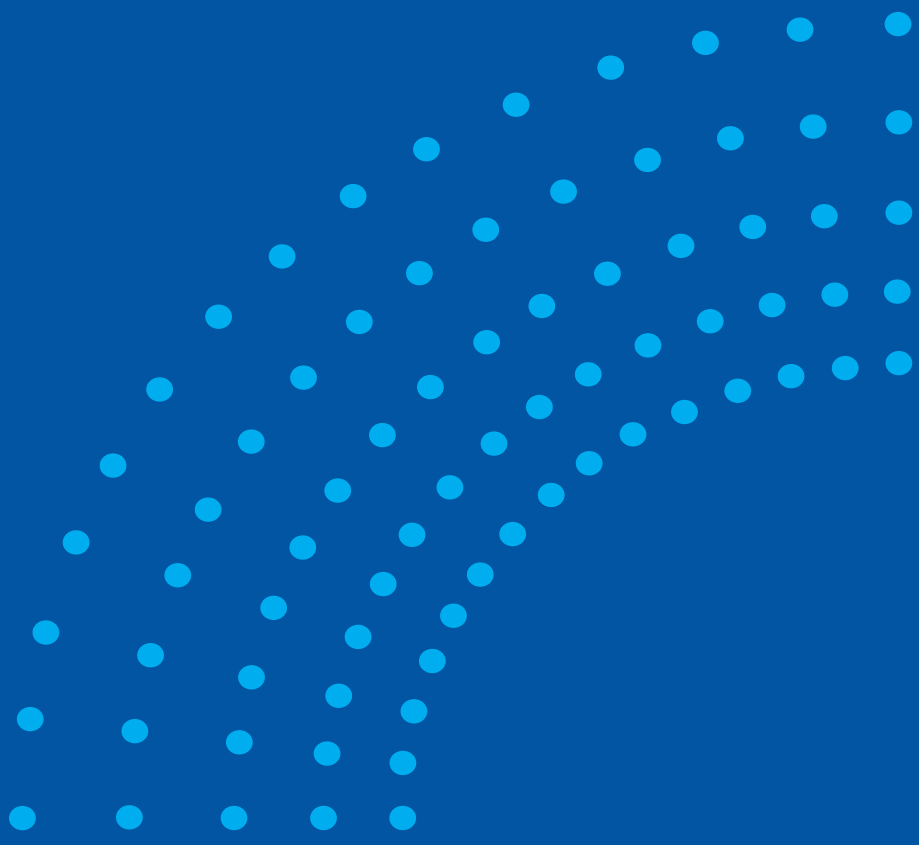
Master Thesis in Informatics

Finding the Virtual Manufacturing Business Case

A study of how to assess the value of Virtual Manufacturing

Kristoffer Porsemo, Saeideh Salehinia
Göteborg, Sweden 2007

Department of Applied Information Technology



REPORT NO. 2007/87

Finding the Virtual Manufacturing Business Case

A study of how to assess the value of Virtual Manufacturing

Kristoffer Porsemo
Saeideh Salehinia

Department of Some Subject or Applied Information Technology
IT UNIVERSITY OF GÖTEBORG
GÖTEBORG UNIVERSITY AND CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2002

Finding the Virtual Manufacturing Business Case

A study of how to assess the value of Virtual Manufacturing

KRISTOFFER PORSEMO and SAEIDEH SALEHINIA

© KRISTOFFER PORSEMO and SAEIDEH SALEHINIA, 2007.

Report no 2007:87
ISSN: 1651-4769
Department of Informatics
IT University of Göteborg
Göteborg University and Chalmers University of Technology
P O Box 8718
SE – 402 75 Göteborg
Sweden
Telephone + 46 (0)31-772 4895

Chalmers Repro
Göteborg, Sweden 2007

Finding the Virtual Manufacturing Business Case

A study of how to assess the value of Virtual Manufacturing

KRISTOFFER PORSEMO and SAEIDEH SALEHINIA

Department of Applied Information Technology

IT University of Göteborg

Göteborg University and Chalmers University of Technology

SUMMARY

This master thesis concerns the problems of IS/IT evaluation. IS/IT evaluation can be viewed as a part of a justification process for investing in IS/IT. Traditionally these evaluations have been performed with a technical or economical approach, focusing on efficiency and productivity expressed in quantitative measures. However, having these approaches increases the risk of not understanding the different social interpretative values of a system. In the light of this, the productivity paradox has evolved; showing fairly static productivity and rising IS/IT expenditures. At the same time more and more businesses get reliant on IS/IT. Researchers talks here about a need to extend the management's view of how to evaluate their investments.

This study is an attempt to create a deeper understanding on how business benefits can be evaluated when investing in new technology. The study has an interpretative approach, aimed to create an understanding for how benefits from concept of Virtual Manufacturing can be evaluated in the justification phase of an investment. Virtual Manufacturing is said to optimize the product development processes within a company, creating great strategic improvements.

We have performed six interviews at the Volvo Group in order to understand the problem area and find a solution that can be applied within the product development domain. The result of this study is a model that highlights the various aspects that should be discussed when investing in this kind of technology successfully.

Keywords: business value, benefits management, benefits identification, evaluation, IS/IT investment, virtual manufacturing, product development, critical success factor

Finding the Virtual Manufacturing Business Case

A study of how to assess the value of Virtual Manufacturing

KRISTOFFER PORSEMO and SAEIDEH SALEHINIA

Department of Applied Information Technology

IT University of Göteborg

Göteborg University and Chalmers University of Technology

SUMMERING

Den här magisteruppsatsen berör problematiken med IS/IT evaluering. IS/IT evaluering kan betraktas som en del av en rättfärdigandeprocess vid IS/IT investeringar. Traditionellt har dessa evalueringar utövats från en tekniskt eller ekonomiskt utgångspunkt som fokuserar på effektivitet och produktivitet uttryckt i kvantitativa mått. Dessa utgångspunkter ökar dock risken att inte förstå de olika socialt tolkande värdena inom ett system. I ljuset av detta har produktivitetsparadoxen utvecklats, vilket visar på statisk produktivitetsökning och stigande IS/IT kostnader. Samtidigt har allt fler verksamheter blivit beroende av IS/IT. Forskare pratar här om att utökade lednings syn på hur de ska evaluera sina investeringar.

Den här studien är ett försök att skapa utökad förståelse hur affärsnytta kan evalueras när man investerar i ny teknologi. Studien tar en tolkande utgångspunkt och försöker förstå hur nyttan från konceptet Virtual Manufacturing kan evalueras. Virtual Manufacturing sägs kunna optimera produktutvecklingsprocessen inom ett företag, vilket skapar stora strategiska förbättringar.

Vi har genomfört sex intervjuer inom Volvo Gruppen för att få en förståelse inom problemområdet. Resultatet av studien är en modell som belyser de olika aspekter som bör diskuteras om man ska lyckas med en investering i den här sortens teknologi.

Keywords: business value, benefits management, benefits identification, evaluation, IS/IT investment, virtual manufacturing, product development, critical success factor

Preface

Our work has been a long journey, filled with a vast sea of information that we needed to sail across. We had to put down a lot of hard work in order to create an understanding about the problem area and to analyze the interview questions.

We would never have been able to reach shore without the help from the following people we want to express our thanks:

- Dan Havner, our industrial coach at Volvo IT, for his time, guidance and all good advises. He have enlightened the “real-world” problems within product development and helped us with generously sharing his experience.
- Our supervisor Elisabeth Frisk, IT-university of Gothenburg, for her guidance, advises and great effort in helping us through this process.
- Finally, we would like to show our deepest appreciation to our respondents for their time. Without their participation we would never have been able to get a practical insight in our problem area.

Thanks again for all your help!

Gothenburg, 3rd of June, 2007
Kristoffer Porsemo and Saeideh Salehinia

Göteborg, 2007

Content

TABLES

Figures

1 Introduction

This chapter introduces the reader to our research area and focus on the reason for our study. We will start by discussing the problem background, which will lead down to our problem area. The discussion will produce our main question and purpose for this study. Further, we will give a description of our delimitations and central definition.

1.1 Problem background

During the decades the role of Information Technology (IT) and Information Systems (IS) have changed from being a tool for rationalization, by automating earlier paper-based processes, to a strategic tool for value creation (Pearlson, 2001). Today IS/IT is perceived to give a competitive advantage (ibid) and at the same time considered as an essential business component when an organization aims to achieve its overall vision and objectives (Skaug, 2005). As a result, organizations have become reliant on IS/IT (Irani and Love, 2001). Investing in IS/IT is also perceived to involve risk and represents at the same time substantial financial investment (Willcocks, 1992). Statistics show that over 70 percent of IT investments fail to deliver the intended benefits (Ward and Daniel, 2006).

"You can see the computer age everywhere, but in the productivity statistics."
(Robert Solow, 1987)

Some authors claim that this reliance to IS/IT and rising expenditures have give birth to the so called Productivity Paradox (Hochstrasser, 1993). This term originated from findings in studies during the 1980s, which concluded that there were no connection between IS/IT investments and the productivity in the US economy. The term was first stated by Solow (1987). This issue grew in interest during the 1990s and was widely discussed but considered little understood (Brynjolfsson, 1993). Findings continued to point toward fairly static productivity and rising IS/IT expenditure (Hochstrasser, 1993). These studies were done on different levels, such as country level, industrial level and organizational level. Findings from these studies could show that IS/IT provide impact on productivity, but that it needs further research in order to explain why some industries have not seen gains of it while others have (Dedrick et al., 2003).

Then, who is to be blamed for these failures? According to a study performed by Doherty and King (2001, see Ashbury and Doherty, (2003) 30 to 70 percent, can be largely blamed on the failure of organizations to address the businesses change and the wider organizational issues when investing in IT. Justifying IT investments is however perceived increasingly difficult (Silk, 1990). This leads us to our problem area.

1.2 Problem area

1.2.1 Evaluating IS/IT investments

Many factors have an impact on IS/IT evaluation but there have been argued that one of the most critical is "*… a sound basis from which to make judgments for the need for and the justification of a system*" (Clay et al., 2003, p. 52). Traditionally justification of IS/IT investments have emphasized on cost savings (McBride & Fidler, 2003). These evaluations

have had an economical approach focused on monetary measurement of organizational effectiveness and productivity (Bannister and Remenyi, 2003). According to Clemons et al. (1995), these methods require that the initial investment, the incremental cash flows, cost of capital and the economic time horizon of the investment are known. Hallikainen et al. (1998) argues that it is assumed that all the effects can be traced, measured and expressed monetary. Intangible costs and revenues are either assumed to be zero while the subjective criteria are ignored. Evaluating and quantifying benefits from an economical approach is also perceived difficult. A benefits nature is mainly intangible, uncertain and extremely difficult to quantify in a meaningful way (Symons & Geoff, 1988). This leads to that subjective arguments are needed (Powell 1992). Another problem with benefits is that they are realized during a long period of time, which makes traditional investment evaluation methods insufficient (Brown, 2005). As a result, studies have noticed that IS/IT investment decisions frequently are based on "*acts of faith*" (Farbey et al., 1999), which other authors refer to as a 'ad hoc management' (Irani & Pervan, 2001, see Hallikainen et al., 1998).

A need for a changed evaluation approach

The measurement of business value of IS/IT investment has been under heavily debate (Lin, Per & McDermid, 2005). Continuing on the discussion above Irani and Love (2001) argue that the IS/IT evaluation process often is ignored, ineffectively performed or inefficiently carried out. Furthermore, managers consider that IS/IT evaluations takes too long, demands a significant amount of money with little visible return, and involves too many people with departmental or individual political agendas. According to Symons and Walsham (1988) most work on IS has focused on the technology, which is socially neutral. Ashbury and Doherty (2003) argue that IS/IT investments have been viewed as an exercise in technical change rather than social-technical change. Therefore, they advocate a change in evaluation approach that oversees unforeseen and unresolved negative impacts on the organization. This would reduce the probability of system failure and at the same time reduce that potential that beneficial impacts not gets fully realized.

Many researchers within the IS/IT evaluation area have advocated a change in evaluation approach. Irani and Love (2001, p. 186) advocate "*a need to extend management's view of IS benefits and costs*". This is also agreed by Huang (2003), who adds that a deeper understanding of perspectives of individuals and groups could reveal the human and political aspects is needed. Hallikainen et al. (1998) also remarks that there is lack of systematic evaluation practice that is seen as a problem by companies.

As we have noticed there is a need to create an understanding of how to manage benefits in IS/IT evaluations, and there is a need for further work within the research area. The success or failure of an information system and the delivery of benefits are dependent on the people who are using it. A successful evaluation approach will seek to understand the users' perception of the proposed system.

1.2.2 Virtual Manufacturing as an IS/IT investment

Continuing the discussion about IS/IT investment evaluation we will now discuss Virtual Manufacturing as an IS/IT investment within the Product development domain.

According to Cooper (2000), there are two ways for companies to win when they develop new products: they can either *do projects right*, or win by *doing the right projects*. Either way,

winning is not easy. Aggressive innovative competition, globalization of markets, technological advances, ever-changing customers' needs and shortened product life cycles stresses companies to develop new products more rapidly. However, even though competing with new products enables opportunities, there is a substantial risk (Ernst, 2002). An estimated 46 percent of the resources devoted to conception, development and launch of new products go to ventures that don't succeed – they fail, or never make it to market (Cooper, 2000).

In order to keep up to this competition new technology such as Virtual Manufacturing (VM) has been adopted by the industry (Kim, Choi & Choi, 2004). VM enables, with the use of IS/IT, optimization of the development of new products and its manufacturing processes (Karlsson, 2005). As an example, VM software lets production engineers create simulations of automated product systems on their computer workstations, and then analyze these simulations before investing in capital equipment. Since there are many steps in preparing for automated production - from designing tools to programming factory floor equipment – can be performed long before the actual production start-up at far less cost than before (Lederer, 1995). However, these optimizations involves various visualizations and data integration aspects that takes place in a collaborative environment (Shridhar & Ravi, 2002), which in turn creates an added complexity for the realization of benefits.

The product development domain is considered vital for managing the business strategic development (Nilsson, 1999) and at the same time an important determinant for sustained company performance (Ernst, 2002). Therefore, investments in IS/IT play an important role in creating improvements. Still, business managers ask themselves *how* to evaluate investments in new technology in order to create sustainable business benefits and *how* to identify and manage these benefits in order to justify the investment. Within the product development domain managers ask themselves the same questions. But, *what* is the resemblance and difference between a VM investments and IS/IT investments in general? There are already methods and an approach to evaluate IS/IT investments in general, but even so, they might not fully take advantage of an interpretative approach that is designed to include the different issues VM has on an organization. Nevertheless, making a VM investment decisions cannot possibly be made on acts of faith.

1.3 Purpose and main question

The purpose is to create understanding for how VM can be evaluated in the justification phase of an investment. The objective is to create an evaluation framework for VM which consider criteria that have been put forward from both a theoretical and an empirical view. Implications for practice will be a model which could facilitate the evaluation and understanding of the contribution of VM.

The main question raised in this thesis is:

> ***How can the benefits of Virtual Manufacturing within the product development domain be evaluated?***

In order to answer our main question in a structured way we need to create an understanding of how benefits within the Product Development domain are perceived, since that is the context of our research. We also find it necessary to create an understanding of the different

prerequisites for benefits to be realized within the product development domain as well as understand factors influence the benefits of VM. We have therefore added the following sub-questions:

1. How can benefits be described within the product development domain?

2. What factors influence the benefits of Virtual manufacturing within the product development domain?

1.4 Delimitations

This study and its empirical findings is delimitated to one company – the Volvo Group - wherein IS/IT investment evaluation, product development and Virtual Manufacturing have been researched within the product development domain. We are aware of the fact that our own interpretation will influence the course of action of this study, which includes the result, discussion and conclusion.

The study has been performed with limited resources of time and number of respondents. We have chosen six respondents from a senior management level.

The theoretical framework for IS/IT investment evaluation approaches in this study uses an economical and interpretative approach, emphasizing on the interpretative approach.

While describing the different Benefit Management approaches we will only describe the initial identification phase of benefits, since our study isn't focused on the complete Benefits Management process.

While describing Virtual Manufacturing a general approach to technology is used.

1.5 Central definitions

Virtual Manufacturing (VM)

VM enables, with the help of different advanced simulation tools for different applications, a business to optimize the development of new products and its manufacturing processes (Karlsson, 2005).

Product development (PD)

PD is a domain which involves everything from invention, product design, marketing research, construction, manufacturing and marketing. The main purpose of PD is to create new products (Nilsson, 1999).

Product development process (PDp)

PDp is an acronym for the Product Development process. According to Kotler et al. (2001), the PDp is crucial for organizations in order to successfully update their product lines and gain competitive advantage (Kotler et al., 2001).

Critical Success Factor (CSF)

CSF refers to factors that have an important impact on the success of new products (Ernst 2002).

Benefit

There are many different definitions of the term benefit. According to Thorp, (1998, p. 254, see Bennington & Baccarini, 2004), a benefit *"is an outcome whose nature and value are considered advantageous by an organization"*. UK Office of Government Commerce defines benefits as: *"… the quantification of the outcomes and are used to direct the programme and inform decision-making along the way*". Ward, Murray and David (2004, p 7) defines benefits as "*an advantage on behalf of an individual or group of individuals*" which is perceived by the stakeholders exposed to change.

Benefits management

Benefits management is the procedural approach of how to handle the benefits evaluation to realize benefits of IS/IT investments (Lin & Pervan, 2001). Bennington and Baccarini (2004) suggest the following phases: Benefits identification, Benefits realization planning, Benefits monitoring and Benefits realization. Ward and Daniel (2006) extend this model with a final "establish potential for further benefit"-phase.

BA/BU

A *Business Area* (BA) creates the conditions for proximity to customers and efficient resource utilization within the Volvo Group. Business areas at Volvo are: Mack/North America, Renault Trucks Volvo Trucks Volvo Bus, Volvo CE, Volvo Penta, Volvo Aero, Financial Services, Nissan Diesel.

Linked to these companies are a number of *Business Units* (BU) that supply components and services to support the Group's business areas globally. The major business units at Volvo are: Volvo Powertrain, Volvo IT, Volvo Parts and Volvo 3P (Volvo Group).

IS/IT

Information System (IS) is a collection of components that work together to provide information to help in the operations and management of an organization. An IS use different types of technology and communication equipments called Information Technology (IT) (Nickerson, 2000).

2 Method

This chapter describes different scientific methods and approaches. By doing this we will explain the different reasons behind our choice of method and approach for our research study. We will also give a description of the course of action, the literature and empirical studies, for this study.

2.1 Scientific methods

There are different methodological approaches within the scientific theory that a research can be conducted in: *positivism* and *phenomenology*. According to Comte (see Patel & Davidson, 1994), the positivistic methodological approach has two main sources for knowledge; the reality that we can observe with our senses and what we can reason with our logic. It is important to make a difference between belief and knowledge and only draw conclusions from exact and secure information. Therefore, the scientist should be neutral and impartial towards the subject and the conclusions. The scientist should also focus on facts and search for causal connections and basic laws. The phenomenology is the opposite of the positivistic methodology. According to Lundahl and Skärvad (1999), phenomenology is distinguished by the scientist's own conclusions regarding the subject. This kind of scientific perspective argues for the personal expectations and experiences, which are seen as an important ingredient in the scientific knowledge. This makes it difficult to separate the domain of facts and the domain of value in scientific studies.

The researcher has to take the decision regarding how to handle the problem area. There are two main approaches: *inductive* and *deductive*. According to Patel and Davidson (1994), the inductive approach refers to empirical findings before the scientist has any theoretical findings. The scientist formulates the theory based on the empirical findings. The deductive approach takes a standpoint in general principles in the theory to make more specific conclusions of single events in the empiric (Backman, 1998).

2.1.1 Different research methods

The usage of the methods depends on the purpose of the study. The *qualitative* method is used when the scientist wants to create a deeper understanding for a specific subject, area or situation (Björklund & Paulsson, 2003). The qualitative data that comes out from a research is often data that cannot be measured. The qualitative method is often time consuming and it can be difficult to analyze and understand the collected data (Easterby-Smith et al., 1991). In a *quantitative* research, the collected data can be measured and evaluated by numbers (Björklund & Paulsson, 2003). According to Backman (1998), the quantitative method is formalized and structured. Examples of this kind of method are experiments, tests and questionnaires. The quantitative method is economic and not time consuming.

The collection of data is a crucial part of the research process which enables the research. There are two different kinds of data: *primary* and *secondary data*. The purpose of primary data collection is to use the data in the research. There are different methods for this kind of data collection, questionnaires and interviews are two examples. Secondary data is the available data that can be collected from earlier academic articles, literature and documentations (Halvorsen, 1992).

Denscombe (2000) mentions four different methods for collecting data. These are questionnaires, interviews, observations and literature. Since each method has a different approach, they should be used depending on the situation. The characteristics for the collected data are dependent on the available resources. Since the resources for data collection usually are limited, the scientist should make some decisions regarding how the resources should be used in the best possible way. In general, the decision concerns which method to use for data collection in the research. The decision is concerning collecting superficial information from a large number of people, or to collect detailed information from a small group of people (Denscombe, 2000). There are some examples of the different methods, their advantages and disadvantages.

