, or interacting with the same module interface. The important thing to take with from this exercise is that a certain logic is built, which will affect how different activities and resources can be divided into activity-resource clusters that will make up modules and later module variants. It will likely be an iterative process of going back and forth between the Deployment Property Matrix and the Activity-Resource Matrix. Changing the structures, including new resources and modifying activities can help in creating more efficient activity patterns. I used the etic account of the current case process as a reference, visualized in Figure 10, to see how an improved, modularized, process might look. Figure 16 shows the difference in how activities are organized after enforcing the interdependency logic by using the steps above. The proposed modules will then be taken to the next step, where they will be checked towards internal strategies.
FIGURE 16. HERE YOU CAN SEE THE RESULT OF THE RESTRUCTURING OF THE CASE PROCESS SO FAR, COMPARED TO THE STRUCTURE SEEN IN FIGURE 10. ACTIVITIES THAT ANSWERS TO THE SAME PROCESS PROPERTIES AND WHICH HAVE THE SAME STRATEGIC GOALS ARE GROUPED TOGETHER. ONE EXAMPLE IS ACTIVITIES INVOLVED IN THE "KITCHEN MOUNTING" ACTIVITY CONFIGURATION, WHICH NOW LINK BETWEEN PROJECT, AS WELL AS WITHIN PROJECTS.
5.5 Process Module Drivers

After the Activity Interdependence Matrix, there should be some obvious module candidates. The next step, see Figure 11, is to ensure that the strategic goals of each module is in line with all activities and resources that are part of it, they should then be checked against module drivers. The idea with module drivers is to avoid strategic conflicts between the component that make up the module. The Module Driver Matrix used in the Modular Function Deployment® (see Figure 11) is relevant for modularizing processes as well, only slight modifications and additions of Module Drivers should be done. As I discussed with senior consultants at Modular Management and studied the case process, it became more and more clear that it was important to include the Module Driver Matrix in process modularization, as it helps us to decide what strategies are important for various parts of the process. Some parts might need to be efficient while other parts should be adapted to the customers need.

As mentioned before, module drivers used in the Modular Function Deployment® can be divided into three categories (reflecting traditional generic strategies for organizations): product leadership, organizational excellence and customer closeness. Erixon (1998) refers to module drivers as the “driving forces” for modularizing your product. There is no reason that the categories used in the Modular Function Deployment® method cannot be used for processes. Instead of using the name “Product Leadership”, “Process Leadership” can be used. The activities and resources used to construct the building and the interior of the apartments would most likely go under either process leadership or operational excellence. Activities associated with customer input and customer contact however, would probably go under the customer closeness category. Mixing activities that fall under different strategic categories will result in inefficiency and loss of quality. People involved in those activity clusters cannot focus fully on either strategy.

When the Module Driver Matrix was applied on the case process, conflicts among activities that had been grouped into the same module candidate was discovered, see Figure 17. Activities and resources in the “Supplier Module Candidate” had conflicting strategies, which means that they should be divided into two different modules with different strategies. A quick glance at the Activity Interdependence Matrix show that there are now dyadic dependencies between activities involved in delivery and activities involved in product development, which otherwise could be an obstacle.
5.6 Module Interfaces

Even if the goal of modularizing a process is to divide activities and resources into separate groups, that does not mean that they do not interact with other modules. There still have to be a flow of both information and resources going between the process modules. As we do not want changes in one module to affect another module, standardizing the module interfaces is important in product modularization (Erixon, 1998), the same would apply to processes. To avoid that a change in one part of the process affect the entire process, there should be an agreement on how different modules communicate with each other. A process module would need to send or receive information, and sometimes material or products under production. That means that a module interface either has to send or receive. To capture the workflow of the process, the process module interfaces has been divided into output and input interfaces. The output must be synchronized with the input of the module variant that it connects to and vice versa. Receiving input could be done by logging into an IT-system to receive data, or it could be through a meeting where information is communicated in person. Using the Activity Interdependency Matrix as a guide, we can see how activities that are now grouped in different modules relate to each other. The Modular Function Deployment® uses a Module Interface Matrix to determine which modules must have interfaces between each other, but also what kind of module interface. The same matrix has been used, but new types of interfaces has been introduced that are more relevant for processes.
There is either an information transfer or there is a transfer of a physical entity between different process steps. Information can be transferred either by a meeting or through a digital interface. A meeting is preferred if it is high variance and complexity in output of one module to another, while digital interface can be used if a form or document can be used as the only means for transferring information. Meeting should have clear goals of what the purpose of the meeting is and an agenda which dictates the procedures of the meeting. For both types of information interfaces, templates should be design so that the receiving module only get relevant information in without uncertainties. If a physical entity as to be transferred, such as a kitchen component, the process module interface should be coordinated with the product modules, as they are likely to depend on each other. A kitchen module set (a group of product modules that will make up a kitchen for an apartment) that has a standardized interface can be mounted with ease if the process modules that is mounting the kitchen know exactly how the physical interfaces of the product modules are defined, then they can work more efficiently. In Table 1 below, you can see the different types of module interfaces that I propose for process modularization.