Table 1 *Summary of data collection methods.*

	Example	Advantage	Disadvantage
Questionnaires	• Questionnaires	• Broad coverage • Inexpensive	• Poor answering frequency • Impossible to control the reliability
Interviews	• Focus group • Telephone interviews	• Deepness of the information • Highly validity	• Time consuming • Complicated analyze
Observations	• Experiments	• Direct data collection • Effective	• Simplifying • Large risks
Written sources	• Literature • Internet	• Cost reducing • Access to data	• Reliability of the source • Secondary data

2.2 Our research approach

We consider that the phenomenological approach has been used in our research since our purpose has been to create an understanding. We are aware of the fact that our own opinions and values may have influenced the collected data. However, our ambition has been to be as objective as possible.

We have in this research decided to base our study on the qualitative approach since the purpose of this approach is to seek a deep knowledge and understanding of the totality. The reason for this decision is the consideration to the main question and problem area. We have also mainly used interviews in order to collect empirical data.

Our study is based on deductive approaches since we have based our empirical finding on the theoretical findings, thereafter we have made conclusions. We have in our study discovered that the theories are not complete so we have in the analyzing phase created new theories. Hence we have used the inductive approach as well.

We have in our research used both primary and secondary data. The primary data has been collected through the qualitative semi structured interviews. The secondary data has been collected from earlier studies that we have found in the literature, databases, the Internet and Intranet at Volvo IT.

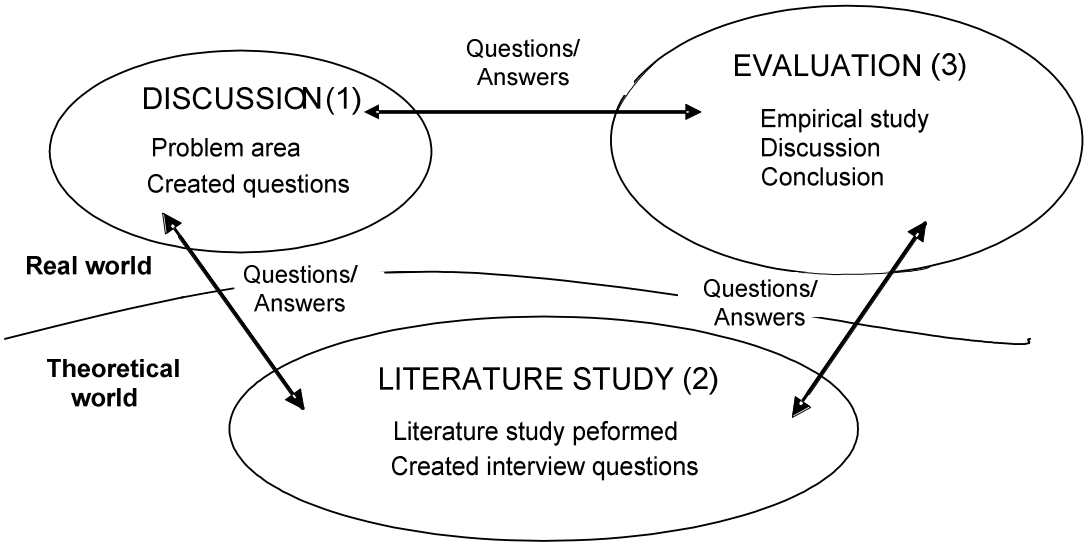
2.3 Course of action

In the initiating phase we had some discussions with our industrial supervisor at Volvo Information Technology and our academic supervisor at the IT-university to define and understand the problem area and design questions to find answers for. Thereafter we started to study the literature, which also constituted the base for our interview questions. We performed a number of interviews and during the time we also started our search for empirical material from the Intranet at Volvo IT.

After the interviews were performed we started to analyze our collected primary data, where we made comparisons between the empirical findings and the theory. The analyzing phase was very time consuming. During the entire period we had constantly meetings with our academic supervisor at the university where we discussed our findings, thought and ideas. In the ending phases of our study we were able to design a model based on our findings and analyses, we could make conclusions and present a result.

Our course of action has been an iterative process as described in Figure 1. This figure is originally based on Checklands Soft System Methodology, which is fully described in Appendix 4.

Figure 1 *Course of action (Checkland Soft Systems Methodology), modified figure.)*



2.3.1 Literature study

During the initiating discussions, we were able to divide the problem area into three different areas; Virtual Manufacturing, Product Development and IS/IT investments evaluations. We could during the literature searching focus on these three areas. Most of the secondary data could be found in article databases at the Economical library of Gothenburg University.

Databases used were: *Academic Search Elite*, *Science Direct*, *Wiley Inter Science* and *Emerald Library*. Articles were obtained from the following scientific journals: *Journal of Information Systems, Information Systems Research, Journal of the Operational Research Society, European Journal of Information Systems, Journal of Applied Systems Analysis, Journal of Information Technology* and *Journal of Global Information Management*.

Some of the searching words we used were: *Product development process, success factor, Virtual manufacturing, IT investments, IT evaluations, business benefits, benefits evaluation, value, measure,* tangible, *intangible* and *assessment*.

Our search led to a huge amount of findings where we had to select the most relevant theories for our problem areas, which was a time-consuming process. Another challenge during the literature study was that Virtual Manufacturing and Product Development were unknown areas for us.

2.3.2 Empirical study

The primary data for our study was found mainly through our interviews. Other sources used in our empirical research were the intranet at Volvo IT. During this study we have had continuous dialogs with our industrial supervisor, who guided us in our search of empirical information.

2.3.3 Interview approach

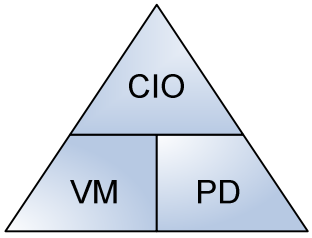
The primary data for our empirical investigation has mainly been collected through six qualitative semi-structured interviews. The purpose of these interviews was to collect empirical data which later would be compared to our theoretical findings. This process has been a challenge for us due to required understanding and knowledge of the theory and the empirical. We handled this challenge by increasing our knowledge during the time.

Selection of respondents

The selection of the respondents for our research was decided in collaboration with our industrial supervisor at Volvo IT. Our request was to perform six interviews with respondents who had excellent insight of VM, Product development (PD) and IS/IT investments. After reviewing our request our supervisor did the final selection of respondents.

All of the selected respondents had long working experiences within the Volvo Group. Most of the respondents had worked within Volvo for 20 to 30 years, at different Business Areas/Business Units. Since they have all worked in different committees and groups within the Volvo Group, we decided to divide the respondents into three areas, which we henceforth will call levels. Each *level* had two respondents. The respondents from CIO-level worked with high level investment decisions. Respondents from VM level were experts in VM-issues and had long experience with VM-implementation issues within the product development domain. Finally, respondents on PD level had long experience of the product development process.

Figure 2 *The different respondent levels.*



Interviews

We based our interview questions on the interview model below, which in turn were based on the theories. The purpose of the model was to give a structure to our interview questions. To insure the quality of the questions, we had some discussions with our academic supervisor where we did some changes in our questions.

One of the six interviews was a telephone interview due to that the respondent lives in North America. The other interviews were performed regularly in Gothenburg. The duration of all interviews was between 80 and 100 minutes, and all of the interviews were, with the knowledge and allowance of the respondents, recorded. The recorded material was thereafter transcribed and analyzed. This process was the most time consuming process during the entire study.

To be able to prepare the respondents for the interview and the subject that would be discussed, we sent them our interview questions and a document explaining the purpose of our study before performing the interviews.

2.4 Designing interview questions

After reviewing the different theories presented in the forthcoming chapters, we designed an *interview guide*, in order to give structure to our interview questions regarding PD and Critical Success Factors of product development, which could be compared to the effects of VM. Our interviews also included questions about IS/IT investments evaluation.

This model is based on the collected theories about the product development process by Cooper (2000) and Olsson (1997); and the theories about Critical Success Factors mentioned by Ernst (2002) and Cooper (2000) and Cooper (2004).

Figure 3 *Sample of interview questions*

	Product Development-phases**					
		1	2	3	…	n
Critical Success Factor*	PDp					
	Stakeholders					
	Culture					
	Role and Commitment of Senior Management					
	Strategy					

* Theories based on Cooper (2004) and Ernst (2002)
** Theories based Olsson (1997) and Cooper (2000)

The interview guides for Virtual Manufacturing, Product Development and IT-investments and IT-evaluations can be reviewed in Appendix 3.

3 Theory

This chapter will introduce our theoretical framework. The chapter is divided into three parts. First, IS/IT evaluations and Benefits Management will be introduced, then Product Development and finally Virtual Manufacturing. Through these parts we will create a theoretical framework that will be used in order to understand our problem area and answer our main question.

3.1 IS/IT Investment Evaluation and Benefits

IS/IT evaluation can be considered as a multidisciplinary topic where different approaches and perspectives can be applied (Berghout & Remenyi, 2005). These evaluations can be performed at different levels such as macro, sector, firm, application and stakeholder levels (Frisk and Plantén, 2004).

The investment decision process of an IS/IT project involves different stakeholders. These can be divided into five groups involved each having their own set of objectives and expectation from the outcomes of an investment (see Table 2) (Milis & Mercken, 2004, see Love et al., 2005).

Table 2 *Parties involved in IT investments (Love. et al., 2005, p 571).*

Parties involved in IT investments	Objectives and expectations
Organization (management)	Interested in the gains (financial/and other) generated by the investment. Seeks to ensure that the project is implemented on time, within budget and to user requirements
Users	Technology should meet their requirements while integrating flexibility to adapt to changing requirements of users/customers
Project team (implementers)	Focus on short-term criteria set by sponsors (used to judge their performance)
Supporters (sub-contractors)	Focus on short-term criteria
Stakeholders (do not benefit from or influence the investment)	Might support or oppose the investment – possible covert resistance

According to Symons (1994, see Lin & Pervan, 2001), evaluation is a process to analyze malfunctions and to suggest suitable development and management by providing feedback information and contributing to organizational planning. It is generally aimed at the identification and quantification of cost and benefit.

There are also a range of different reasons for evaluating an IS/IT investment. From a management perspective evaluation is to contribute to the rationalization of decision making (Symons & Walsham, 1988, see Lin & Pervan, 2001). This is also agreed by Silk (1990) who adds that evaluation aims to create motivated and justified IT investments. From an interpretative approach (see chapter 3.1.1) Stockdale and Standing (2006) advocate that the organizational context will determine the reasons for an evaluation and is therefore be an answer to the *why* of evaluation. Both Lin and Pervan (2001) and Stockdale and Standing (2006) have in their research found a numerous of reasons. Table 3 on the next page summarizes Stockdale and Standings findings on the *why* of evaluation.

Table 3 *The why of evaluation (Stockdale & Standing 2006, p 1094).*

Why	Comment
Ritualistic reasons	Ritual evaluation reinforces existing organizational structures
Budgetary process that gives 'a final *yes* or *no – pass* or *fail* – verdict'	Expectably manufacturing – focus on justification rather than constructive appraisal
Systems to participate in current business processes	Justification outweighs need to evaluate
Hoop jumping exercise	Ritual rather than effective process
Project closure	Not an opportunity for improvement

3.1.1 IS/IT investment evaluation approaches

Formative and Summative evaluation

Some authors use the terms formative approach and summative approach to categorize evaluation approaches. Each of these approaches contains different measures and criteria since their purposes are different. A *formative* evaluation aims to provide a systematic feedback. A *summative* evaluation focus on the identification and assessment of initially specified success criteria's in order to review change outcomes (Walsham, 1993, see Cranholm & Goldkuhl, 2003). According to Remenyi & Sherwood (1999), these kind of evaluations is for the purpose of improving the management of an IS/IT investment.

Regardless on whether a summative or formative evaluation is performed, there are two main questions needs to be asked: *how* the evaluation should be performed and *what* to evaluate (Cronholm & Goldkuhl, 2003).

Ex-ante, during and ex-post evaluation

The time for evaluation, e.g., the question of *when* to evaluate along with the IT investment life-cycle process is important for a successful outcome (Smithson & Hirschheim, 1998; Irani & Love, 2001; Remenyi & Sherwood-Smith, 1999).

Wehr (1999) describes these evaluations during the different stages of an investments life-cycle as either ex-ante or ex-post, *e.g.* before or after an investment. GAO (1997) adds a *during* evaluation phase and argue that an IS/IT investment evaluation should be an iterative process, starting with ex-ante, then during, and finally ex-post evaluation, rather than something that is conducted once.

The ex-ante phase identifies problems and analyze IT requirements (GAO, 1997). According to Piric and Reeve (1997), an ex-ante evaluation is based on a subjective analysis. A *during evaluation* involves issues with the design, development and implementation of IT (GAO, 1997). An *ex-post* evaluation refers to the consequences of the investment after the system has been implemented (Smithson & Hirschheim, 1998) and aims to quantify the effectiveness of an investment (Farrell et al., 1998). These evaluations are based on hard data (Piric & Reeve, 1997). Norris (1996) advocates four reasons for ex-post evaluations where several are similar to what GAO suggest. Firstly, they help organizations to make more realistic estimates in the future. Secondly, they give the organization the opportunity to take corrective action, i.e. to improve their actions in future. Thirdly, it helps build organizational confidence in the business focus and professionalism of the department. The fourth reason is that they give feedback if the actual value has been achieved from the IT/IS investment or not.

Economic, Technical and Interpretative approach

Kefi (2003) groups the different approaches of evaluation into four groups: technical perspective; financial and economic perspective; strategic perspective; and organizational perspective. The *technical perspective* focus on issues like: monitoring, data quality management, technological viability and risk evaluation. The *financial and economic perspective* focus on issues like time for evaluation; ex-ante and/or ex-post assessment of IS/IT contributions to performance, productivity ratios, return on investment ratios and financial auditing. The s*trategic* perspective focus on the value chain and the competitive advantages of IS/IT. The *organizational perspective* focus on what IS/IT contribute to the organizations effectiveness and how IS/IT enable change.

Frisk and Plantén (2004) uses similar vocabulary and categorize the different evaluation approaches and groups them after by the following: Economic, Technical and Interpretative.

3.1.1.1 An Economic Approach

The economical approach is focused on monetary measurement of organizational effectiveness and productivity (Bannister and Remenyi, 2003). According to Cronholm and Goldkuhl (2003), this implies a focus on harder economical criteria having a summative approach.

The methods used require that the initial investment, the incremental cash flows, cost of capital and the economic time horizon of the investment are known (Clemons, Tatcher & Row, 1995). Hallikainen et al. (1998) argue that it is assumed that all the effects can be traced, measured and expressed monetary. Intangible costs and revenues are either assumed to be zero while the subjective criteria are ignored.

Criteria derived from the economic school consider persons to be rational and therefore a lot of the methods claim that acting and behavior is predictable (Bannister, 2001).

3.1.1.2 An Interpretative approach

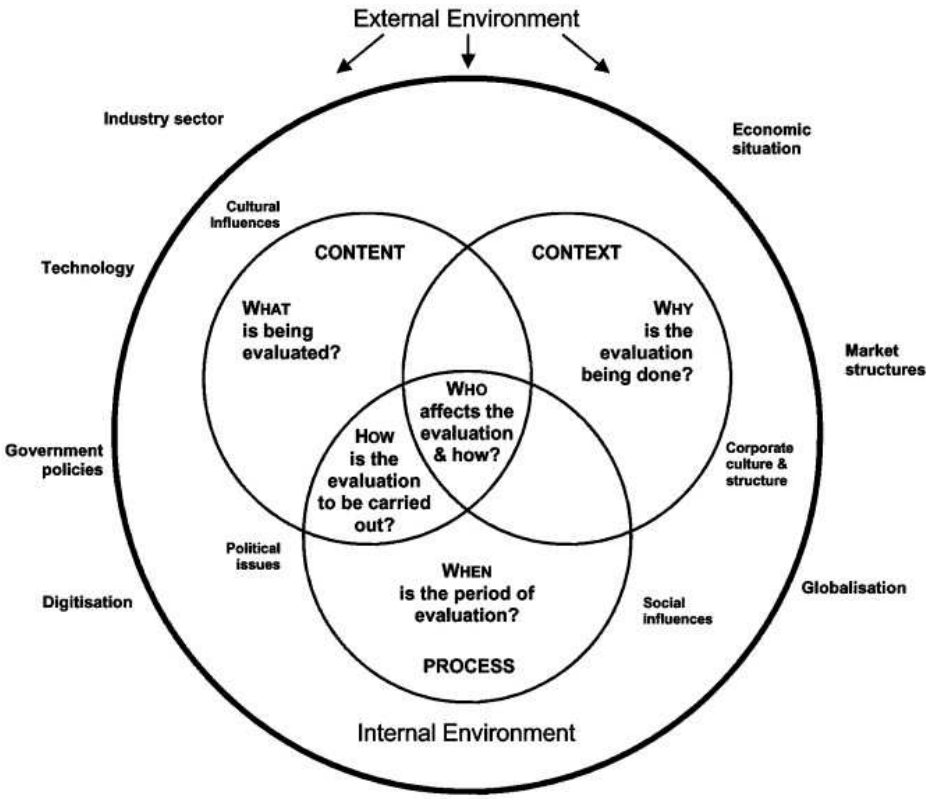
Only looking into the economic aspects of an IS/IT investment have been argued to limit the evaluation since it only considers those who have economic benefits and not the rest of the stakeholders who can take part of the qualitative benefits (Simmons, 1996).

Jones and Huges (2001) argue that these traditional methods/techniques tend to be prescriptive and mechanistic in nature since they have neglected the complex social processes that are associated with IT/IS decision-making. The authors therefore argue, that there is a need for a situated hermeneutic evaluation approach which aims at understanding the subtleties of the social, contextual situated dynamic world in which IS is implemented. Similar findings have been done by Cuba & Lincoln (1991) and Remenyi and Sherwood-Smith (1999).

The interpretative approach "*addresses on qualitative issues and is aimed at producing an understanding of social contexts and the social processes of the organization into which the IS is to be introduced*" (McBride & Fidler, 2003, p. 6).

McBride & Fidler (ibid) explains that the interpretative approach is based on interpretivism and sets focus on the users' perception of reality. This approach examines the content, context, process and linkage between content and context (see Figure 4).

Figure 4 *The content, context and process framework (Stockdale & Standing, 2006 p. 1099)*



Context

According to Smithson and Hirschheim (1998, see Stockdale & Standing 2006), an information system can impact on social economic, organizational and management terms. McBride and Fidler (2003) agrees to this and implies that it is necessary to understand the social context in which both the users and information system is placed in. Therefore, McBride and Fidler (ibid) advocate that it is important to be aware of the possible political and cultural issues that should be considered during an evaluation.

Stockdale and Standing (2006) also argue that it is necessary to understand the different perceptions and beliefs of the involved stakeholders since they are a part of the inner and outer context. According to Bannister and Remenyi (2003), these different stakeholders also have different views of value and benefits (see Table 4 on the next page**Error! Reference source not found.**) Stockdale and Standing (2006) group stakeholders into four groups: *initiators* of the evaluation, *evaluators* who conduct the evaluation, *users* of the systems being evaluated and a range of *other* parties such as trade unions and government agencies.

Table 4 *The who of evaluation; the stakeholders (Stockdale & Standing, 2006, p. 1095).*

Who	Comment
Initiators	• influence the evaluation process • issues of accountability and dissemination of results • impact on the purpose and level of formality of evaluation process • application of power implementations from senior management involvement
Evaluators	• deep understanding of stakeholders perspectives • human intuition • understanding of politics • moral agent stakeholder conflict interpretation • need to recognize different stakeholder perception of benefits
Users	• long recognition of use as a measure of success • major stakeholders in the evaluation • contributes information for evaluation process • different perspective from it people • close perception of benefit delivery • subjectivity-differences of opinion can be seen as a rich source of data
Interested parties	• focus on short-term criteria

According to Kefi (2003), the context relates to the following factors: Organization's size, corporate strategy, structure, culture, role of the IS/IT functions in the organization, IT strategy and role of the leadership in the decision making concerning IS/IT. Stockdale & Standing (2006) divides the concept of context further into a more micro- and macro-perspective. They suggest that the context is influenced by both an internal and external level. *Internal* context influences on different organizational factors such as structure, goals and strategies and culture as mentioned earlier, *External* level is influenced by social, political, economic and technological factors. They argue that the evaluators must decide which groups are relevant to the project being evaluated (see Table 5).

Table 5 *Influence on context (Stockdale & Standing, 2006).*

Context	Influences on context
Inner or organizational context	• organizational structure • organizational goals and strategies • organizational culture • political structures • hierarchical structures (e.g. management structures) • social structures and processes • stakeholders
Outer or external context	• social, political, economic and technological factors: o national economic situation o government policy and legislation o market structures and conditions o competitive environment o industry sector o globalization o privatization o cultural influences o technological developments

Process

As explained earlier *how* of evaluation concerns how the evaluator should act (Cronholm & Goldkuhl, 2003). There are different methodologies and instruments to examine the *how* of

evaluation, such as simulation modeling (Giaglis et al., 1999), cost benefit analysis, return on investment (Ballantine & Stray, 1999) and the traditional measure of user satisfaction that has been developed over many years.

According to Stockdale and Standing (2006), there are many factors that can significantly influence the conduct of an evaluation, but these factors are ignored and the benefits of the interpretative approach are lost. According to Farby et al. (1993, see Lin & Pervan, 2001), one of these factors include recognition of the role of evaluation in organizational learning, more examination of the strategic value of systems and exploration of the softer methods for determining benefits.

Symons (1991) describes the informal procedures and information flows around an IS as integral to the work done using the system and argues that evaluation should consider the diversity of official and unofficial information flows. Other *how* factors to be considered include the involvement and commitment of stakeholders and the conducting of both formative and summative evaluations. According to Remenyi and Sherwood-Smith (1999), continuous formative evaluation helps to minimize cases of failure, whereas summative evaluation is aimed at assessing outcomes and impacts and is by nature more financial/statistical. According to Stockdale and Standing (2006), the process needs to analyze the linkage between social context and social process. It is therefore necessary to understand and consider the involvement and commitment of stakeholders. They also assert that the *when* of evaluation, which we earlier discussed, have an impact on how to perform an evaluation.

Content

As explained earlier, *what* to evaluate is one important factor in an evaluation since it implies what to measure (Stockdale & Standing, 2006; Cronholm & Goldkuhl, 2003).

According to Stockdale and Standing (2006), the two biggest influences on what to measure and evaluate comes from the stakeholders and the context of the organization. They mean that the choice of criteria determines the content; e.g. what it includes and excludes. Stockdale and Standing (ibid) also advocates that it is necessary to use recognized success measures within a holistic in a holistic interpretative model improves the evaluation process.

Summary

Table 6 Summarizes our theories about the different approaches of evaluation.

Table 6 *A comparison of the Financial and Interpretative approach.*

Approach	Purpose	Time horizon	Summative or formative	Objective or Subjective	Example of methods
Financial approach	Monetary value of investment	Ex-ante and/or ex-post	Summative	Objective focus	Economic and financial oriented methods: ROI, Payback, IRR, NPV
Interpretative approach	Understanding of social context, social processes and their linkage	Continuous	Formative	Subjective focus	Benefit Management, CCP Framework (Stockdale and Standing, 2006)

3.1.2 Benefits

What to measure and evaluate, e.g. the content, within a given context also implies an understanding of the perception and nature of benefits and how to measure the outcome of benefits.

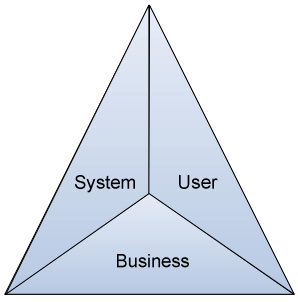
Different perceptions of Value

From an economical evaluation approach the term value has been focused on monetary measurement of organizational effectiveness and productivity (Bannister & Remenyi, 2003). Loveman says the following about this: "*First and foremost, what ultimately matters is value – to the firm, individuals or society*" (Loveman, 1992, p 101; see Bannister and Remenyi, 2003). Bannister and Remenyi (2003) use this quote to underline that the question of value is not only about defining *what* value is, but also to who the value is for. They argue that the meaning of the term value is assumed to be implicitly understood and that the business and human concept of value should be regarded much deeper and wider than narrow rationalism that economic and accounting models allow. According to Irani and Love (2001), stakeholders have problems agreeing on what is important and meaningful to value when intangibles are measured in an evaluation.

Parker and Bengson (1988, see Bannister and Remenyi, 2003) defines IT value based on Porters Value Chain and describes IT value as: "*the ability of IT to enhance the business performance of the enterprise*".

From an interpretative approach Cronk and Fitzgerald (1999) introduce the concept of dimensions of value and define IS business value as the "*…sustainable value added to the business by IS, either collectively or by individual systems, considered from an organizational perspective, relative to the resource expenditure required*" (Cronk and Fitzgerald, 1999, p. 44). They suggest that the IS business value should be viewed as the sum of three value adding dimensions: System, User and Business (see Figure 5). Here, *the system dependent dimension* is the value added to the organization as a result for the system characteristics, such as downtime, response time or accuracy; *the user dependent dimension* is created by the value added to the organization as a result of user characteristics, such as improved skills and attitudes that may result in more effective usage; and *the business dependent dimension*, which is the value added to the organization as a result of business factors, such as alignment between system and business goals.

***Figure 5** – IS business value dimensions (Cronk and Fitzgerald, 1999, p. 47, modified).*



Cronk and Fitzgerald's model also highlights earlier contributions by Symons (Symons, 1991, see Cronk & Fitzgerald, 1999, p 41) who claims that there are conflicting value perspectives within the social context of an organizational culture and that the concept of value is influenced by many contextual factors that creates an overall IS context. Also Taylor (1998,

see Klecun-Dabrowska & Cornford, 2001) discusses the social context and advocates that it is necessary to consider the effects of societal benefits in order to assess value.

Different perceptions of benefit

According to Thorp, (1998, p. 254, see Bennington & Baccarini, 2004), a benefit *"is an outcome whose nature and value are considered advantageous by an organization"*. These outcomes are achieved from the utilization of use of IS/IT through successful implementations of an investment (ibid).

UK Office of Government Commerce (OGC) defines benefits as: *"… the quantification of the outcomes and are used to direct the programme and inform decision-making along the way*".

Ward, Murray and David (2004, p. 7) defines benefits as "*an advantage on behalf of an individual or group of individuals*" which is perceived by the stakeholders exposed to change. They argue that a benefit and it's outcome frequently is confused with each other. An *outcome* is said to be a result of introducing an IT-enabled system whose benefit is what the business subsequently derives when or if the organization exploits the new capability. In other words, "*IT only enables an outcome – it is managers who choose how to into that outcome into a benefit*" (Ward, Murray & David, 2004, p. 8).

According to Cronk and Fitzgerald (1999), a benefit is also something that has long term influence on a business.

Generic Benefits of IS/IT

There have been many suggestions to categorizing benefits. Weill (1992) suggests that organizational benefits of IS can be classified into three dimensions: *strategic*, benefits from change of an organization's product or the way the organization competes; *informational*, benefits from change of the information and communicational infrastructure of the organization, and *transactional*, benefits from change of operational management support and reduction of it costs. Furthermore Weill argues that it is possible for a single IS to have all of these dimensions.

Based on earlier studies by Farbey et al. (1993, see Ward & Daniel, 2006) Ward and Daniel (2006) suggest a list of benefits categorized according to Mintzberg's five organizational structures. These benefits are *Strategic*, *Management*, *Operational*, *Functional* and *Support*.

Benefits can also be categorized in terms of efficiency and effectiveness. Efficiency benefits is according to Bennington and Baccarini (2004), benefits who seek to reduce cost of performing a particular process by utilizing IT, while efficiency benefits are ways of doing different things that better achieve the required result.

Tangible and Intangible Benefits

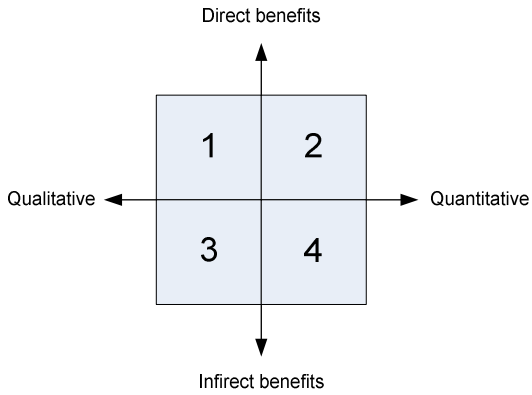
According to Ward and Daniel (2006), benefits arising from IS/IT are either be tangible or intangible. *Tangible* benefits can be measured by an objective, quantitative and often financial measure. *Intangible* benefits measured by subjective, qualitative measures. Lundberg (2005) suggests the use of different Key Performance Indicators (KPI) to measure these benefits.

Brown (2002) and Giaglis et al. (1999) also explains that benefits than be of either tangible or intangible nature but uses the terms *hard* benefit for tangible benefits and *soft* for intangible benefits.

Direct and Indirect Benefits

According to Lundberg (2004), benefits can also be divided into direct or indirect. This can be visualized by using a benefits matrix-model (see Figure 6). Lundberg argues out that most businesses have focused on benefits placed in square 2 in this model, since they are the easiest benefits to identify. A benefit placed in square 4 is not created as direct result but are still possible to measure in monetary terms. In order to realize these benefits further investments are needed. Benefits placed in square 1 and 3 are of a more qualitative nature. Since they are not easy to express in monetary terms KPI:s are used. Benefits placed in square 2 is of a more short term character while square 3 is of a more long term strategic character.

Figure 6 *The benefits matrix (Lundberg, 2004, p. 96, modified).*



Lundberg (2004) also advocates out that most businesses have focused on benefits placed in square 2 since they are the easiest benefits to identify. A benefit placed in square 4 is not created as direct result but are still possible to measure in monetary terms. In order to realize these benefits further investments are needed. As we can see square 2 is of a more short term character while square 3 is of a more long term strategic character.

Emergent Benefits

According to Farbey et al. (1993, see Ward & Daniel, 2006), IS/IT projects give rise to unplanned or emergent benefits. These benefits appear to be “second order” benefits, which arise from achieving an initial or planned benefit. These unplanned benefits tend to be more intangible than the planned benefits.

Disbenefits

Ward and Daniel (2006) the adverse effects of disbenefits needs to be considered, since benefits at individual or group level many times are ignored or only explored if they are consistent with the organizational benefits sought.

Summary

Table 7 summarizes our theoretical findings about benefits.

Table 7 *Benefits.*

Benefits	Summary
General definitions	• value has been focused on monetary measurement of organizational effectiveness and productivity • *"is an outcome whose nature and value are considered advantageous by an organization"* • *"…the quantification of the outcomes and are used to direct the programme and inform decision-making along the way*" • "*an advantage on behalf of an individual or group of individuals*" which is perceived by the stakeholders exposed to change
Different perceptions of benefit	• the IS business value should be viewed as the sum of three value adding dimensions: *System*, *User* and *Business* • there are conflicting value perspectives within the social context of an organizational culture • the concept of value is influenced by many contextual factors that creates an overall IS context
Generic Benefits of IS/IT	• benefits of IS can be classified into three dimensions: *strategic, informational, transactional* • benefits can also be categorized in terms of efficiency and effectiveness
Tangible and Intangible Benefits	• *tangible* benefits can be measured by an objective, quantitative and often financial measure • *Intangible* benefits measured by subjective, qualitative measures
Direct and Indirect Benefits	• benefits can also be either direct or indirect. • benefits can be placed in different squares in the matrix-model, depending on if they are direct or indirect
Emergent Benefits	• IS/IT projects give rise to unplanned or emergent benefits. These unplanned benefits tend to be more intangible than the planned benefits

3.1.3 Benefits Management

There is a wide range of different approaches to managing benefits with different focuses. According to Lin and Pervan (2001), benefits management is the procedural approach of how to handle the benefits evaluation to realize benefits of IS/IT investments.

Ward and Daniel (2006, p. 36) defines benefits management as "*the process of organizing and managing such that the potential benefits arising from the use of IS/IT are actually realize*d". Furthermore, Ward et al. (1996, see Lin & Pervan, 2001) argues that in addition to investment justification and evaluation it is necessary to establish a clear process for ensuring that IS/IT development initiatives actually deliver the benefits intended.

OGC defines Benefits Management (2007) as "*… the activity of identifying, optimizing and tracking the expected benefits through to their realization. It is a core activity and a continuous management process running throughout the programme*".

Management driven outcomes of benefits

Both OGC (2007), Ward et al. (2004) and Ward and David (2006) advocate that there need to be an active management of the indented outcomes of an IS/IT investment. According Ward et al. (2004), it is only with the conscious intervention of managers that an outcome becomes a business benefit. Ward and David (2006) elaborates this by pointing at the result from study

of 11 strategic IS/IT investments varying in cost between £5m and £100m carried out across a range of industries, that showed that the most successful investments were does with a senior management had a commitment and involvement of senior managers, and especially does where the involvement maintained throughout the project. Ward et al. (2004) also explains that since "*the outcome is a result of an IT-enabled system; the benefits are what the business subsequently derives when/if the organization exploits the new capability*", (Ward et al., 2004, p. 8) and therefore requires managers who turn outcomes among stakeholders into benefits.

The Benefits management difference

Both Ward and Daniel (2006) and Truax (1997, see Lin & Pervan, 2007) describes the differences of Benefits management. Ward and Daniel (2006) also compares the different views between traditional IS project and a Benefit Management project (see

Table **8**). Truax (1997, see Lin & Pervan, 2007) have identified that a paradigm shift on the approach to Benefits Management (see table 9).

Table 8 *Benefits management and traditional IS project approaches (Ward & Daniel, 2006, p. 37).*

Traditional IS projects	Benefit Management projects
Technology delivery	Benefits delivery
Value for money – low level task monitoring	Value for money – benefits tracking
Expenditure proposal – loose linkage to business needs	Business case – integration with the business drivers
IT implementation plan	Change management plan
Business managers as onlooker/victim	Business managers involved and in control
Large set off unfocused functionality	IT investment that is sufficient to do the job
Stakeholders "subjected to"	Stakeholders "involved in"
Trained in technology	Educated in exploitation of technology – talent harnessed
Carry out technology and project audits	Obtaining business benefits then review with learning – leverage more benefits

Table 9 *Paradigm shifts for Benefits Realization (Lin & Pervan, 2001, p. 17).*

Traditional Benefits Realization Principles.	New Benefits Realization Principles.
Benefits are stable over time	The potential benefits from an investment change over time
The investment determines the nature and scope of the benefits	The organization and its business context determine the benefits
Financial returns represent the most valid justification for an investment	All the outcomes of an investment represent potential sources of value
It is sufficient to manage the investment to generate the benefits	The organization must be proactive in realizing benefits

Benefit management phases

Bennington and Baccarini (2004) suggest a four phase model for managing benefits containing the following phases: (1) Benefits identification, (2) Benefits realization planning, (3) Benefits monitoring, (4) Benefits realization.

The Cranfield Process Model also uses these four phases but extends Bennington and Baccarini's Model with a fifth stage: "establish potential for further benefits" (Ward and Daniel, 2006).

We will only describe the initial Benefit Identification phase since our research is focused on the initial stages of an IS/IT investment evaluation. A complete description of the all of the stages can be found in Appendix 2.

3.1.3.1 Benefit Identification

During the Benefits identification phase many different methods in order to identify potential benefits are suggested. Bennington and Baccarini (2004) and Ward et al. (2004) suggest the use if interviews or workshops with key stakeholders and that these interviews should be performed in collaboration between project managers and project stakeholders. They also advocate that it is very important to consider the stakeholders since "*a person or people must perceive and agree that they now have advantages over the previous way of working...*" and that the solutions "*which deliver benefits will have been designed from the stakeholders' view what constitutes a benefit*" (Ward et al, (2004, p. 7).

According to Ward et al. (1996, see Lin & Pervan, 2001), proposed benefits should be listed and agreed by managers whose activities are affected by the system. Each benefit should be given suitable business measures. They also advocate it is needed to identify benefit areas were the benefits will occur. Identified benefits are structured in order to understand and their linkage between technology effects, business changes and overall business effects. Undesirable impacts and disbenefits on the business or organization should also be considered.

According to Ward et al. (2004), responsible managers need to consider outcomes that are, expected, unexpected, positive or negative. They also have to agree that unexpected negative outcomes "…*are a price worth paying to obtain the positive benefits*" (ibid, p. 15) and that the risk associated to these outcomes can be less painful "…*by employing risk assessment techniques and the learning from earlier projects or earlier phases of the same project*" (ibid, p. 15).

Ward et al. (1996, see Lin & Pervan, 2001), Bennington and Baccarini (2004) and OGC (2007) argues for a formal project benefits management. Bennington and Baccarini (2004, p. 28) also adds that there is a need for this management to continue as a "… *post-project until the benefits have been fully realized*".

According to Ashbury and Doherty (2003), the first thing in their benefit management process is to identify and calculate the planned outcomes of an IS development project and deciding how these benefits are to be achieved. This process is divided into two levels. First, IS/IT strategy should be formulated to present a broad overview of the IS applications will support the realization of business benefits and contribute to the corporate objectives. Secondly, the benefits planning process should be performed more detailed for every individual project. They also advocate that it is required that business change programmes are identified directly from the formulated strategy since the projects takes place in a dynamic organizational context that sets priorities for change and improvements. Therefore, it is very important to clearly formulate how the change will benefit the stakeholders. Results from their research showed that most projects focused on technology delivery rather than organizational change and benefits realization. Furthermore, no measures for benefits were defined during the planning phase and that there was no clear linkage between the technological solution back to the project's business objectives.

OGC (2007) also expresses a need to understand the different involved stakeholders and advocates that it is necessary to document the involved stakeholders and their relations in order to produce a Stakeholder Map and Communications Strategy on how to understand and communicate. Furthermore, OGC suggests that the development of an investment strategy to identify strategic outcomes that the IS/IT investment generates, seen from a business perspective. They also advocate that the benefits need to be structured and mapped in order to explain the relationship between benefits, their dependencies and the sequence of benefits. An example if this is Benefit Cascade-model (see OGC[2], 2007) which shows the links between the high level vision and objectives down to proposed options for delivery. By doing this broken links are identified.

The Active Benefits Realization Model approach advocated by Remenyi et al., (1997, see Lin & Pervan, 2001) focuses on identification of the key stakeholders of the information system. They argue that the initial phases of a Benefits Management process should start with documenting the context and the required benefits and metrics that later will be used for monitor and control.

According to Lundeberg's (2005) FEM-model the Benefits Identification stage should contain five different activities:

1. Point out benefit areas and benefit effects
2. Structure benefit effects
3. Secure the traceability
4. Quantify benefits
5. Put time to benefits

These activities initiates questions like: Where are the benefits located? How are they related to each other? What effects do the benefits have and how could they be measured? How can the traceability of the benefits be secured? How can the benefits be quantified and expressed in monetary terms or with *KPI:s*? How will the benefits develop over time? How can the benefits be maximize and their lifetime extended? Lundberg (ibid) suggest a variety of different models and tools to be able to answer these questions. One of these models is a benefit-map, which helps point out the location of identified benefits within the business and also weights their importance and risk. Another model is the benefit-matrix-model mentioned earlier.

Summary

The literature of IS/IT evaluation and Benefits Management gives the impression that IS/IT evaluation is a very complex process. There are a variety of different stakeholders influencing an IS/IT investment as well as wide range of participants in an IS/IT evaluation. An evaluation can be conducted during different stages of an investment from different approaches. The participants involved in these evaluations have different perceptions of benefits and value, which can be conflicting.

At the same time benefits is of a complex nature whose outcome is dependent management. Benefits can be categorized in many ways; they can be tangible or intangible; direct or indirect; emergent; disbenefits and also change over time.

In order to manage these benefits different methods and frameworks have been suggested (summarized in

Table **10**). Each framework has different approaches and doesn't cover all the five phases of the Benefits Management process. After reviewing the IS/IT literature the most important questions can be summarized into the *why*, *what*, *where*, *who* and *when* of evaluation.

Table 10 *The initial pre-planning phase for six Benefits Management and Realization approaches.*

Benefits Management Approach	Content
UK Office of Government Commerce (OGC)	Identify and structure, strategic outcomes and structure benefits
Ashurst and Doherty (Ashurst & Doherty, 2003)	Identify and enumerate the planned outcomes in order to document relevant benefits to decision-makers
Bennington and Baccarini (Bennington & Baccarini, 2004)	Identify and structure strategic outcomes, structure benefits
Cranfield Process Model of Benefits Management (Lin & Pervan 2001, Ward & Daniel, 2006)	Identify and structure the 'overall' benefit set" structure benefits
Active Benefits Realization Model (Remenyi et al., 2001	Identify, structure, secure traceability, quantify and put time to benefits
FEM-model (Lundberg, 2005)	Identify, structure, secure traceability, quantify, put time to benefits and structure benefits

3.2 Product Development

Since Virtual Manufacturing investments takes place within the product development domain we find it necessary to understand the different characteristics of this domain. Product Development (PD) is a domain which involves everything from invention, product design, marketing research, construction, manufacturing and marketing. The main purpose of PD is to create new products. These development projects need to create new products which satisfies the customers wants, needs and expectations (Nilsson, 1999).

Michael N Kennedy (2003, p. 42) defines PD as "… *the collective activities, or system, that a company uses to convert its technology and ideas into a stream of products that meet the needs of customers and the strategic goals of the company*".

3.2.1 The Product Development process

There are many ways to describe the Product Development process (PDp). Kotler et al. (2001) describe the Product Development process as process of eight phases using a financial approach. He argues that it is crucial for organizations to successfully update their product lines in order to reduce decline in sales and not loosing a competitive advantage.

Improving and updating product lines is crucial for the success for any organization. Failure for an organization to change could result in a decline in sales and with competitors racing ahead. The process of NPD is crucial within an organization. Products go through the stages of their lifecycle and will eventually have to be replaced There are eight stages of new product development. These stages will be discussed briefly below:

1. Idea generation
2. Idea Screening
3. Concept Development and Testing
4. Marketing Strategy and Development

5. Business Analysis
6. Product Development
7. Test Marketing
8. Commercialization

An industrial approach is suggested by Olsson (1997) who divides the PDp into six different phases (Olsson, 1997):

1. Feasibility study- or initiating phase
2. Preparing development phase
3. Main development phase
4. Prototype and testing phase
5. Production and usage phase
6. Liquidate phase

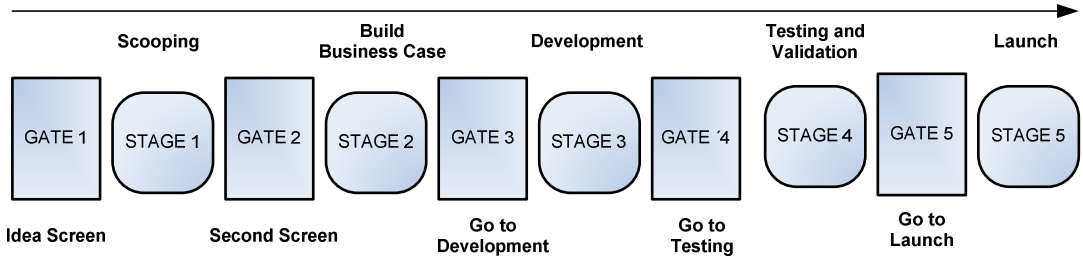
A detailed description about these phases can be found in Appendix 1.