<table>
<thead>
<tr>
<th>Name</th>
<th>Shortening</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Interface</td>
<td>D</td>
<td>Transfer of information that can be in standardized format.</td>
</tr>
<tr>
<td>Meeting Interface</td>
<td>M</td>
<td>Transfer of more complex information that cannot be transferred in standardized format.</td>
</tr>
<tr>
<td>Physical Interface</td>
<td>P</td>
<td>Transfer of physical products, tools or other physical entities.</td>
</tr>
</tbody>
</table>

TABLE 1. SHOW THE THREE TYPES OF INTERFACES THAT HAVE BEEN IDENTIFIED.

If you look at Figure 18 below, you can see that the “Supplier Module” has been split into two modules after the conflict of strategy was discovered using the Module Driver Matrix. They are now divided into a Product Development that develops and improves the product together with the kitchen supplier, and a Delivery module that work close with the supplier in improving the logistics of delivering the kitchens to all the construction sites. You will also discover another new module that was added after a failed attempt to create module interfaces. The first attempt showed that there would be a lot of interfaces between different modules which would create unnecessary complexity. Instead I decided to add a IT-system module, which is thought to be a software through which a lot of the information transfers can occur. That gathers all information in the same place, allowing for better governance and fewer module interfaces.

![Figure 18. The module interface matrix shows how the modules connect to each other with different types of interfaces. The arrows shows which way the flow goes, which module has a input and which module has a output interface between the two modules.](image)

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Two modules that contain activities which were marked as having a joint interdependence could have the same type of input module interface. Most module variants probably have both output and input interfaces. But there are examples of module variants that do not take input from other modules but only give output to other modules. To be able to take input from another module variant, there must be an output from that module variant. A module variant that can scan its environment to gather information without connecting to a standardized output interface of another module variant cannot be said to have an input interface. The same goes for modules that only take input but does not give output in a standardized manner to other module variants within the process. An example of that could be an archiving module of a process, that are legally obligated to archive documents.

It is likely that the product development module need to have meetings and discussions with both the Production Module, that mounts the kitchens, and the Costumer Module, that meets the customer, in what their opinions are for development of the kitchen. The process of improving the interior design process is its own activity configuration and is why those activities has been excluded here. That process could of course be modularized as well, but for now I have only modularized the activities which belongs to the everyday operations. As mentioned before, some of these activities might still belong to other activity configurations.

Figure 19 below show the proposed modules of the case process with interfaces and how they connect with each other. Even if some activities are excluded, this mock-up serve as a good example of how process modules could look in a hot case. If a new process design is to be implemented in an organization it is likely that the changes have to be implemented one by one.

**Centralized**  
**Automated resources**  
**Regional**  
**Local sites**

![Diagram of process modules and interfaces](image)

**FIGURE 19. THE PROPOSED MODULES, ITS MODULE INTERFACES AND HOW THEY CONNECT. EACH MODULE IS PLACED AT DIFFERENT LEVELS, ALL ACTIVITIES THAT I HAVE LOOKED AT ARE MOVED FROM THE LOCAL SITES TO EITHER REGIONAL OR CENTRAL LEVEL. TWO OF THE MODULES ARE AUTOMATED DIGITAL RESOURCES THAT WILL REPLACE ACTIVITIES.**
6 DISCUSSION

There will now be a discussion about the overall contributions of this study, both for industry and for academia, as well as a discussion on how the ideas presented will impact these domains. The chapter takes off in the research questions presented in the introduction and then move on to discuss possible societal and etic issues.

During this study, the case process has been mapped and then analyzed by using the ARA-model, which has shown the case process as part of a network of activities, resources and actors. Adaptations and improvements of the Modular Function Deployment® has been presented in parallel with the modularization of the case process, contributing towards a process modularization method, as well as offering an example of how that approach can be used in practice. Both the mapping and analysis of the case process, as well as the modularization of the case process, contains the answers to the research questions.