3.2.2 Stage-gate model

According to Cooper et al. (2000), the stage-gate model (see Figure 7) is one of the most used product development models. A stage-gate process is a conceptual operational road map for moving an idea for a new product to a finished product. The stage-gate is based on the identification of the different stages within the product development process, and gates between the stages. Each of the stages consists of a set of prescribed, cross-functional and parallel activities undertaken by people from different functional areas in the firm, working together as a team and led by a project team leader. The gates basically consist of quality controls, also the decisions about going back, continue or terminate the process.

The stage-gate manage risks by a method, the parallel activities in a certain stage must be designed to gather vital information- technical, market, financial and operations- in order to drive down the technical and business risks. Each stage costs more than the preceding stage, so the process is based on incremental commitments. Figure 7 shows the general flow of the typical, or generic, stage-gate process.

Figure 7 *The Stage Gate Model (Cooper, 2000, modified)*



3.2.2.1 The stages

A typical stage-gate consists of five stages. During the first stage a quick investigation of the project is performed. Thereafter preliminary market, technical and financial assessments are performed, and an action plan for the next stage is designed. In the second stage the investigation work leading to a business case, a defined product, a business justification and a detailed plan of action for the next stage are designed. In the third stage the actual design, technology and prototype are developed. Marketing launch and operating plans are developed, and the test plans for the next stage are defined. The fourth stage consists of testing and

validation, the verification and validation of the proposed new product, its marketing and production. The fifth and final stage manages the commercial launch, production and fully commercialization of the product.

3.2.2.2 The gates

The gates are meant to control the success of a fast-phased new product process. Each gate controls the quality and that continuations or termination of the new product process. At each gate, the senior managers from different areas take decisions regarding the required resources needed to go further. A standard set of deliverables are specified for each gate. These deliverables are inputs into the gate review, the project leader and the team delivers something to the meeting. The delivered issues are the result of the actions of the previous stage, and are based on a standard menu of deliverables for each gate. Further on there are questions and metrics on which the project is judged in order to make the decision regarding the continuation or termination, these are called *criteria*. The result of the gate review is called *output*, there is an action plan approved where agreements has been made regarding the date and deliverables for the next gate.

3.2.3 Critical Success Factors for Product Development

According to Kotler et al. (2001), effective NPD is lead by a well defined product strategy. This strategy should contain four main goals. The first goal should focus on team performance, which gives direction on how product development teams should work. The second goal puts focus on how to integrate functional workers. The third goal is that the strategy is understood by the product development team. The fourth and last goal focuses on manufacturing and involves the creation of an understanding among project leaders and senior management that the strategy needs an active leadership. According to Kotler (ibid), a key success factor for a successful innovation process is said to rely on that everybody in the company need to work in the same direction.

Several empirical studies in NPD by Cooper et al. (2004) and Ernst (2002) have identified different areas that have an important impact on the success of NPD-projects. These areas or Critical Success Factors (CSF) are: *Product Development Process*, *Organization*, *Culture*, *Leadership*, *Role and Commitment of Senior Management* and *Strategy*.

3.2.3.1 Product Development Process

According to Ernst (2002), there are several aspects that have a positive influence on the success of new products but two are major aspects. One aspect is the proficiency of activities carried out in the individual phases of new product development, especially in development, test marketing and market introduction. Another aspect is the use of market information along the entire NPD. Furthermore, Ernst (2002) argues that there are four aspects that have a positive influence on the financial success of a new product:

1. Clear definition of the product before developing begins.
2. High-quality preparatory work on the project in which the idea is initially broadly defined.
3. Clear orientation of the NPD process to market demands.
4. The existence of a high-quality NPD process.

3.2.3.2 Organization

There are five essential organizational success factors for new products (Ernst, 2002):

1. Cross-functional NPD team.
2. A strong and responsible project leader.
3. An NPD team with responsibility for the entire project.
4. The commitment of the project leader and the team members to the NPD project.
5. Intensive communication among team members during the course of the NPD process.

3.2.3.3 Culture

Ernst (2002) explains that the existence of systematic scheme for suggesting new products, separate from other company-based suggestion schemes can have a positive influence on the success of new products (Barczak 1995; Cooper 1984b,c,d, 1986; Cooper & Kleinschmidt 1995a, see Ernst, 2002). An innovation-friendly climate in the organization together with risk-taking behavior has been identified as being relevant to success (Voss 1985, see Ernst, 2002). The following aspects are examined:

- The possibility for employees to use a part of their work day for developing their own ideas.
- Support for work on unofficial projects which may have already been stopped by management.
- The availability of internal "venture capital" to assist the realization of creative ideas.

One of the driving forces when developing product is the culture/climate that is available at the organization. Innovations, innovators and project teams which succeed will be rewarded and will have the attentions which also can be viewed as success factors (Cooper, 2000).

3.2.3.4 Role and commitment of senior management

The support of senior management and adequate resource allocation are success factors in NPD (Cooper and Kleinschmidt, see Ernst, 2002). Expenditures for market research and the introduction of new products to the market are meaningful for the success of new products (Cooper, 1982, 1984a; Balbontin et al. 1999; Maidique & Zirger, 1984, see Ernst, 2002). With increased support of senior management, the probability that the project will be terminated decreases. This can be interpreted as positive since senior management has a guiding hand in disputed NPD projects and may overcome internal resistance (Balachandra, 1984, see Ernst 2002).

3.2.3.5 Strategy

A well defined and obvious product development and technical strategy is one of the most important success factors. This strategy should have a strong connection to the general strategy of the organization, express the goals with the product development, limit strategic areas and define which resources are supposed to be allocated for the product development (Cooper et al, 2004).

The strategies of NPD support the conclusion that the presence of a clear NPD strategy has a positive influence on the success of new products (Griffin, 1997; Meyer & Roberts, 1986; and Thamhain, 1990, see Ernst, 2002)

According to Ernst (ibid), the strategy of NPD programme is measured as a construct consisting of four variables (Cooper and Kleinschmidt, 1995a, see Ernst, 2002). First the objectives of the NPD programme need to be defined and the meaning of their attainment for the overall goals of the organization must be clearly communicated. Furthermore, the NPD programme should have a strategic focus which gives overall direction to the individual NPD projects. Finally, the NPD programme has a long-term thrust as expressed by a substantial number of long-term projects in the entire NP portfolio.

Summary

The purpose of product development is to create new products (Nilsson, 1999). Product development is a domain that involves all phases and stages in a product lifecycle.

Product development process can be described as a process with eight phases using financial approach. It is crucial for the success of organizations to improve and update their product line (Kotler et al., 2001).

The stage-gate model is one of the most used product development models (Cooper et al., 2000). A stage-gate process is a conceptual operational road map for moving an idea for new products to terminated product. The model is based on the identification of the different stages within the product development process and gates between the stages.

There are several success factors identified that have an important impact on the success of NPD-projects, Product development process, Organization, Culture, Leadership, Role and Commitment of Senior Management and Strategy (Cooper et al., 2004; Ernst, 2002).

Table 11 *Critical Success Factors (Cooper et al, 2004; Ernst 2002).*

Area	Successful NPD projects are characterized…
NPD process (Ernst, 2002)	• by clear definition of the product, and clear orientation of the NPD process to market demands • by high-quality preparatory work and NPD process, to market demands
Organization (Ernst, 2002)	• through intensive communication and interactive relationships
Culture (Ernst, 2002)	• by an innovation-friendly culture which promotes the entrepreneurial spirit and commitment
Role and Commitment of Senior Management (Ernst, 2002)	• by the support of senior management and adequate resource allocated
Strategy (Cooper, 2004)	• by clear and well defined objectives of the NPD programs • by how well the meaning of their attainment for the overall goals of the organization is communicated

3.3 Virtual Manufacturing

As explained earlier in the introduction productivity is an important issue (Hochstrasser, 1993). In order to meet competition; reduce costs and shorten the time for new product entries, the manufacturing industry have started to explore concepts that rely on new technology such as the concept Virtual Manufacturing (Kim, Choi, Choi, 2004).

According to Karlsson, VM "*… is the name given to an area of research that aims to integrate diverse manufacturing related technologies*" (Karlsson, 2005, p. 14). VM enables, with the help of different advanced simulation tools for different applications, a business to optimize the development of new products and its manufacturing processes. VM is therefore said to open up great strategic possibilities for benefits (Karlsson, 2005).

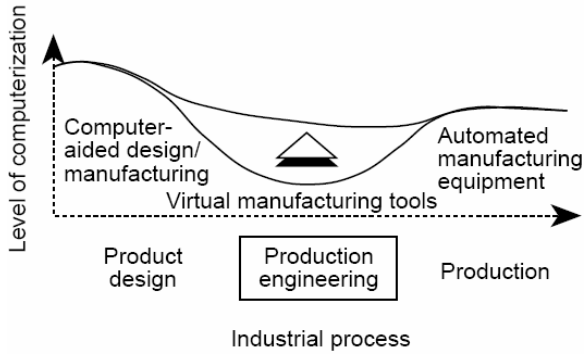
As an example of use VM software lets production engineers create simulations of automated product systems on their computer workstations, and then analyze these simulations before investing in capital equipment. Since there are many steps in preparing for automated production - from designing tools to programming factory floor equipment – can be performed long before the actual production start-up at far less cost than before. Both blueprints and work cell mockups can now be replaced by virtual manufacturing's simulations of robots and machine models, instead of real machines. This also adds realism to engineers who can better understand how robots and workers will work during the manufacturing processes. This improves detection of potential errors (Lederer, 1995).

3.3.1 Defining VM

The literature contains a wide range of definitions of VM with different focuses. For example, some focus on the integration of the integration of multiple organizations into one *virtual enterprise* (Huang, 2003). Other researchers have only focused on manufacturing activities. According to Kim et al. (2004), the general meaning of VM is focused to only real systems in the factory life cycle, which they call "*narrow VM*". Shridhar and Ravi (2002) defines VM as "*…an integrated, synthetic manufacturing environment exercised to enhance all the levels of decision and control*" (Shridhar & Ravi, 2002, p. 116). Venkateswaran, Manmohan and Young-Jun Son (2001) have a broader definition of VM and define it as: "*… the use of computer models and simulations of manufacturing processes to aid in the design and production of manufactured products*" (Venkateswaran, Manmohan and Young-Jun Son, 2001, p. 3).

According to Lederer (1995), VM fills the gap in automating the industrial process by increasing the level of computerization (see Figure 8).

Figure 8 *Virtual manufacturing software fills the gap in automating the industrial process (Lederer, 1995, p. 16)*



3.3.2 Paradigms of VM

Historically the role and use of VM has changed and three different paradigms have been identified that have shifted the role of what VM optimize (Shridhar & Ravi, 2002 and Shukla et al., 1996; see Karlsson, 2005; Schmeink 2005). These are Design-centered, Product-Centered and Control-Centered Virtual Manufacturing, which we will explain below.

Design-Centered

The use of simulation to optimize product development process and evaluation of different production scenarios at various levels of fidelity and scope in order to inform design and manufacturing decisions. Potential problems with the design can be identified and its advantage can be estimated.

Production- Centered

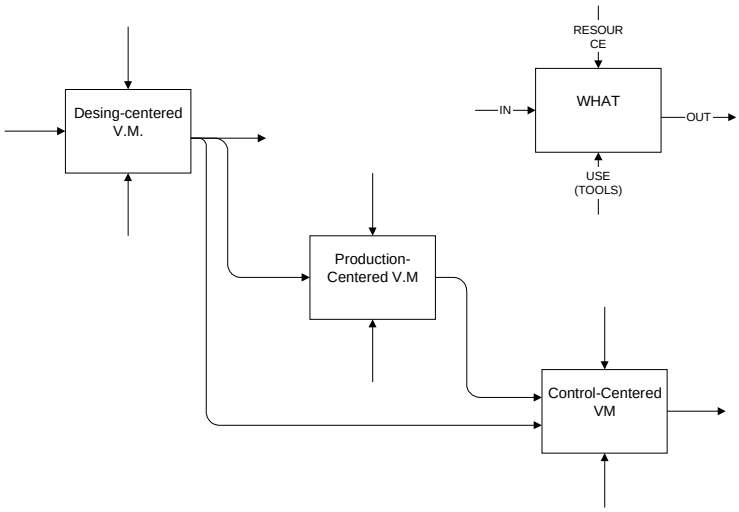
The use of simulation to optimize manufacturing process and planning with purpose of allowing inexpensive, fast evaluation of many processing alternatives. This paradigm adds analytical production simulation to allow higher confidence validation and resource availability. Manufacturing proficiency is maintained without actually building products.

Control- Centered

The use of additional simulations to control models and actual processes, allowing seamless simulation of optimization during the actual manufacturing.

Figure 9 summarizes the relation between the different paradigms.

Figure 9 *The information flow of the three design paradigm of Virtual Manufacturing (Schmeink, 2005, p. 28).*



3.3.3 Realizing the potential of benefits of VM

Shridhar and Ravi (2002, p. 116) have identified four different areas where VM can realize the potential benefits within the product development process. These areas are: *product*, *process*, *the plant* and *resources*.

Virtualization of Product

This area includes various aspects if visualization of product data designs, product prototyping etcetera (Shridhar and Ravi, 2002). According to Tseng, Jiao & Su (1998), physical prototypes are commonly used during the *product development process* in order to evaluate ecstatic and perceptive aspects, such as size, weight and color.

Virtualization of Manufacturing Process

This area includes various sub-areas such as process design. Process configuration and toll and equipment design (Shridhar and Ravi, 2002).

Virtualization of Manufacturing Equipment and Factory layout

This area includes various aspects of factory equipment layout, ergonomic assessment; container placement and operator walk path studies (ibid).

Virtualization of Manufacturing Resource management

This final area includes the possibilities to minimize tool inventory and improvement of asset utilization.

Summary

The role and use of Virtual Manufacturing has developed through three identified paradigms. Starting as a design-centered solution for optimizing the product, to a production-censed solution for optimizing the product development process and lastly a control-centered solution where manufacturing processes are optimized.

VM is used in order to meet competition; reduce costs and shorten the time for new product entries (Kim, Choi, Choi, 2004). The aim of VM is to integrate diverse manufacturing related technologies. VM enables a business to optimize the development of new products and manufacturing processes. VM opens up great strategic possibilities for benefits (Karlsson, 2005). VM is an integrated, synthetic manufacturing environment exercised to enhance all the levels of decision and control (Shridhar & Ravi, 2002).

Shridhar and Ravi (2002) have identified four different areas identified where VM can realize the potential benefits within the product development, these areas are: product, process, the plant and resources.

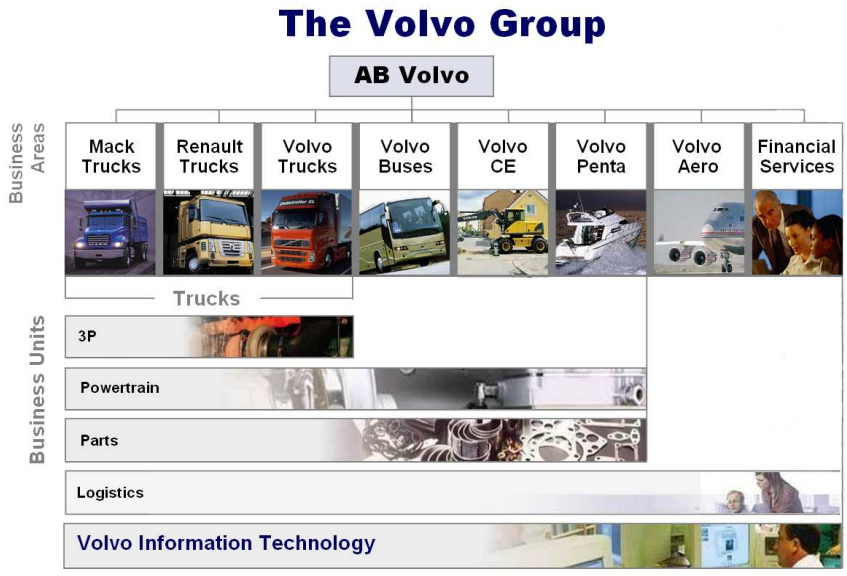
4 Empirical Study

This chapter introduces the reader to our empirical study. We will first describe our findings from the intranet at Volvo IT and then present our interviews.

4.1 The Volvo Group

The Volvo Group was founded in 1927 and has more than 90,000 employees, production facilities in 18 countries, and sales activities in some 180 countries. The Volvo Group is a Swedish supplier of commercial transport solutions providing products such as trucks, buses and construction equipment, drive systems for marine and industrial applications, aerospace components and financial services. The organization can be divided into eight product-related business areas and a number of supporting business units. The organization, with business areas and support units, creates the conditions for proximity to customers and efficient resource utilization within the Volvo Group. The business units are responsible for development and delivery of components, services and support to the business areas worldwide.

Figure 10 *The Volvo Group.*



4.1.1 Volvo IT

Volvo Information Technology (Volvo IT) provides IT solutions and services for the entire industrial process. Their competences and knowledge are in system development areas, methodology, architecture and integration. The solutions must be highly useful, functional and provide security.

Volvo IT´s experience goes back to the 1960s when computers first were used in the industry. In 1998 the current Volvo IT was grounded. Volvo IT has the position as one of the leading IT suppliers in the automobile industry. Their clients include the Volvo Group, Ford-owned

Volvo Cars, and other large industrial companies. The main customers are in the automobile industry but the number of customers in other industries has increased in the recent years.

4.1.2 The GDP and the IS-GDP

4.1.2.1 The Global Development Process

The Volvo Corporate Global Development Process (GDP) includes “best practices” and years of practical experience from different business areas and business units. The Volvo Corporate GDP is a model introducing a common value base and a common project tool box for the involved Business Areas/Business Units.

The GDP model describes what activities must be considered from the time an idea for a product change or a new product but also the development, industrialization, commercialization and delivery to the customer. The GDP model is divided in three classes dependent on the complexity of the projects. Class 1 projects are the least complicated projects while class 3 projects are the most complicated. A project with a lower class number can has a much shorter process time, while higher project classes takes longer process time.

Figure 11 *The Global Development Process Model.*

The GDP consists of a set of gates and phases where the phases can be described as below.

- **Pre-study phase**
  Developing requirements and alternative solution concepts. market and technical feasibility investigation.

- **Concept study**
  Evaluation of concepts, concept selection and requirement setting.

- **Detailed Development**
  Detailed development and documentation of the solution.

- **Final Development**
  Building, testing and refinement of product and processes.

- **Industrialization**
  Installation, preparation and verification of the industrial system product launch.

- **Follow-up**
  Project validation and hand-over. Follow up project target fulfillment, summarize project experiences and close project.

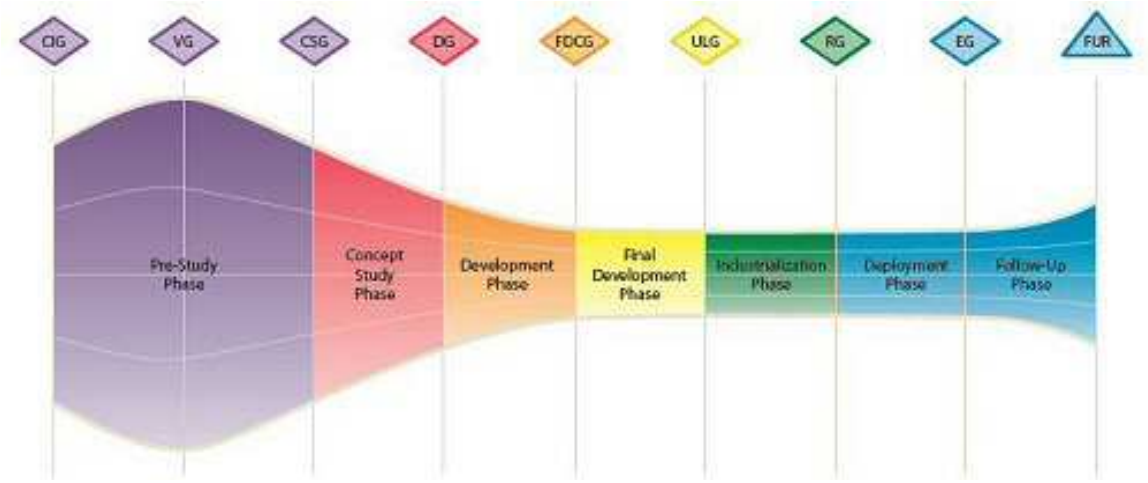
4.1.2.2 IS-GDP

The Information System Global Development Process (IS-GDP) is a model that is used by the business areas and the business units as a demand side project control model for IT projects.

IT project managers use this model to communicate with the demand side using the terminology of IS-GDP. The purpose of the IS-GDP model is to enable successful delivery and management of process and system change all the way from stating the business value to deployment and realization of the value in the user organization. It provides a common method to structure process and IS/IT projects in the Volvo Group from a business point of view.

The model supports the steering committee to take decisions regarding vision, scope, business objectives fulfillment, time, cost, quality, content and implementation. It also supports the project team to ensure that all key issues have been covered and have got answer or solution at the right time, at the right cost, at expected quality and content.

Figure 12 *The Information System Global Development Process Model.*



IS-GDP and benefits management

The purpose of the first gate which is the CIG (Change Initiation Gate) is to approve the business value of the request and formally start a pre-study. The gate opens the first part of the pre-study phase which aims at developing the project vision and conducting the diagnosis, a common understanding of the problem/opportunity.

At the second gate called VG (Vision Gate) the purpose is to approve the project vision and the diagnosis. The project manager has the responsibility to define what the project will give the company in terms of quality, time and costs and to quantify the efficiency gains. The gate opens the second part of the pre-Study phase which aims at defining possible solutions.

The third gate, CSG (Concept Study Gate), decisions about which solutions to investigate further will be made. This gate marks the end of the pre-study phase and beginning of the project. The gate contains profitability analyses, estimating cost and savings together with a quantification of efficiency losses and gains. Furthermore the organizational impact, its feasibility and risk assessment is also reviewed along with the projects alignment with the business and the IS/IT strategy. The gate opens the Concept study phase which aims at gathering the detailed arguments to decide the solution to choose and decide ways of working.

At the fourth gate, which is the DG (Development Gate) a solution will be selected, it´s way of working combined with technical concept will be approved. The purpose at this gate is to approve how the selected solution is expected o realize the vision and how it will support the key business drivers. A comparison will also be made to examine if there is a better solution. This gate opens the Development phase which aims at developing all details necessary to freeze the solution and reach the contract.

The fifth gate, FDCG (Final Development Contract Gate), has the purpose to freeze the solution and sign the contract. The profitability analysis will also be looked over again to check if any changes have been made regarding the costs and savings. An approval will be made if the proposed solutions fulfill the business needs. The gate also opens the Final Development phase which aims at developing technical solutions and preparing for deployment.

The sixth gate is ULG (User Launch Gate) where an approval will be made if the solution is ready for user validation tests. The gate opens the industrialization phase which aims at performing the user validation tests and finalizing the preparations for deployment.

The seventh gate is RG (Release Gate) where the overall purpose is to approve that the solution is ready for deployment and the organization is ready to receive it. The gate opens the Deployment phase which aims at delivering the solution and training the organization.

The eighth gate, is the EG (End Gate) the purpose is to approve that the solution contents and deployments are achieved according to the contract, hand over the responsibility to the maintenance organization, close the project and stop any expense on the projects budget. This gate opens the Follow-Up phase which aims at validating that the business objectives are achieved.

The last, ninth gate, is the FUR (Follow-up report), the overall purpose in this stage is to validate that the business objectives have been achieved and, if needed, decide action plans and further change management activities.

4.1.3 Virtual Manufacturing at Volvo

As a strategic solution for achieving better control over their different IS/IT solutions used among their different manufacturing units around the world, UGS Corporation was selected as provider for their Virtual Manufacturing software in February 2005. UGS is one of the leading global companies specialized in 3D and Product Life Cycle management software solutions for the automotive, electronics, aerospace and other manufacturing and processing industries. The applications used of the Volvo Group are: Teamcenter Manufacturing, which concerns product knowledge management and collaboration solutions; E-factory, which is UGS' digital manufacturing solution; and Tecnomatrix, which enables global coordination in manufacturing process planning. UGS long-term commitment to research and development, open strategy and scalability for multi-site implementation were all key factors in the decision to select Teamcenter Manufacturing software, which will enable the Volvo Group to leverage new technologies and current business critical systems. Figure 13 gives some examples of the different use of VM at Volvo

Figure 13 *General examples of the use of VM at Volvo.*

According to Volvo IT, VM is a solution for a common product and production development process. VM is a new way of working, with front loaded efforts and documented processes. VM is a digital representation of manufacturing processes, resources and products for a planned or existing factory.

The aim of VM is to define and optimize manufacturing processes, manage the process information, control change management in manufacturing process.

The aim is also to optimize products from manufacturing perspective, and to support effective collaboration internally and externally. VM increases the understanding relating to manufacturing process functionality. This enables a higher level of quality in operator training, which in turn leads to shorter installation and production times.

Virtual manufacturing increases know-how relating to manufacturing process functionality. Among other things, this enables a higher level of quality in operator training, which in turn leads to shorter installation and production times.

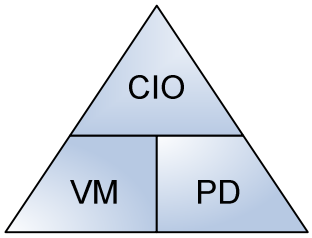
4.2 Responses from the interviews

We will now present a summary of the most important findings from our interviews. As described earlier in chapter two, we performed six interviews with respondents who have excellent insights of VM but also in the areas of PD and IS/IT investments. We use the term *level* (see Figure 14), when we refer to one respondent from the specific area, for example:

"*One respondent on PD-level said…*"

More information about our interview can be found in chapter 2.3.3.

Figure 14 *The different respondent levels.*



We will start by presenting our findings about IS/IT investment evaluations, continuing by presenting our findings about VM as an investment, and finally present out findings about the different characteristics of PD and VM.

4.2.1 IS/IT investment evaluation

4.2.1.1 IS/IT investments

When we asked the respondents about their view of IT in an investment, most of the respondents expressed that IT is an enabler for improvements. Though, most of the respondents said that it was much easier to view IT as a cost. One of the respondents on PD-level described IS/IT as a medium for formulating knowledge and at the same time was the foundation for all activities within the product development and manufacturing domain. Another respondent on CIO-level said that IS/IT was a tool used to describe the products in their context from product data management perspective.

All of our respondents agreed that IS/IT investment tends to end up as a change-management-process.

Participants in IS/IT investments

According to one of the respondents on CIO-level, investments are managed in two ways. Either they are treated as individual Business Area/Business Unit (BA/BU) errands or joined

in joined investments between different BA/BU:s. During an individual BA/BU IT investment each BA/BU is responsible for their budget and requirements formulation. When the board in a BA/BU has given approval for the investment, an IT-Governance function reviews the investment. If everything is aligned to and supported by the overall corporate strategies and objectives, an order is placed to Volvo IT. During joined IT investments key, stakeholders from each involved BA/BU forms a thematic group where investment projects that benefit the whole group are discussed, budgeted and approved. One example of a joined thematic group is the Global Issues Board for Information Technology of Process Management that involved all the CIO's from the thematic area are joined together with IT-governance stakeholders.

4.2.1.2 IS/IT evaluation

The reasons for evaluation

According to one of the respondents on CIO-level there are two main functions for IS/IT evaluations: learning and control. It was also said to increase business efficiency, creating an understanding for if they do the right things and if they are in the right direction. An evaluation is also said to be a way to communicate that they have control of an investment.

Performing IS/IT evaluations

One of the respondents on VM-level said that communication was something important during an evaluation. It was necessary to understand each other in order to create an understanding and at the same time be able to communicate the different reasons behind an investment. This was also said to be an even more important issue when the investment participants involved stakeholders from different cultures. In these global investments different cultural differences such as different understanding, perception, language and basic words could lead to misinterpretation. Therefore this respondent advocated that the cultural aspects were something very important to consider during these global investments.

One respondent on CIO-level talked about how IS/IT enables harmonization of the organization. By that the respondent meant that the same tools and way of work needs to be performed the same way everywhere.

Another respondent at CIO-level said that these difficulties don't necessarily only rely on communicational problems between "*IT-people*" and "*Business people*". It was also advocated that the early phases of an investment much relies on understanding. By this, the respondent meant that the problem needs to be understood; that the question needs to be understood; and that the reason for the investment needs to be understood.

4.2.1.3 Different views on perception

One of the respondents on PD-level had the opinion that benefits and cost in an evaluation had different relevance in different cultures. According to this respondent, this was something noticeable when comparing the Swedish and American culture. The American culture was said to have a tayloristic approach. As a result, this leads to differences when putting value to benefits. The respondent also argued that this approach could lead to a short term focus on benefits realization rather than a long term focus, due to the choice of methods used during an evaluation.

A common opinion among all of the respondents was that the outcome of benefits was something that was developed over time. Furthermore, most respondents expressed that it many times were difficult to see the linkage between a benefit and its outcome.

One respondent on CIO-level expressed that there is a short term focus on the realization of benefits, but that this rarely was possible to achieve since there is a "…*human factor involved*". Therefore, the implementation of IS/IT was said to be achieved much faster than the actual benefit outcome of IS/IT. This human factor was explained to involve way of work, motivation and culture.

Some of the respondents said that there are different perceptions about benefits depending on what level within an organization you are looking at. One respondent on PD-level had the opinion that there was a huge difference on view of benefits between the strategic level and operational level, and that lack of transparency in investments can lead to implementation problems. Furthermore, the same respondent said that it is quite difficult to decide which level you want to calculate your profit at.

One of the respondents on VM-level had the opinion that the size of the company also influenced on benefit perception, since an investment many times needs to fit many different stakeholders. The respondent said:

> "*It is not easy working in a global collaboration. We can not build a solution just for ourselves, but a solution that suits everyone."*

According to one respondent on CIO-level, indirect and intangible benefits become more important when a business chase did not show convincing figures.

One respondent on PD-level said that even though these qualitative benefits generate profit, they are very difficult to motivate financially. However, not paying attention to these intangible benefits was said to result in unwelcome disbenefits and resistance to change.

4.2.2 VM as an IS/IT investment

4.2.2.1 VM investments

One respondent on PD-level had the opinion that it is difficult to predict how you actually would work after investing in a totally new technology, such as VM, and that "… *you need to have little religious belief, since there is not much to refer to*".

A common answer was that investing in VM ends up as a change management process, where organizational and cultural change was in focus rather than technical IT-issues.

Most of the respondents defined VM as an enabler. It enables possibility to visualize and analyze the design for manufacturing issues in earlier phases of the development of a new product. One of the respondents on VM-level had the opinion that the technology of VM has the role to support the people in the process in a simulating way. The respondent meant that the best use of technology is when the users are not aware of the existence of the technology and that *"…it should be just like turning the key into the car."* Later the same respondent said the following about VM technology and the PDp:

"So, so it is a critical part of the process but should not drive it. It should support it and facilitate it."

The value of not investing

Another respondent on PD-level considered that VM creates advantage over the competition by reducing the cost in the time it takes to get new products to the market.

However, there are some IT-related costs hence there are always need for other technology to support these kind of capabilities, there are a huge amount of data moving through the local and wide network. There are also organizational costs; people need to be trained in technical tools and in a new way of doing business.

4.2.2.2 Evaluating VM investments

Involved Stakeholders

One respondent on VM-level advocated that the evaluation of VM should be performed in partnership between the businesses area and the IS/IT supplier. This respondent said that it is necessary to understand the environment of the technology and the reason for this is that the business area owns the process and has the greatest understanding. The respondent expressed it like this:

"… having a fundamental understanding of the environment in which the technology will be deployed and the challenges that the business area is trying to aggress."

One of the respondents on PD-level had the opinion that it is very important to create a transparency in these kinds of investments, in order to motivate users on operational level. This respondent meant that the benefits of an investment need to be understood throughout the organization. Not emphasizing on this issue would only lead to resistance to change on operational level when adapting to new technology. The respondent said the following about this sort of disbenefits:

"… when you start influence on responsibilities and power structures, you will have such a solid opposition so that the management […] gets completely powerless."

Therefore, the respondent argued that it is important to understand how the different IT-systems are connected to each other and to understand their context.

Difficulties during VM investment evaluations

While discussing the various benefits of VM one respondent on VM-level argued that the technology influences the evaluation of intangible benefits, which was said to be dependent on understanding the technology. The respondent said:

"… until you have a good understanding of the technology and the additional capability that are provided by that technology, you cannot adjust your key performance indicators in a good way to be able to measure …"

The same respondent later said that technology changes the way intangibles can be measured when new technology improves communication and breaks down organizational barriers. The respondent said:

> *"As you eliminate the barriers […] your KPI change*".

One respondent on CIO-level also said that the actual outcome of benefits from an investment could be realized in other areas than predicted. One of the reasons for this was that there could be more than one investment project that had the same benefit expectations as another benefit. The respondent said:

> *" … so you calculate the benefits twice […] and when you summarize everything you don't quite know where it comes from."*

Another respondent on VM-level said that a major problem were organizational barriers which created difficulties on the contribution of new products since there are so many different organizations involved in the overall process.

Benefits realization from VM

While discussing the realization of benefits from VM in relation to time one respondent on PD-level said that a short term view on benefits would only lead to a conservative attitude towards investments, since the benefits could take time to be fully realized.

One respondent on VM-level advocated that it is important to have a clear understanding of how to actually work with new technology and to understand the processes. By doing this the business case would improve its justification and reduce possible implementation failures. Not doing so creates an "*I can build the product without it, and you haven't done your case"*-attitude that in the end builds up a business leadership that is hesitant and cynical about investing in new technology, since the benefits are not achieved in a good way. The respondent answered to our question regarding how to solve this kind of problems:

> *"… by understanding your process and understanding your problems […] IT obviously has tremendous value to the customer, but if they not understand their process and then understand the weaknesses and the strengths of the process then they have no possibilities to leverage the technology"*

Therefore, this respondent argued that it is each business areas' responsibility to document their processes and being able to understand their local needs.

One of the respondents on the VM-level described how critical handling data can be. The respondent also described the importance of using correct data from the first phases to the end phases of development. The reason for this is the increasing chance to succeed if correct data is used. The respondent said:

> *" It doesn't matter how good analyzes or simulations you can make if you don't know that you are using correct data; the same data that will be used in the production. Everything is based on that you have the basic information, and it is the same information that will be used by all disciplines. "*

Negative effects

One respondent on PD-level talked about one major problem that can be, when investing new technology, that the managers do not have the knowledge that is required about the new IT.

If the employees have the knowledge that the managers do not manage the managers will feel uncomfortable and their oversight decreases over their area of responsibility, the managers will loose some of their control over the organization. When that happens an organization will be sensitive for disturbances

4.2.3 Product Development and VM Characteristics

All of the respondents had different opinions about the different characteristics of PD and VM. They also had different views of what factors were important for PD and VM.

4.2.3.1 General characteristics

PD Characteristics

A common view among the respondents was the importance of understanding and "doing it right" in the initiating phases due to the increasing cost in the later phases. According to one respondent on VM-level, it is important to have documentations and understanding of the current processes in order to work cross-functional effectively and create improvements. The documentation of the process was considered important since this facilitates the understanding of the overall contribution of the work. One of the respondents on VM-level said that:

> *"…you have to break down organizational barriers to open up communication. Make it available so we can work kind of collaboratively…"*

Later, the respondent said the following about the involved stakeholders:

"... they need to participate as early as possible. So you need to break down organizational barriers, you need to begin to think in a way of understanding what everybody's issues may be."

Some of the respondents mentioned the importance of understanding cross-functional working which requires well defined and documented processes and includes answers for questions *what* is done, *who* did something, *responsibilities* and *roles*. It was said that this requires a commitment to the process by everybody.

One respondent on PD-level considered that the role of PD is to interpret the market needs, make them to technical needs and develop solutions that eventually will be products that will be assembled at the factories.

According to one respondent on PD-level, one success factor for PD is the attribute profile for the product, which is important in the customer segment. It is important to be able to have a balance and find solutions for the market demands. The market demands are dependent on the "brand profile". One of the respondents on PD-level expressed the importance of having an agile and flexible process. Furthermore some respondents argued that the process at the same time should be consistent and repetitive.

VM characteristics

One respondent on VM-level advocated a clear need to understand the process and said the following while discussing VM and technology:

> *"There's a lot of technology out there, but unless you have a good process all that you end up doing with technology is that you're able to create errors more quickly.*

The respondents agreed about the effectiveness of VM which does not come automatically. In order to achieve the benefits of VM a change in the business culture is needed according to one of the respondents on the VM-level.

> *"VM is not magic, it requires commitment from you to know all areas."*

Another problem that one of the respondents on VM-level talked about is that much resource is spent on the technical issues while not enough resources are spent on understanding how to work in a good way. This has led to not being able achieving the benefits parts of VM in a good way, which in turn has made the business leadership very kind of hesitant and cynical about VM.

4.2.3.2 Organization

PD characteristics

Being able to work cross-functional was considered an important issue among the respondents on PD- and VM-level. According to them, PD is a collaboratively work, requiring extensive communication which can be improved by breaking down organizational barriers. This would in turn improve a holistic view on what everybody in the process contributed with.

One respondent on VM-level explained that there is a need to create an understanding among the engineers that they all worked in the same direction, focusing on delivering a product to the end customer. The respondent considered that everybody have to be committed to the process.

Another respondent on VM-level said that a major problem is organizational barriers that create difficulties in the contribution of new products since there are so many different organizations involved in the overall process. The respondent said:

> *"…you have just a slice of the overall pie but who has the pie that should be given to the customer?"*

The respondent continued by explaining that there is a need to create an understanding among the stakeholders that they all worked in the same direction, focusing on delivering a product to the end customer. The respondent said the following about all of the involved stakeholders:

> *"... they need to participate as early as possible. So you need to break down organizational barriers, you need to begin to think in a way of understanding what everybody's issues may be."*

The respondents all agreed about the role of communication, it is one of the most crucial success factors.

VM characteristics

VM was said to be a way of being able to meet the customers´ needs in a more efficient way, which in the end gives value to the customer. This requires the information to be managed in an efficient manner.

Both respondents on VM-level described how the users have been changing their mindset. With the usage of VM the users are able to visualize their problems in another way than earlier, the users can make their thoughts and opinions visible, they can be proactive and they can make suggestions about improvements.

The respondents also mentioned the difficulties and the risks that come with changes.

Most of the respondents expressed that VM enables a new ways for communication, which in turn creates new possibilities for cross-functional collaborative work. It was also said that VM enables visualization and sharing ideas and thoughts. One interesting side effect by this was that the relationship and roles between different involved engineers changed. This in turn could create uneasiness among the engineers since they had to share ideas earlier during the product development. Therefore, change management and a creation of a more holistic mindset among the employees were advocated by the respondents on PD- and VM-level. One respondent on VM-level said:

> *"… you guys have to basically open up your magic box so we can see what you have in mind, maybe a bit earlier than that you were used to, but that´s OK because we all work for one company. So if it's not perfect, that's fine, but just let me see it anyhow."*

Furthermore, the same respondent explained that VM eliminates organizational barriers and that VM is approaching to product development.

4.2.3.3 Culture

PD characteristics

One of the respondents on VM-level had experienced cultural barriers. The respondents mentioned the importance of seeing the "*big picture*", having an understanding for flexibility, designing and total context.

Regarding the internal organizations, there are still barriers in the culture depending on the organization that should be handled, the people within the organization, the organization and the knowledge about the organization is developing successively. One of the respondents on VM-level had the opinion that the cultural issue was something important to highlight since they worked globally.

4.2.3.4 Role and commitment of the senior management

PD characteristics

One of the respondents on VM-level stressed that *"someone in the authority must point with the entire arm"*. The respondent explained that the role of the management is crucial for success.

Some of the respondents considered that the role and commitment of the senior management is essential to create changes among employees. The role of the management is important in motivating the engineers to change their way of working. Concurrently create an understanding that the change is beneficial and necessary since "*…people don't like changes"*, as one of the respondents on PD-level expressed it. Later, the same respondent also argued that leadership is an important issue to address in order to utilize the development of a contextual understanding. Furthermore, leadership was said to be important in the coordination of resources. The respondent said:

> *"…we are all contributing our part of the responsibilities to the overall kind of heuristic vision and then all these activities need to be coordinated"*.

One of the respondents on the VM-level advocated the need for a commitment and support from an executive level. The respondent said:

> *"It has been a struggle through the years to get executive level support, we get verbal support and encouragement but this kind of technology requires a great deal of investment of resources…"*

This support was not only described as capital investment, but also human resource investment.

VM characteristics

Most of the respondents had the common opinion that the leadership has a very important role in VM investments. One respondent on VM-level argued that this was important since employees within the domain need to be motivated by enthusiasm in order to accept changes and reduce resistance to changes. This could improve the realization of benefits. The respondent said:

> *"… that requires leadership to get you to see the benefit, and kind of get excited about it. 'Yeah, I have to learn something new, but this is good!'"*

Later the same respondent said the following about investing in VM and the role of the leadership:

> *"In the end of the day it's not a technical exercise, it's a leadership exercise."*

5 Discussion and analysis

In this chapter we will discuss our reflections and interpretations around the theoretical and empirical findings earlier presented. We will first analyze the different perception of benefits in IS/IT investments, important success factors in Product development and the characteristics of Virtual Manufacturing which will answer our sub-questions.

5.1 Describing benefits

How can benefits be described within the product development domain?

5.1.1 Product development process

Evaluating benefits have been perceived by CIO's in Sweden to be one of the most challenging tasks and also the most difficult (Frisk and Plantén, 2004). According to Bannister and Remenyi (2003), decision-makers should avoid a narrow perspective, which is the most frequently method used is a Business case with an economic focus (Ward and Daniel, 2006). Several researchers have come up with different suggestions how to improve the evaluation in order to achieve value from IT investments.

5.1.2 A need for a strong leadership

Results from studies performed by Ashbury and Doherty (2003) showed that most projects are focused on technology delivery rather than organizational change and benefits realization. Our research gives support to this since the respondents expressed a need to emphasize on leadership and management commitment rather than technical issues. It was said to be the leadership's responsibility to make the stakeholder perceive that the outcome of change was a benefit. This in turn is similar to Ward, Murray and David (2004), who argue that it is managers who choose how to turn an outcome into a benefit.