The first research question asks if there are any additional relevant information that is revealed by depicting the case process from an ARA-perspective. The workgroup at Company X they used a traditional approach of portraying a process as sequential and parallel activities, an approach which has been criticized by scholars for not capturing the true nature of a business process (e.g., Alotaibi, 2016). One of Company X’s main goals has been to find a common process for all regions and project, which their approach might help in achieving. Nevertheless, by only lifting out activities directly related to the interior of the apartments, the emic account of the case process is a virtual process that does not exist as such in reality. Participants in the workshops, involved in different stages of the case process, struggled to see how the case process fit in their own view of reality. When the case process is portrayed using the ARA-model, it was revealed that it is a gathering of activities that all belong to other processes (see Figure 10). This resonates with research question one, since the traditional approach of visualizing processes failed to capture that aspect of the case process (see Figure 9). In addition, the network perspective shows more clearly how the case process move between organizational units, both within and without Company X. With these aspect mind, the ARA-model depicts the case process closer to reality, meaning that additional information about the true state of the case process is revealed. That supports the claim of ARA-advocates, that the ARA-model captures the true nature of the business landscape (Håkansson et al., 2009). By revealing different actors involved in the case process, complexity can be understood by studying how their different demands on the process might have shaped it. However, there is still much work in exploring how the actor and resource aspect of the ARA-model relates to business processes. These aspects have been integrated in the modularization of the case process, but due to time restrictions of this study, they have not been fully integrated in the analysis of the mapped case process. Actors are somewhat represented in Figure 10, by how each cluster of activities tend to represent an actor’s (organizational unit’s) intent. However, resources are not given much attention in this study. Future research will have to explore how an ARA-analysis of resource combinations in business process can contribute towards improving models for portraying processes even more in line with reality. If business processes are to be seen as more than abstractions, the true conditions of the business landscape have to be taken into consideration. Actor’s intents, as well as the limitations that available resources bring, affects how activities can be configured.

The second research question asks how the Modular Function Deployment® method should be adapted so that it can be applied to business processes. That has been explored by studying the case process to
see how it relates to the Modular Function Deployment® method (originally designed for products), meaning that the proposed modifications of the method have been done with a particular business process in mind. That entails that it is important to be careful about generalizing the results to other types of business processes. Conditions of different business processes might affect how certain aspects of the method for modularizing them should be designed, meaning that there could be some aspects of the modified Modular Function Deployment® method that need to be improved or adapted to work in a more general setting. The contribution of this study, however, is not in the details but in the proposed overall logic that is embodied in the matrices presented earlier. Tuunanen & Merisalo-Rantanen (2012) proposed that a method for service modularization (which overlaps with process modularization), should have a holistic approach, taking more than the customer’s perspective into account. The proposed method of this study integrates a stakeholder perspective and take organizational strategies into account, which is in line with their reasoning. Earlier publications on process modularization use an ad-hoc approach that help improving the intelligibility of the process but fail to integrate a modular logic in the process design (Reijers & Mendling, 2008). This study show how modular process design can be more than an ad-hoc division of a process into sub-process by sorting activities and resources by how they relate to stakeholder values, internal strategies and their inter-dependencies.

The potential benefits of process modularization should be similar as those with modularizing a product. If different parts of a process interact through standardized interfaces, it allows independent process modules to make changes and improvement within the modules without affecting the rest of the process. There are several potential reasons for why that might be desirable, including adapting to a change in external circumstances. But there are also other potential benefits, such as enabling different strategies for different parts of the process, or reusing process modules. In the long run, process modularization could lead to what Daft and Levin’s (1993) refer to as the Modular organization. Autonomous, flexible and self-empowering units of people that would replace big, complex, hierarchical and bureaucratic organizations. The development of sophisticated IT-systems would most likely help in enabling that type of organization, replacing much of the administrative work. However, much of the administrative work is also integrated in the process architecture by standardizing process module interfaces and is not necessarily dependent on IT-solutions.

Innovation and industrialization has had an enormous impact and will continue to forcefully restructure society. Industrialization has led to the birth of massive organizations that has brought with it extensive administrative work. Modularizing business processes is a way to deal with the complexity of big organizations bring with them, by reducing dependencies and standardizing interaction between process modules. The impact for employees could therefore be an increased sense of empowering, as they are free to improve their own process modules without the risk of affecting the rest of the organization.
7 CONCLUSIONS

This study has explored a new approach for depicting business processes that reveal process properties that traditional process models fail to capture. Compared to a physical product, processes are abstract and therefore reliant on models to describe them. The ARA-model has proven to provide information about business processes that is essential for process-modularization. It showed how the case process was part of a bigger network of activities, resources and actors. Only focusing activities is not enough when designing processes, since they depend on resources to enable them and actors that have demands on them. The goal with process modularization, to decouple parts of a process without affecting the rest of the process, is impossible if modules in different process modules still depend on each other through a co-dependence on a common resource. These ideas have been incorporated into the Modular Function Deployment®, so that it is adapted for business processes.

Going into this study, there were uncertainties in what process modularity is or should be. If the logic of the Modular Function Deployment® method is applied, process modularization is more than an ad-hoc division of processes into sub-processes. By seeing process modularization as a method for designing business processes rather than a tool for dividing them, the benefits could be similar to those of product modularization. The method developed in this study ensure that activities and resources are grouped so that they resonance with the same external and internal demands. By incorporating standardized process module interfaces into the process architecture, each process module can improve internally while not affecting the rest of the organization. The modified version of the Modular Function Deployment® method proposed, contributes towards a new approach for process design.
REFERENCES