5.1.3 Different dimensions of value

Cronk and Fitzgerald (1999) describe IS value as the sum of three value adding dimensions: System, User and Business. The system dependent dimension, which is the value added to the organization as a result for the system characteristics; the user dependent dimension, which is created by the value added to the organization; and the business dependent dimension, which is the value added to the organization as a result of business factors. All of the respondents expressed that they perceived business value as something that was added to the organization. We discovered that this value could be created by the belief that the change was beneficial and meaningful to the one exposed to change or that the change enabled new ways of communication across the organization. These findings are similar to what Cronk and Fitzgerald (ibid) describe in their user dependent dimensions.

All of the respondents advocated that users' benefits were something important. But the common view from all of the respondents was that an investment was managed with an economic approach where value either increase the revenues or reduce the cost, and that the investment should be aligned with the overall corporate strategies and goals. We also found that there are organizational functions within the company controlling the strategic alignment between IS/IT investments and overall corporate objectives and that these functions played even a more important role when large joined investments were under evaluation. Therefore, we believe that these findings are similar to what Cronk and Fitzgerald (ibid) describe as value of a business dependent dimension.

Most of the respondents said little or nothing about the system characteristics or focused on the technical dimensions Cronk and Fitzgerald (ibid) describe, other than expressing a need to have reliable and consistent data within their systems and applications. We found that this is a critical success factor and condition for using new technologies such as VM. Since our study had an interpretative approach, interviewing senior management we cannot say much about the actual end users and their perception of the system characteristics and their perception of value. Therefore we recommend that a more technical approach is needed in order to research these dimensions, interviewing end users and system managers.

5.1.4 Different levels at the organization

We also found that benefits can be perceived differently. It was said to be either differently within an organization, at different levels, strategic and operational; or between organizations. This is something that agrees to Symons (1991, see Cronk and Fitzgerald, 1999) earlier findings of existing conflicting value perspectives within the social context of an organizational culture.

5.1.5 Cultural delimitation

Our findings also indicate that the perception of benefits and value is something that goes beyond an organizational culture; that it is something perceived differently in different countries. These findings are not supported by Cronk and Fitzgerald's (ibid) research since they only focus on an organizational inner. An answer to this can instead come from Stockdale and Standing (2006), who argues that the context is divided into an inner and outer context that influences an evaluation and perception of benefits.

However, our findings indicate that something that can create IS/IT value in the business dependent dimension at the same time can be considered a disbenefit in the user dependent dimension, e.g. among engineers, since they might feel discontent from the necessary changes. With other words, the dimensions seem to correlate to each other. This is something that is agreed by Bannister and Remenyis (1999) critique that it is insufficient that Cronk and Fitzgerald see each dimension as uncorrelated.

Therefore, we believe that it is very important to view benefits from different perspectives and that by doing this broaden the view of what IS/IT adds in value for an organization. Cronk and Fitzgerald (1999) add a new perspective in looking at IS/IT value, but should be viewed in wider context of influence. After comparing, the presented theoretical and empirical research gives us the impression that it is necessary to take the external contextual factors into consideration, when performing an IS/IT evaluation involving stakeholders from different cultures. We also believes that this issue should be even more addressed when performing an

IS/IT investment evaluation on a global level. A good way to do this is a PEST-analyze (Political, Economic, Social and Technological factor analyze). This could give valuable input in understanding how benefits are perceived.

Summary

Table 12 Summarize our discussion on how benefits can be described.

Table 12 *Benefits description*

Benefits description	Summary
Need for strong leadership	• there is a need emphasizes on leadership and management commitment rather than technical issues
Different dimensions of value	• business value as something that was added to the organization • common view that the investment was managed with an economic approach where value either increase the revenues or reduce the cost and • organizational functions within the company that controlled the strategic alignment between IS/IT investments and overall corporate objectives
Different levels at the organization	• benefits can be perceived differently
Cultural delimitation	• perception of benefits and value is something that goes beyond an organizational culture • something that can create IS/IT value in the business dependent dimension, at the same time can be considered as disbenefit in the user dependent dimension, e.g. among engineers, since they might feel discontent from the necessary changes • it is very important to view benefits from different perspectives

5.2 Influencing factors

What factors influence the benefits of Virtual Manufacturing within the product development domain?

5.2.1 Product development process

According to Ernst (2002), one important aspect that has a positive influence on the success of new product development is the proficiency of individuals participating in the new product development. Another important aspect is the usage of the market information during the New Product Development (NPD). There are also aspects that influence the financial success of the new product. These are: having a clear definition of the planned product, having a preparatory work of high quality when the initially definitions are broad. A high quality NPD process and a clear orientation of the NPD process to market demands are required.

Our study shows the importance of having an understanding of the PDp during the initiating phases. This can be compared to Ernst's (2002) theory regarding having a clear definition of the planned product, and having a high quality preparatory work before starting the production. Our study shows that having such understanding could improve performance, which in turn could lead to cost savings.

We also noticed that documentation of the process improves understanding and enables guidance in their way of working. This would in turn help them understand their roles in the collaborative work within the process. We also discovered that this also guided them to realize their different needs and demands. This can be explained by Ernst's (2002) theories about the high quality NPD process and a clear orientation of the NPD process to market demands and requirements. Our result shows that a clear definition of the processes facilitates the way of working, cross-functionality and the roles of involved. This would in turn influence the economical aspects since a deep understanding prevents misunderstandings.

We also discovered that the GDP model investigates the market needs and technical feasibilities during the initiating phases. These findings are similar to Ernst's (2002) theories where he argues that market information should be used along the entire product development. This required a detailed documentation of the process, which Ernst (2002) describes as a success factor for product development.

While discussing VM specifically we discovered that VM was perceived as an enabler, just like any other major IS/IT improvement within the PD domain. Interestingly we noticed that the success of VM was not a technical issue. Instead, it was perceived as a leadership and change management issue. This required a detailed documentation of the process, which Ernst (2002) describes as a success factor for product development.

5.2.2 Organization

Ernst (2002) argues that the organizational success factors for NPD are: Cross-functional NPD teams, strong and responsible project leaders, NPD teams that are responsible for the entire project, the commitment of the project leader and the team members of the NPD project and finally the communication among the members should be intensive during the entire NPD process.

We discovered that working cross-functionally requires collaborative work, which in turn requires intense communication. These findings verify Ernst's (2002) theory of cross-functional NPD teams and intensive communication. This also shows that each factor correlates to each other since cross-functional work requires communication.

Our study also shows that there is a need to create a holistic understanding among the team members, so that they work in the same direction and focus on the same issue. The team members have to be committed to the process. This is similar to Ernst's (2002) findings that there need to be a commitment of the team members and project leader. We also noticed that it was the leadership's responsibility to create this holistic understanding and that the "*focus on the same issue*" was a focus on the customer, e.g. the buyer of the final product. Worth noticing here is to answer oneself who the actual customer is. Our impression was that this was something difficult to see, since there was such a great need to create a holistic view in order to understand benefits.

We also found that communication requires documentation of the process and that a well defined process would both improve a holistic view of the process and improve the collaboration work. While discussing VM specifically we discovered that VM enables improved communication between engineers in a much richer and intensive way. It was also said to break down organizational barriers, improving cross-functional work. These findings are similar to the success factors that Ernst (2002) points out. However, we noticed that in order to achieve these improvements in a good way, it was necessary to understand the process. Hence, documentation also improves communication, and subsequently also cross-functional work.

5.2.3 Culture

According to Ernst (2002), an innovation-friendly climate in the organization together with risk-taking behaviors are relevant aspects to success. He argues for example that the possibility for employees to develop new ideas on parts of their working day is a critical success factor.

Our result found little or no support by Ernst's theories about this, since he focuses on the aspects of creating an innovative organizational environment. Our respondents talked more about cultural issues when working together globally. However, we believe that since we have discovered that culture influences the different benefit perceptions within the PD domain, we believe that this also might influence on the way employees perceive to be an innovative environment when working together both locally and globally.

5.2.4 Role and commitment of senior management

Ernst (2002) mentions that the support of senior management and adequate resource allocation are two important success factors. His research found that the increased support from senior management decreased the number of NPD project termination. The senior management was explained to be a guiding hand in disputed NPD projects and may overcome internal resistance (ibid). Our study shows that the senior management has an essential role to create changes among employees. The management was said to be able to create a holistic view of the context and at the same time enable understanding about necessary changes. It also said that the management was important to coordinate resources and at the same time needed to be involved in projects. Our findings are similar to Ernst's (2002) theory where he argues that the role and commitment of the senior management is a crucial success factor. The involvement of the management is necessary to succeed. Furthermore, while discussing VM specifically we discovered that the involvement and support from senior management was something very important, since they motivated employees easier accepted changes. This was not discussed by Ernst (2002) when describing this critical success factor. However, it might be that motivation and expressed commitment are closely correlated, since our result show that both commitment and motivation was something important to enable changes within the process.

5.2.5 Strategy

The strategic issue is maybe one of the most abstract issues since it is future oriented. Our findings emphasize that benefits takes time to be realized, which is argued by Brown (2005). We also noticed that IS/IT investments needs to be align to overall vision and corporate goals. Therefore we believe that identified benefits needs to be aligned with both an overall

corporate strategy and the PD strategy. VM is also considered to create advantage over the competition by reducing the costs and the time for the product entries to the market. This sort of improvement is similar to Ernst (2002).

5.2.6 IS/IT

Ravi (2002) also argues that the key challenge is to integrate all the information that the different applications requires. Our study gives support to this, since all of the respondents emphasized that VM required correct and consisted product data management.

Interestingly, in our research we also found that this also implied that even though problems in the PDp could be reduced, the reliance to IS/IT increased, and that since communication was more intense, new problems could be created much faster than before. There is always need for other technology to support not only VM´s capability, but also for the reason that a huge amount of data moves through the local and wide network. This is, according to our study, one of the costs that VM brings. There are also other costs, like the organizational costs.

Summary

There are different factors that influence the benefits of VM within the product development domain. Some of these factors can be described as Critical Success Factors (CSF) for PD in general, while others are more specific or unique for the use of Virtual Manufacturing within the PD domain.

Table **13** summarizes our discussion and resemblance and difference between the CSF for PD and VM. This clearly show that there are some factors that are unique for VM and some that are applied for PD in general, which also influence the benefits of VM, and therefore needs to be taken into consideration during an evaluation.

Table 13 *The difference and resemblance between CSF for PD and VM (continues on the next page)*

	Critical Success Factors	
Area	Product Development	Virtual Manufacturing
Process	• a clear definition of the process facilitates the way of working cross-functionality and creates an understanding of the different the roles involved in the collaborative work. • a clear definition of the process influences the economical and financial success	• leadership and change management requires a clear definition of the process in order to work efficiently • documentation enables efficient communication
Organization	• working cross-functionally requires collaborative work, which in turn requires intense communication. • there is a need for a holistic understanding among the team members, so they work in the same direction and focus on the same issue. the team members have to be committed to the	• VM enables improved communicate between engineers, but also requires communication in order to be implemented effectively by the leadership • VM breaks down organizational barriers improving cross-functional work.

	process. • documentation improves communication, and subsequently also cross-functional work. • since there are so many involved participants in this collaborative cross-functional work, organizational barriers need to be reduced in order to improve communication.	• there is a need to change mindset and create a holistic understanding
Role and commitment of senior management	• the involvement of the management is necessary to succeed since they coordinate resources needed • the leadership can create a holistic mindset	• VM requires a strong committed and motivating leadership which is focus on change management
Culture	• that culture influence benefit perception	-
Strategy	-	• benefits needs to be aligned to both the overall vision and corporate goals and pd strategy
IS/IT	-	• VM requires correct and consisted product data management.

5.3 The VMB-model

Before attempting to answer our main question we designed our own model based on the theoretical and empirical findings. Both the theory and empirical findings helped us to understand how VM influenced the Product Development process and the outcome of benefits within this process. We also learned that these Virtual Manufacturing benefits are influenced by different Critical Success Factors that creates prerequisites for their realization.

The model is specifically design for benefit identification of Virtual Manufacturing benefits, within the product development domain.

The design of our Virtual Manufacturing Benefits-model (VMB-model) has been influenced by certain prerequisites:

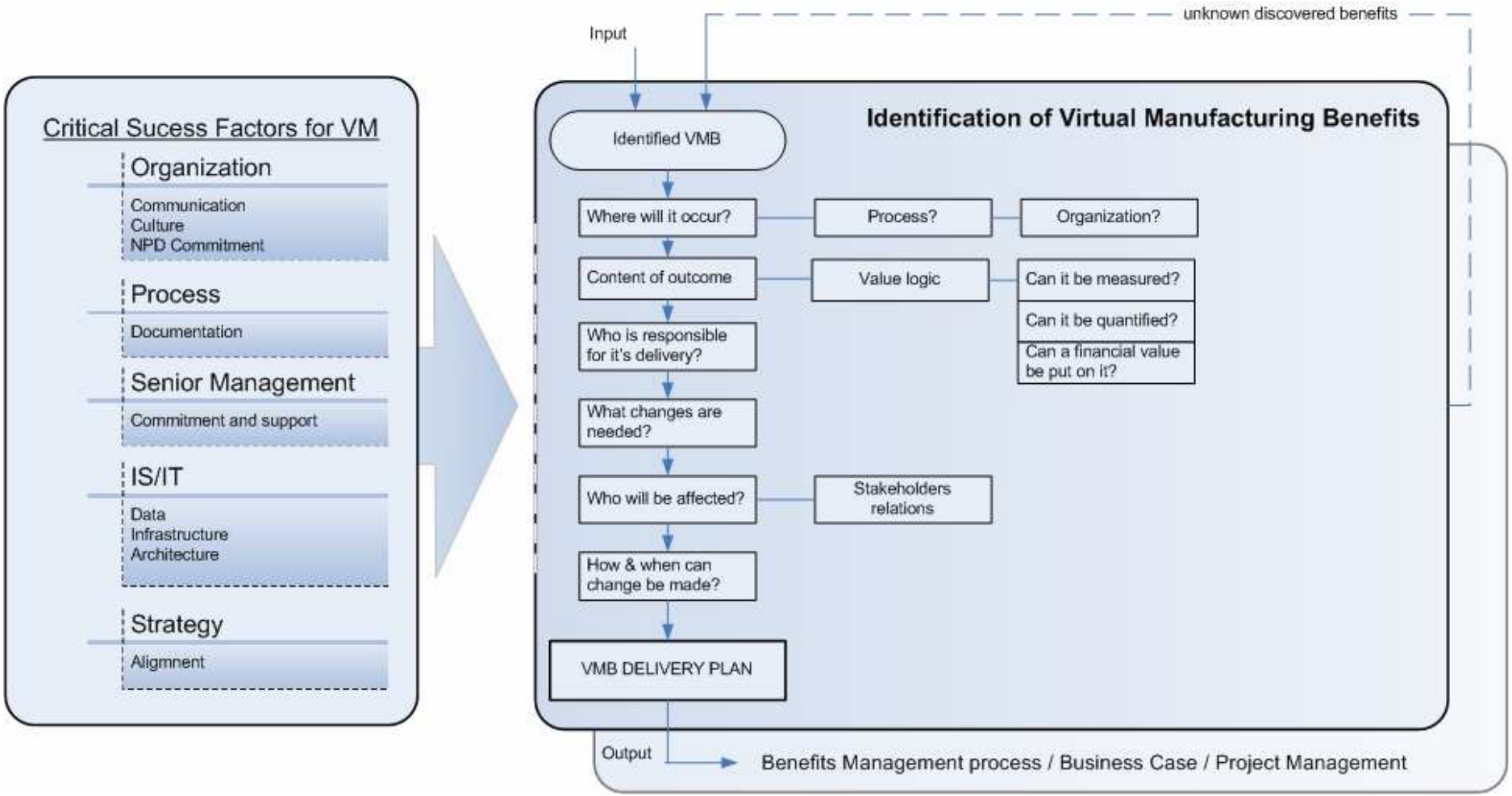
- Our assignor Dan Havner, from Volvo Information Technology, who expressed that there is a need for a model to locate strategic benefits of a customer that have impact on the value chain and the same time are affected by the IT-system implementation,. This will in turn support the development of a business case before or during pre-study phase.

- None of us (the authors) have worked with Virtual Manufacturing investments or within the product development domain, prior this study.

- We had a limited amount of recourses available in form of time available from both the side of Volvo IT, their customers and from the limit set for our thesis.

In the following chapter we will explain each part of the VMB-model (see Figure 15 on the next page).

Figure 15 *The Virtual Manufacturing Benefits Model – VMB-model (our design)*



5.3.1 The reasons for a VMB-model

Ashbury and Doherty (2003) argue that the first thing to do is to identify and calculate the planned outcomes of an IS development project and deciding how these benefits are to be achieved. This view is also shared by Ward Murray & David (2004), Ward et al. (1996) and Lundberg (2005).

Our findings indicates that there are methods and models used to identify and calculate benefits in general both before during and after an IS/IT investment which are similar with the Benefits management approaches suggested by Ashbury and Doherty (2003), Ward Murray & David (2004), Ward et al. (1996) and Lundberg (2005).

The IS-GPD uses different plug-ins that contains general tools for identifying and managing benefits during the pre-study phase. We also found that there is a strong need for a management process of benefits and that the IS-GDP was the answer for this need. The IS-GDP was said to be used in every business case involving an IS/IT investment evaluation. This approach is similar to Ashurst and Doherty's (2003) approach who argues that a benefits management process should be performed for every individual project.

However, we noticed that the IS-GDP is focused on a general view of managing benefits in a business case, which subsequently creates a general approach for managing and identifying the benefits of VM in an evaluation. At the same time we also discovered that VM was viewed as any other IS/IT investment.

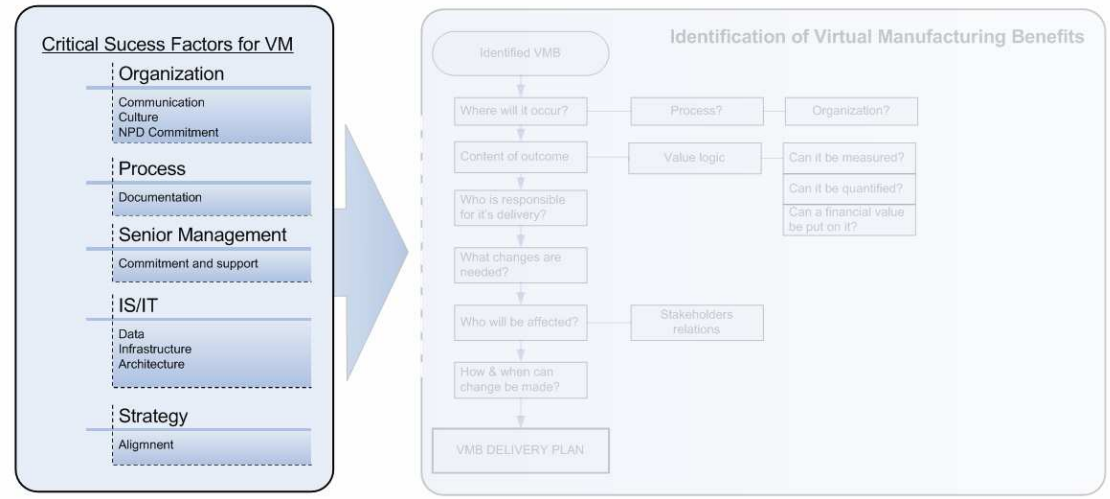
Therefore we believe that there should be a special designed process of identifying benefits from VM. Furthermore, we believe that it is necessary to understand that the realization of benefits from Virtual Manufacturing is influenced by different Critical Success Factors.

We will now give an overview of the model and describe the essential parts. First we will discuss how the success factors are integrated into the identification model, and then we will cover the main areas of the VMB-model.

5.3.2 Critical Success Factors for VM

Our result from the analysis resulted in the following Success Factors for Virtual Manufacturing: Organization, Process, Senior Leadership, Strategy and IS/IT (see Figure 16).

Figure 16 *The Critical Success Factors for VM (our design)*



Organization

Our result identified Communication, Organizational, Cultural and NPD commitment as important success factors for VM. By comparing the results from our interviews we could see that VM affected *Communication* in many ways. For example communication was improved and breaks organizational barriers and improves cross-functional work. However, knowing how to communicate also implies a good understanding of ones process. This in turn gives support when managing the benefits from VM, in order to ask the "*right questions*" and develop a communication strategy for change-management.

Our result also noticed that the aspect of *Organizational Cultural* need to be focused since VM takes place in a social context, where there are different perceptions about the outcome of VM benefits. These benefits take place within the process of product development, at its different stages, and within different organizational levels.

We also found that the organizational success factor NPD commitment also is a success factor since our result was similar to Ernst's (2002) research findings. We noticed that in order to success with VM commitment should come from everyone; including NPD project managers, NPD groups and involved stakeholders. Not understanding this could only result in delaying the benefit delivery or create dysfunctional resistance to change, as our study points out.

Process

The result from our analysis based on Ernst's (2002) findings about the process as a success factor showed that documentation of the process is essential. A detailed documentation of the process showed improves communication, cross-functional work and change-management. At the same time a detailed process enables a much easier way to identify, locate, describe and structure the relevant stakeholders and benefit outcomes.

Senior Leadership

Continuing from the earlier discussion about commitment, we strongly emphasize that the commitment and support should come from senior management. It is their responsibility to influence and motivate the different stakeholders among the organization in order to promote the necessary change and at the same time motivate the rest of the organization. Our findings are similar to Ernst (2002) theory where he argues that the role and commitment of the senior management is a crucial success factor.

IS/IT

Something that Ernst (2002) and Cooper (2004) don't discuss is the issue regarding IT and IS. However, our findings indicate that both information technology and information systems require reliable and consistent data management, which in turn requires integration of several information systems. These findings can better be explained by Shridhar and Ravi (2002), who argues that the key challenge is to integrate all the information that the different applications requires.

Strategy

The strategic issue is maybe one of the most abstract issues since they are future oriented. Our findings do however emphasize that benefits takes time to be realized which also is argued by Brown (2005). We also noticed that IS/IT investments needs to be align to overall vision and corporate goals. Therefore we believe that identified benefits need to be aligned with both an overall strategy and the strategies that the PDp implies. A strategy also implies strategic input to a communication strategy and change management, which is conducted after the VMB-model has been used.

5.3.3 Identification of Virtual Manufacturing Benefits

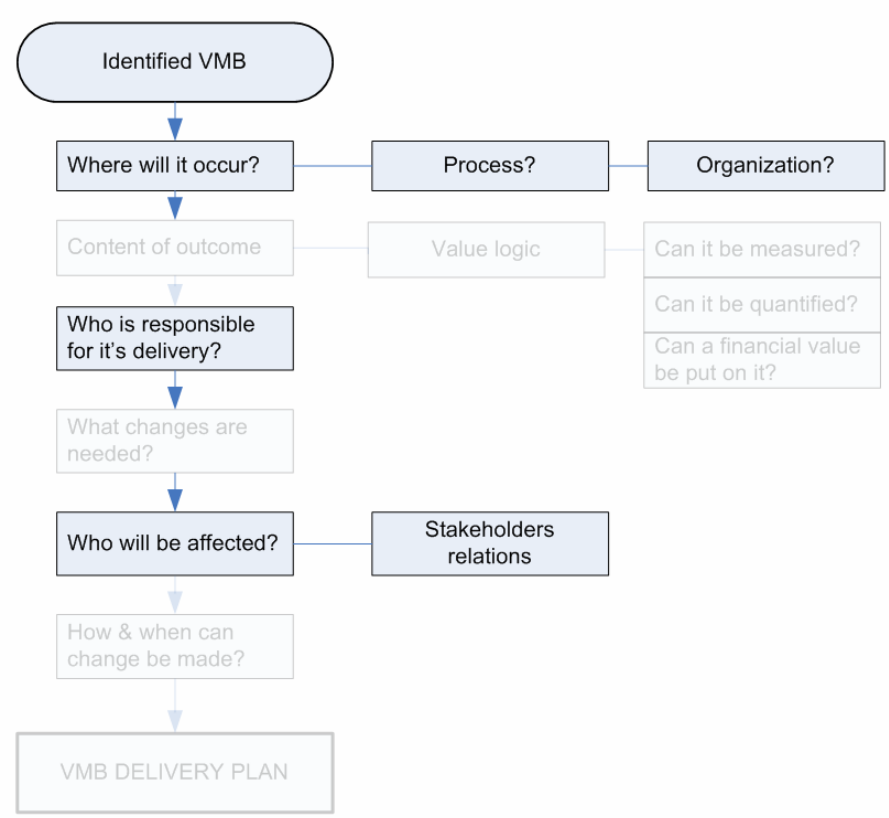
The different parts of the VMB-model can be described by discussing using a context, content and process approach. The model is built up after a set of questions which, if answered sensibly and thoroughly, resolves in a benefit delivery plan-document describing each benefit.

5.3.3.1 Context

Since new benefits can be discovered along the way these unknown benefits should also be analyzed as well as already identified or realized benefits.

The contextual questions (see Figure 17) focus on *where a benefit outcome will occur* within the process and organization. The context also asks questions about the stakeholders relations in order to create a communication strategy and at the same time understand their different relations to both the process and the organization. Understanding *who will be affected* by the planed outcome of a benefit and the changes needed, also allocates *who should be responsible* for the realization of the planed outcome so it becomes a benefit.

Figure 17 *The contextual questions within the VMB-model (our design).*

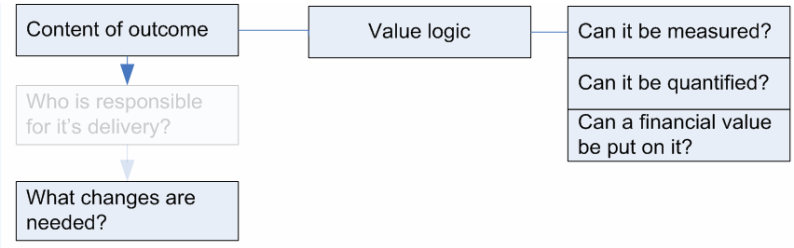


5.3.3.2 Content

The content of the outcome needs to be linked back to both the strategy and outcome. Therefore questions about the nature of the benefits results in an understanding whether the outcome is of a tangible, intangible, direct or indirect nature. The outcome has to be structured and traceable to its benefit. Its dependency to other benefits and requirements also needs to be understood.

The content also asks *what changes are needed* in order to realize these outcomes.

Figure 18 *The questions of content within the VMB-model (our design).*



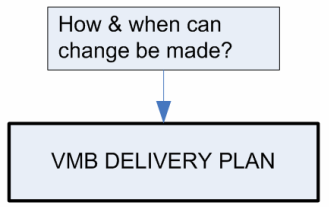
5.3.3.3 Process

Knowing where the outcome will occur in the contextual environment also addresses a need to ask who is the responsible for the benefits delivery. Last the questions of *how and when* a change can be made have to be answered in order to time to benefits (see Figure 19).

The result from these stages will go to a VMB-delivery plan which describes each benefit as a benefit-profile.

Every identified benefit is also stored in the “Identified VMB”-field for future analysis.

Figure 19 *The question of Process within the VMB-model (our design).*



5.4 How to evaluate the benefits of VM

How can the benefits of Virtual Manufacturing within the product development domain be evaluated?

In order to answer our main question we have designed our own model, the VMB-model, based on the theoretical framework earlier presented. We will attempt to answer our main question by following a discussion comparing the theoretical findings with the empirical findings and our model. The discussion will follow in the following order: context, content and process.

5.4.1 Context

Our research shows that it is necessary to first create an understanding of the environment in which IS/IT is deployed in before engaging in an investment. It was discovered that there is a need to understand how different IT-systems are connected to each other and to understand their context.

It was also discovered that it is necessary to understand organizational issues like organization culture and hierarchical structure and power structures among the involved stakeholders. Therefore, the issue of context will be discussed around the complexity of locating the benefits outcome and locating the stakeholders.

5.4.1.1 Locating the outcome

According to the VMB-model, one should start looking at the different stages of the process and try to locate the outcome on different organizational levels.

Our research findings indicate that by starting to look at these areas, one could be able to create an understanding on *where* and *when* within the process an outcome will occur.

Using the different success factors for VM, as mentioned in VMB-model, an evaluators search for benefit effects can be improved. The evaluator needs to understand how the benefit and the success factors influence each other. Paying attention to these factors are supported by both Cooper (2004) and Ernst (2002) who advocates that there is a need to understand ones success factors.

5.4.1.2 Locating the stakeholders

According to Stockdale and Standing (2006), evaluators must decide relevant stakeholders to the project being evaluated. This view is also shared by Remenyi et al., (1997, see Lin and Pervan, 2001), who claims that benefits are utilized within this context among key stakeholders.

Our research findings agree to Stockdale and Standing, since the respondents advocate that the stakeholders need to be understood in order to make them change their way of work and believe that the changes create improvements and are necessary. Furthermore, we discovered that the involved participants in an evaluation should be made in partnership between stakeholders from the business area and the IS/IT supplier, since the stakeholders from the business area has the greatest understanding of their process.

A way to understand ones context was by our research respondents explained to have a well defined documentation of their processes. This would subsequently lead to a better understanding of the involved stakeholders roles; their needs; and contextual perception.

The VMB-model emphasizes both process and communicational issues, since these are success factors for VM. Both of these issues can be explained in general by Ernst's (2002) research findings. According to Ernst (ibid), the new product development process needs to have a clear documented definition, and that intensive commutation and an interactive relationship among team members in NPD projects improves organizational success.

Our research shows that there is a need for an understanding of how the processes in the product development domain in order to create a more holistic view among the involved stakeholders. Therefore, we believe that these findings are similar to Ernst's (ibid) success factors and need to be taken into consideration during the identification process. Furthermore, we argue that there are two major reasons to why the VMB-model should implement these two factors during the evaluation of VM. Firstly, evaluators need to understand the value perception of the stakeholders. Secondly, evaluators need to initiate the formulation of a communication strategy.

Understand their value perceptions

One reason for locating and understanding the key stakeholders is explained by Symons (1991, see Cronk and Fitzgerald, 1999), which we earlier mentioned when we discussed how benefits could be described. Symons argues that there are conflicting value perspectives.

The VMB-model takes this into consideration and addresses the stakeholders by asking the questions "*Who will be affected*" by the changes needed to create a certain benefit outcome and "*How*" they will be affected. When the stakeholders are identified, the VMB-model advocates that each of these key stakeholders should be analyzed in order to understand their relations to each other; their relation to the process; and their relation to

the organization. Doing so also enables an understanding about their roles, needs and contextual perception.

We believe that these questions are essential, since our findings indicate that a benefit can be perceived in many ways on different organizational levels. This is even more important when the evaluation requires participants from different countries.

Formulate a commutation strategy

A well defined process also improves the organizational VM success factor of communication. We find support for this from Ernst's (2002) research results that are similar to ours, since VM is perceived to enrich communicational and improve cross-functional collaboration work.

Documenting the stakeholders' relation is also suggested by OGC (2007) in order to formulate a communication strategy.

Our research shows that understanding how to communicate with the involved stakeholders was something important. This meant that one should understand how to address the stakeholders in the right way by asking the right questions and at the same time be able to control them with the correct senior leadership, so that everyone moved in the right direction when change was necessary. Our research also discovered that the communicational issues also should consider cultural aspects, which was explained to be very important when an evaluation involves stakeholders from different cultures.

Furthermore, we noticed that if one, the consequences of not paying attention to the stakeholders could create to bad investment decisions and increased resistance to change among users and resilience by investment decision makers.

Another reason for why communication is so important was discovered when the respondents discussed why communication was important within the product development domain. Since the product development process itself involves intensive communication according to Ernst (2002), we believe that our similar findings from the communicational effects of VM therefore advocate that the communicational effects should be analyzed both on a human system level and IS-level.

5.4.2 Content

Our research found that intangible benefits tended to change as new technology was implemented. They were therefore perceived difficult to measure. This is agreed to by Brown (2005), who argues that benefits tend to be realized during a long period of time.

However, our research showed that intangible benefits had different relevance in an evaluation depending on how convincing the tangible benefits were. Furthermore, we noticed that the actual outcome of benefits was something perceived as difficult to trace, since more than one investment project could lead to the same benefit. Therefore, we

believe that there is a need to create traceability between a benefit and its outcome. This is agreed by OGC (2007), Ward et al. (1996), Ward Murray & David (2004) and Lundberg (2005), who suggest that the benefits should be structured and mapped in order to explain the relationship between benefits, their dependencies where they will appear and the sequence of benefits. According to OGC (2007), broken links of the value logic could also be identified.

The VMB-model advocates this issue and argues that a logical value chain needs to be documented. Therefore, the questions: "*Can it be measured*", "*Can it be quantified*" and "*Can a financial value be put on it*" need to be asked. These questions are also advocated by Ward, Murray and David (2004).

Since the contextual factors during the VMB-model's earlier stages describe the environment in which the outcomes will occur; which is within the process and organization, evaluators should start asking these questions on the identified benefits.

5.4.3 Process

After identifying the contextual factors of where within the process and organization (see chapter 5.4.1) the outcome of a benefit will occur and analyze its content. The question of who should be responsible for the delivery of benefit outcomes needs to be answered according to the VMB-model. This is also advocated by Ward et al. (1996, see Lin and Pervan, 2001), Bennington and Baccarini (2004) and OGC (2007), who argue for a formal project benefits management.

In practice, this is though something that was perceived difficult. Our research indicates that more than one investment project could create the same improvements, which creates added complexity to the traceability of benefit outcomes. However, we believe that a formal benefits management, by assigning a benefit owner, improves a commitment by the involved managers. This is also supported by Ward and David (2004), who advocates that a committed senior management should be maintained throughout the project.

Another reason for this is that our research noticed a need for following up IS/IT investments. Having a benefit owner could improve such work.

When the question of who should be responsible for the changes needed the final question "*who and when the changes can be made*" should be asked according to the VMB-model. Putting time to benefit realization is important, since they seem to change over time, which our result shows. This is also discussed by Brown (2005) who argues that benefits takes time to be realized.

Summary

To answer the main question of this thesis, we believe that it is necessary to create an understanding of how benefits can be described within the product development domain and how the critical success factors of VM influence these benefits. Since a VM investment has special characteristics that makes it more unique than a general IS/IT investment, we believe that it is necessary to have an interpretative approach that can be used as a complementary method to the existing methods used for building a Business case.

Therefore, we designed the Virtual Manufacturing Benefit model (VMB-model) that is specifically designed do identify structure and analyze benefits and their outcome achieved by VM within the product development domain.

Using a model, such as the VMB-model, could improve the identification of Virtual Manufacturing Benefits. The VMB-model should not be seen as an universally tool but an important complement to the IS-GDP:s when identifying Virtual Manufacturing benefits . It focuses on the areas of Context, Content and process and integrates the knowledge of success factors for VM.

5.5 Future research

During this study we discovered that there are some areas for future research. Due to the delimitations of our research we have not been able to create a deeper understanding of these areas. Therefore we would like make some recommendations for future researches.

The critical success factors

One interesting discovery made during our study was the critical success factors for VM benefits. We believe that there is a need to thoroughly understand these factors; how they correlate to each other and how it is possible to measure each factor's performance in order to understand its maturity. This would create an understanding on how to fully realize the benefits of VM. Furthermore, a study about the VM maturity of different organizations within different industries could give important insight in what is required from the organization.

We were also able to verify the different success factors for PD and would like to have a deeper understanding about how these factors correlate when a new technology is used within the product development domain. Understanding ones critical success factors is something that we believe is important, and should therefore be thoroughly understood. Therefore, we believe that a future research of these factors on different businesses and in different industries can create a higher understanding on what to focus on when investing within the PD domain.

IS/IT investments

Another recommendation which has some connections to the last mentioned recommendation is to study the organizations prerequisite for any kind of IS/IT investment. The reason for this is to be able to prevent failures with the investments.
Regarding the benefits a study could also be performed to find the measurement difficulties of the benefits. The study could be over the processes or over the cultural issues in the organization.

We found that the follow-up identification of the benefits is a crucial part of projects. The problem today is that these kinds of identifications are performed. A study could be performed to investigate how/if the follow-up identification is performed.

Furthermore, we advocate that a deeper understanding of how different cultures influence an IS/IT investment evaluation. Culture was discovered to be an important factor, not only for benefits perception, but for actually being able to work globally. How can improvements are made when a company goes global and what factors are important to emphasize in order to invest and work with success are some questions we've been thinking about. For a company working globally, growing by mergers and acquisitions, these things are important, since cultural barriers seems to create difficulties during an IS/IT investment.

Understanding the users

Since we delimitated our study to only understand senior managements view of benefits, we advocate that the end users perception of VM and IS/IT investments should be understood. We discovered that there are different perceptions of benefits within the organization. Therefore, we believe that an insight of the end users perceptions of benefits could be important. This is also advocated by for example Stockdale and Standing (2006) who argues that it the users have a close perception of benefit delivery. We believe that this is very important during the benefits realization phase of a benefits management process. This would also help a change-management process.

VM for Small and medium enterprises

Since our study was performed on a global corporation, we believe that it would be valuable to research what sorts of results an equal study would be for a small or medium enterprise. Questions raised here concerns all of our areas; IS/IT evaluation, benefits and VM. It would, for example, be interesting to understand how benefits from VM can be identified within these enterprises and how they can create their own models for benefits identification.

6 Conclusion

This master thesis started by describing the problem background and problem area resulting into our main question:

"How can the benefits of Virtual Manufacturing within the product development domain be evaluated?"

As a result from our theoretical framework and empirical research, we designed our own model – the Virtual Manufacturing Benefits-model - which is an answer to this question. Subsequently this concludes that VM should be viewed, not only as an IS/IT investment, but as a unique IS/IT investment that requires more than general methods building a business case.

Throughout our work we also found some other important conclusions:

Business benefits can be perceived differently at different levels within an organization and in its outer context. They can also be view from different dimensions. At the same time there are cultural delimitations that influence the way a benefit is perceived. Finally the actual realization of benefits is much influenced by the leadership carried out on the stakeholders. This leadership needs to be motivating and be able to communicate with the stakeholders. Therefore evaluators need to take all these issues into consideration when they initiate an evaluation. A good way to do this is to complement traditional methods of evaluations with an interpretative approach, which provides detailed insights in how the organization and its social-context can be related to the IS. This becomes even more important when performing an IS/IT evaluation within the product development domain. Within this domain we discovered that there are different critical success factors that influence the performance of the product development process. We noticed that these factors are mainly of an intangible nature, including the following factors: the product development process itself, organizational issues, culture, the role and commitment of senior management and strategy.

We also discovered that there are success factors of VM that influences the benefit realization, and that it is necessary to understand how these factors correlate to each other. Therefore we conclude that the success factors of VM need to be thoroughly understood while performing an identification of benefits coming from VM. We discovered that these factors were mainly of process, organizational, technical and strategic nature.

Throughout this thesis work we have showed that VM influences the PDp, which in turn creates great improvements. However, since these improvements takes place in an collaborative environment, we believe that the success on the concept of VM is dependent on in the way leadership influences the stakeholders to make these improvements and the way the decision makers understand the importance of interpretative evaluations.

References

Ashbury, C., & Doherty, N.F. (2003). Towards the Formlation of a 'Best Practice' Framework for Benefits Relisation in IT Projects. *Electronic Journal of Information Systems Evaluation,* Volume 6, Issue 2, pp. 1-10.

Backman, J. (1998). *Rapporter och uppsatser*. Lund: Studentlitteratur.

Ballantine, J.A., & Stray, S. (1999). Information systems and other capital investments: Evaluation practices compared. *Logistics Information Management, 12 (1/2)*, pp. 78-93.

Bannister, F. (2001). Dismantling the silos: Extracting new value from IT investments in public administration. *Information systems Journal, 11*. pp. 65-84.

Bannister, F., & Remenyi, D. (2003). *Value Perception in IT Investment Decisions*. <http://www.ejise.com/volume-2/volume2-issue2/issue2-art1-abstract.htm> Latest visited: 26-05-2007.

Bennington, P., & Baccarini, D. (2004). Project benefits management in IT projects – An Australian perspective. *Project management journal,* 35(1), pp. 20-30.

Berghout , E., & Remenyi, D. (2005). The Eleven Years of the European Conference of IT Evaluation: Retrospectives and Perspectives for Possible Future Research. *Electronic Journal of Information Systems Evaluation, Vol. 8, Issue. 2.* pp. 81-98.

Björklund, M., & Paulsson, U. (2003). *Seminarieboken- att skriva, presentera och opponera*. Lund: Studentlitteratur.

Brown A., (2005). IS Evaluation in Practice. *The Electronic Journal Information Systems Evaluation, Volume 8,* Issue 3, pp. 169-178.

Brynjolfsson, E. (1993). *The Productivity Paradox of Information Technology.* New York. Communications of the ACM.

Checkland, P.B. (1989). Soft Systems Methodology. *Human Systems Management 8.* pp. 273-279.

Clay, M., Edwards, H.M., & Maguire, J. (2003). Establishing a Strategic Context of IT Projects- A Case Study from the Automotive Industry. *Electronic Journal of Information Systems Evaluation,Vol.6, Issue.2.* pp. 45-54.

Clemons, E.K., Tatcher M.E., & Row M.C., (1995). Identifying Sources of Reengineering Failures: A Study of the Behavioral Factors Contributing to Reengineering Risks. *Journal of Management Information Systems,* 12, pp. 9-36.

Cooper, R.G. (2000). Winning with new Products: Doing It Right, *Ivey Business Journal, Vol. 64:6*, pp. 54-61.

Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (2004). Benchmarking Best NPD Practices – I, *Research Technology Management, Vol. 47:1*, pp. 31-44.

Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (2004), Benchmarking Best NPD Practices – II, *Research Technology Management, Vol. 47:1*, pp. 50-60.

Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (2004), Benchmarking Best NPD Practices – III, *Research Technology Management, Vol. 47:1*, pp. 43-56.

Cronholm, S., & Goldkuhl, G. (2003). *Strategies for Information Systems Evaluation - Six Generic Types. Electronic Journal of Information Systems Evaluation, Vol. 6*, Issue 2.

Cronk, N.C., & Fitzgerald, E. (1999). Understanding IS Business Value: derivation of dimensions logistics Information management. *Vol. 12 (1/2)* pp. 40-49.

Davies, D., & Powell, P. (without year). *Appraising investments in IS infrastructure.* Communications and information.

Dedrick, J., Gurbaxani, V., & Kraemer, K.L. (2003). Information Technology and Economic Performance: A Critical Review of the Empirical Evidence. *ACM Computing Survey, Vol. 35, No.1*, pp. 1-28.

Denscombe, M. (2000). *Forskningshandboken – för småskaliga forskningsprojekt inom samhällsvetenskaperna.* Lund: Studentlitteratur.

Easterby-Smith, M.. Thorpe, R., & Lowe, A. (1999). *Management Research: an Introduction*. Redwood Books, Trowbridge, Wiltshire.

Ernst, H. (2002). Success Factors on New product Development: a Review of the Empirical Literatur. *International Journal of Management Review, Vol. 4:1*, pp. 1-40.

Farbey, B., Land, F., & Targett, D. (1999). Moving IS evaluation forward: Learning themes and research issues. *European Journal of Information Systems, Vol. 8(2)*, pp. 189-207.

Farrell, D., Harrington, W., & Krupnick, A. J. (1998). *Learning from Experiments: An Evaluation Plan for CMAQ Projects*.
<http://www.rff.org/Documents/RFF-DP-98-18.pdf> Latest visited: 03-06-2007.

Frisk, E. and Plantén, A. (2004). *IT Investment Evaluation – A Survey of Perceptions among Managers in Sweden. Proceedings of the 11th European Conference on Information Technology Evaluation, Amsterdam, Netherlands.*

GAO - United states Government Accounting Office. (1997). *Assessing Risks and Returns: A Guide for Evaluating Federal Agencies' IT Investment Decision-making*. < http://www.gao.gov/special.pubs/ai10113.pdf > Latest visited: 02-06- 2007.

Giaglis, G.M., Mylonopoulos, N., & Doukidis, G.I., (1999). The ISSUE methodology for quantifying benefits from information systems. *Logistics Information Management, Vol.12, no. (1/2),* pp. 50-62.

Hallikainen, P., Heikkilä, J., Peffers, K., Saarinen, T., & Wijnhove, F. (1998). Evaluating Information Technolgy Projects in Finland: Procedures, Follow-Through, Decision Making and Percieved Evaluation Quality. Journal *of Global Information Management,* Vol. 6 No.4.

Halvorsen, K., (1992). *Samhällsvetenskaplig metod*. Lund: Studentlitteratur.

Hochstrasser, B. (1993). Quality engineering: a new framework applied to justifying and prioritizing IT investments. *European Journal of Information Systems, Vol. 2 No.3,* pp.211-23.

Huang, *J.P.H.* (2003). *An Evaluation Framework to Support Development of Virtual Enterprises*. Glasgow Caledonian University, Scotland < http://www.ejise.com/volume6-issue2/issue2-art13-huang.pdf > Latest visited: 03-06-2007.

Irani, Z., & Love, P.E.D. (2001). Information systems evaluation: past, present and future. *European Journal of Information Systems, Volume 10,* pp. 183-188.

Johnson, P., Nordström, L., & Lindström, R., (2006). *Formalizing Analysis of Enterprise Architecture*, I-ESA 06

Jones, S., & Hughes, J., (2001). Understanding IS evaluation as a complex social process: a case study of a UK local authority. *European Journal of Information Systems, Vol. 10, no. 4,* pp. 189-203.

Karlsson, T. (2005). *Information Structuring and Reuse for Virtual Manufacturing.* University of Skövde

Kefi, H. (2003). *IS/IT Evaluation: A Context-Based and Process-Oriented Perspective.* <http://www.ejise.com/volume-6/issue1-art5.htm> Latest visited:03-06-2007.

Kennedy, M.N. (2003). *Product Development for the Lean Enterprise. Why Toyota's System is Four Times More Productive and How You Can Implement It.* Richmond. Va: The Oaklea Press.

Kim, B.H., Choi B.K., & Choi B.W. (2004). R&D ACTIVITIES IN KOREA ON VIRTUAL MANUFACTURING. *Journal of Advanced Manufacturing Systems, Vol. 3, No. 2,* pp. 193–204.

Klecun-Dabrowska, E. (1999). The evaluation of deployment of Internet facilities within primary care. Proceeding of the Second Oxford Clinical Intranet and Internet Conference, Oxford.

Kotler, P., Armstrong, G., Saunders, J., & Wong, V. (2001). *Principles of marketing.* Prentice Hall Inc.

Lederer, G. (1995). Making virtual manufacturing a reality. *Industrial Robot, Vol. 22, No. 4*, pp. 16-17.

Lin, C., & Pervan, G. (2001). A review of IS/IT investment evaluation and benefits management issues, problems and processes. In Grembergen (Ed.), *Information technology evaluation methods & management*. Idea Group Publishing. pp. 2-24.

Love, P., Irani. Z., & Edwards, D.J. (2005). Research in the investment of information technology in construction: An examination of evaluation practices. *Automation in the Construction, Vol.14,* pp. 569-582.

Lin, C., Pervan, G., & McDermid, D. (2005). IS/IT Investment Evaluation and Benefits Realization Issues in Australia. *Journal of Research and Practice in Information Technology, Vol. 37, No 3.*

Lundahl, U., & Skärvad, P. (1992). *Utredningsmetodik för samhällsvetare och ekonomer* (2a uppl.), Lund: Studentlitteratur.

Lundberg, D. (2004). *IT och Affärsnytta – Konsten att lyckas med investeringar i IT.* Lund: Studentlitteratur.

McBride, N., & Fidler, C. (2003). *An Interpretative Approach to Justification of Investment in Excecutive Information Systems*. De Montfort University, Leicenter, UK, <http:www.ejise.com/volume-6/issue1-art6.htm> Latest visited: 03-06-2007.

Nickerson, R.C. (2000). *BUSINESS AND INFORMATION SYSTEMS.* New Jersey. Prentice Hall.

Nilsson, L. (1999). *Process Orientation in Product Development.* Lic-avh. Linköpings universitet. Linköping.

Norris, Nigel (1995) Contracts, control and evaluation. I: *Journal of Education Policy*, Vol. 10, No 3:271-285.

OGC. (2007). <http://www.ogc.gov.uk > Latest visited: 03-06-2007.

OGC [2]. (2007). *Successful Delivery Pocketbook*. <http://www.ogc.gov.uk/documents/cp0043.pdf> Latest visited: 03-06-2007.

Olsson, E. (1997). *Industriell produktutveckling*. Mälardalens Högskola, Eskilstuna

Patel, R., & Davidson, B. (1994). *Forskningsmetodikens grunder: Att planera, genomföra och rapportera en undersökning.* (2a uppl.). Lund: Studentlitteratur.

Pearlson, K. E. (2001). *Managing and Using Information Systems: A strategic approach*. New York: John Wiley & Sons Inc.

Piric, A., & Reeve, N. (1997). *Evaluation of Public Investment in R & D – Towards a Contingency Analysis*. <http://www.oecd.org/dataoecd/2/51/1822593.pdf> Latest visited: 03-06-2007.

Powell, P. (1992). Information Technology Evaluation: Is It Different?. *Journal of the Operational Research Society, Vol. 43, No. 1* , pp.29-42.

Remenyi, D., & Sherwood-Smith, M. (1999). Maximise information systems value by continuous participative evaluation. *Logistics Information Management, vol. 12:½,* pp. 14-31.

Schmeink, M. (2005). *Introduction to Product Lifecycle Management.* <http://www.expa.hvu.nl/~huy/Voltijd_W/ProgrammaV4/IO_ANA/Sept_2005/Week%201/Intro_PLM_Theoriedeel_sept2005.doc > Latest visited: 2007-06-03.

Shridhar, J.M., & Ravi, S. (2002). Virtual Manufacturing: An important aspect of collaborative product commerce. *Journal of Advanced Manufacturing Systems, Vol. 1, No, 1* pp. 113-119.

Silk, D.J. (1990). Managing IS benefits for the 1990s. *Journal of Information Technology, 5*, pp. 185-193.

Simmons, P., (1996). Quality Outcomes: Determining Business Value. *IEEE Software, Vol. 13, No.1*, pp. 25-32.

Skaug, J.E. (2005). *Kreativ Företagsutveckling i ett affärsstrategisk perspektiv: en inriktning mot affärsstrategisk ledarskap och marknadsstrategisk mobilisering där sambandet mellan ledarskap, personal och uppnådda prestationer står i fokus*. Göteborg: Handelsboden.

Smithson, S., & Hirschheim, R. (1998). Analyzing Information Systems Evaluation: Another Look at an Old Problem. *European Journal of Information Systems, Vol. 7*, pp.158 - 174.

Solow, R., (1987). *We'd Better Watch Out.* New York Times Book Review 12.

Stockdale, R., & Standing, C. (2006). An interpretative approach to evaluating information systems: A content, context, process framework. *European Journal of Operational Research, 173*, pp.1090-1102.

Symons, V.J. (1991). A review of information systems evaluation: Content, context and process. *European Journal of Information Systems, Vol. 1(3),* 205-212.
Symons, V., & Walsham G. (1988). The Evaluation of Information Systems: A critique. *Journal of Applied Systems Analysis, Volume 15*, pp. 119-132.

Symons, V., & Walsham G., (1988) The Evaluation of Information Systems: A critique. *Journal of Applied Systems Analysis, Volume 15*, pp. 119-132.

Tseng, M.M., Jiao, J., & Su, C.J. (1998). Virtual Prototyping for Customized Product Development. *Integrated Manufacturing Systems.* pp.334-343.

Venkateswaran J., Manmohan M., & Son Y., (2001). Virtual Manufacturing: Online Control of Shop Floor Operations, *Proceedings of the 16th International Conference on Production Research, Prague, Czech Republic.*

Ward, J., Taylor, P., & Bond, P. (1996). Evaluation and realization of IS/IT benefits: An Empirical Study of Current Practice. *European Journal of Information Systems. 4,* pp. 214- 225.

Ward, J., & Daniel, E. (2006). *Benefits Management: Delivering Value from IS & IT Investments.* Wiley, Chichester.

Ward, J., Murray, P., & David. E-. (2004). Benefits Management Best Practice Guidelines. School of Management.

Wehr, W.E. (1999). *A Roadmap for IS/IT Evaluation*. *In Measuring Information Technology Investment Payoff: Contemporary approaches*. Mahmood, M.A. & Szewczak, E.J., Eds. Hershey, PA: Idea Group Publishing.

Weill, P. (1992). The Relationship Between Investment in information Technology and Firm Performance: A Study of the Valve Manufacturing Sector. *Information Systems Research, Vol. 3, No. 4,* pp. 307-333.

Willcocks, L. (1992). Evaluating Information Technology investments: Research findings and reappraisal. *Journal of Information Systems, No.2,* pp. 243-268.

Appendix 1

An industrial approach to explain the Product Development process (PDp) is suggested by Olsson (1997), who divides the PDp into six different phases:

1. Feasibility study- or initiating phase
2. Preparing development phase
3. Main development phase
4. Prototype and testing phase
5. Production and usage phase
6. Liquidate phase

1. Feasibility study- or initiating phase

This phase contains a long-term research and development. Organizations usually spend some of their resources on long-term generating of product ideas, but not all the ideas and proposals lead to developed products. When the ideas are mature for the product development the responsibility will be brought over to a project organization. In this phase an economical calculation for the costs of a developing project till completed product will be compared to future net income and a satisfying repayment time will be found.

The first step in developing an idea is to formulate the requirements for the completed product. These requirements will be gathered in a document and will be called Product Design Specification (PDS). The PDS has to be as detailed as possible since the document will be in use in the following development work.

2. Preparing development phase

In the preparing phase ideas and proposals for different solutions should be presented, thereafter the solution proposals should be analyzed and then select one or several of the solutions to work further with. This phase is about to work with different principal solutions and not detail working. It is also in this phase that estimations regarding competence needs, resources, time-consumption and economy will take place

3. Main development phase

This phase is the most extensive phase in the entire product development process. By way of introduction the work consists of constructions which eventually will lead to a complete basis of drawings, purchase specifications, technical descriptions, testing and control instructions. As the construction work goes further while the technical production work must pursue substantial to be able to use the time efficiently and finding optimal

solutions.

The third step in this phase is to choose suppliers and close a deal The supplier questions have in many organizations been developed to great strategic questions, since quality here implies reliable and justified deliveries, to fulfill requirements and having competitive prices. Eventually a documentation must be created that will handle the service of the market, containing for example operational instructions and price lists.

4. Prototype and testing phase

The significance of prototyping is the term of a product or a system that has been manufactured for its ultimate technical usage. The prototyping and testing phase constitutes a decisive verifying for the entire project. Prototypes and examples for testing will be produced to test the drawing basis. Methods and tools for manufacturing will be tested and adjusted. The assembly process and the possibilities for services and maintaining work will be tested as well. In this phase it is important to in advance make plans for what kind of tests, the consumption of time and in what order the tests will be implemented. If any changes would be done in this phase the costs would still be much lower than implement changes when the production has started.

5. Production and usage phase

This phase is the most important phase for the developed product and for the greatest parts of the organization. In this phase the product will be manufactured, sold and used. The project group hands over the basis and the responsibility to the line organization, where the line organization has a main task during the usage phase. They have to collect information that could come from the manufacturing but mainly from the market concerning the product. This information concerns failures that occurs or other kinds of problems that have to be corrected. From the assembled data the basis for knowledge concerning market demands for development/further developments of the product will be produced.

It is also during this phase that the product should generate to a surplus which will cover the costs for the development.

6. Liquidate phase

This phase is like the last phase a phase is placed outside of the development work, especially this phase comes far after and can be described in several stages.

In the first stage the development ceases, in the second stage the service toward the market ceases, and in the third stage scraping of the product takes place. The third stage in this phase has to be considered in the initiate work with the construction.

The cost for the liquidating is a fart of the essential part of the life cycle cost.

Appendix 2

Benefits Management approaches summary

The Benefits Management model can be comprised into five sequential stages: (1) Benefits identification, (2) Benefits realization planning, (3) Benefits monitoring, (4) Benefits realization and (5) establish potential for further benefits (Ward et al., 2004; Ward & Daniel, 2006, OGC 2007, Lundberg 2005).

1. Benefits identification

During the Benefits identification phase many different methods in order to identify potential benefits are suggested. Bennington and Baccarini (2004) and Ward et al.. (2004) suggest the use if interviews or workshops with key stakeholders and that these interviews should be performed in collaboration between project managers and project stakeholders. They also advocate that it is very important to consider the stakeholders since "*a person or people must perceive and agree that they now have advantages over the previous way of working...*" and that the solutions "*which deliver benefits will have been designed from the stakeholders' view what constitutes a benefit*" (Ward et al, (2004, p. 7).

According to Ward et al. (1996, see Lin & Pervan, 2001), proposed benefits should be listed and agreed by managers whose activities are affected by the system. Each benefit should be given suitable business measures. They also advocate it is needed to identify benefit areas were the benefits will occur. Identified benefits are structured in order to understand and their linkage between technology effects, business changes and overall business effects. Undesirable impacts and disbenefits on the business or organization should also be considered.

According to Ward et al. (2004), responsible managers need to consider outcomes that are, expected, unexpected, positive or negative. They also have to agree that unexpected negative outcomes "…*are a price worth paying to obtain the positive benefits*" (ibid, p. 15) and that the risk associated to these outcomes can be less painful "…*by employing risk assessment techniques and the learning from earlier projects or earlier phases of the same project*" (ibid, p. 15).

Ward et al. (1996, see Lin & Pervan, 2001), Bennington and Baccarini (2004) and OGC (2007) argues for a formal project benefits management. Bennington and Baccarini (2004, p. 28) also adds that there is a need for this management to continue as a "… *post-project until the benefits have been fully realized*".

According to Ashbury and Doherty (2003), the first thing in their benefit management process is to identify and calculate the planned outcomes of an IS development project and deciding how these benefits are to be achieved. This process is divided into two levels. First, IS/IT strategy should be formulated to present a broad overview of the IS applications will support the realization of business benefits and contribute to the

corporate objectives. Secondly, the benefits planning process should be performed more detailed for every individual project. They also advocate that it is required that business change programmes are identified directly from the formulated strategy since the projects takes place in a dynamic organizational context that sets priorities for change and improvements. Therefore, it is very important to clearly formulate how the change will benefit the stakeholders. Results from their research showed that most projects focused on technology delivery rather than organizational change and benefits realization. Furthermore, no measures for benefits were defined during the planning phase and that there was no clear linkage between the technological solution back to the project's business objectives.

OGC (2007) also expresses a need to understand the different involved stakeholders and advocates that it is necessary to document the involved stakeholders and their relations in order to produce a Stakeholder Map and Communications Strategy on how to understand and communicate. Furthermore, OGC suggests that the development of an investment strategy to identify strategic outcomes that the IS/IT investment generates, seen from a business perspective. They also advocate that the benefits need to be structured and mapped in order to explain the relationship between benefits, their dependencies and the sequence of benefits. An example if this is Benefit Cascade-model (see OGC[2], 2007) which shows the links between the high level vision and objectives down to proposed options for delivery. By doing this broken links are identified.

The Active Benefits Realization Model approach advocated by Remenyi et al., (1997, see Lin & Pervan, 2001) focuses on identification of the key stakeholders of the information system. They argue that the initial phases of a Benefits Management process should start with documenting the context and the required benefits and metrics that later will be used for monitor and control.

According to Lundeberg's (2005) FEM-model the Benefits Identification stage should contain five different activities:

6. Point out benefit areas and benefit effects
7. Structure benefit effects
8. Secure the traceability
9. Quantify benefits
10. Put time to benefits

These activities initiates questions like: Where are the benefits located? How are they related to each other? What effects do the benefits have and how could they be measured? How can the traceability of the benefits be secured? How can the benefits be quantified and expressed in monetary terms or with *KPI:s*? How will the benefits develop over time? How can the benefits be maximize and their lifetime extended? Lundberg (ibid) suggest a variety of different models and tools to be able to answer these questions. One of these models is a benefit-map, which helps point out the location of identified benefits within the business and also weights their importance and risk. Another model is the benefit-matrix-model mentioned earlier.

2. Benefits Realization planning

OGC (2004) underlines the importance of doing a management plan that describes how the organization wishes to manage and achieve benefits from any investment in business change. Ward et al. (1996) see Bennington and Baccarini (2004) means that without a plan it is difficult to predict how an organization might effectively realize business benefits. Therefore the planning of benefits must occur prior to the project being approved for implementation

According to Thorp (2001), the fundamental concepts of benefits realization help organizations deal effectively with the issue of measuring value in four important ways:

1. Identify the outcomes to measure, and how to measure them
2. Show the reasoning about the linkages relating programs and projects to outcomes, making it easier to understand what's going on
3. Make measurement come alive by clearly tying accountability to measured results, and
4. Take action based upon measurements through full cycle governance

3. Benefits monitoring

According to Ward and Griffiths (1996), benefits monitoring compares project results with the benefits realization plan during the project and assesses if any internal or external changes have occurred that will affect the delivery of planned benefits. It is necessary to monitor the benefits of IT projects because issues arise that may prevent the delivery of the benefits. It is also possible that, at this stage, further benefits are identified.

According to Ward and Griffiths (1996), to be able to monitor benefits organizations have to actively overcome and handle the challenges with benefits monitoring.

Ashurst and Doherty (2003) call the benefits monitoring stage for benefits delivery and define it as *"the execution of the set of actions necessary to realize all of the benefits specified in the benefit plan"*. Consequently the process of benefits delivery typically runs from project initiation, after approval of the business case or benefits realization plan, through to completion of the project. Benefits delivery focuses upon the organizational change necessary to facilitate benefits realization, rather than the delivery of the technical solution.

4. Benefits Realization

The benefits realization management programme can be defined as : *" the process of organising and managing, such that the potential benefits arising from the use of IT are actually realised"* (Ward & Elvin, 1999, see Ashurst & Doherty 2003). Typically such programmes focus upon the organizational change that is necessary to facilitate benefits realization, rather than the system's functionality (Ashurst & Doherty, 2003). As Ward et al (1996) note, it is becoming increasingly recognized that benefits are generally derived from the organizational change that accompanies the introduction of IT, rather than from

the functionality provided by the IT. While a benefits realization programme is typically focused upon planned impacts, it is likely that by maintaining a focus on benefits throughout a project many incidental impacts should also be identified and proactively managed. While there is a growing recognition that IT projects should focus upon the realization of business benefits, rather than the delivery of technical solution.

Farbey et al. (1992) mean that the benefit realization should be performed in the beginning of utilization of the IT product once it has been in operation for some time, hence the benefits of the IS/IT investment are actually shown at that time.
Usually a comparison between planed benefits and the benefits that are actually delivered is involved in benefits realization.

Ward et al. (1996), see Lin & Pervan (2001), means that the previously developed business measures are used to evaluate the effects of the project. Review of 'before and after' measures provides an explicit device for evaluating whether the proposed business benefits have actually been realized. This evaluation, which should involve all key stakeholders, has several purposes:

- To maximize the benefits of the particular project
- To provide experience for other future projects
- To identify what was achieved, what has not been achieved, and why; and
- To identify any unexpected benefits who have been achieved.

5. Establish potential for further benefits

It may become apparent that, after the benefits realization, further benefits are now achievable, which were not expected in the beginning. This stage provides the opportunity to plan for and realize these further benefits as well as to learn from the overall process. (Ward et al., 1996, see Lin & Pervan, 2001)

Another key aspect of this process is that the stakeholders learn to understand better what is required and what is possible.

The benefits review may identify opportunities for realization of benefits which were not identified at the start of the process. Such opportunities may arise at any time during or after the process, and mechanisms should be in place to capture these opportunities and exploit them, by bringing these new benefits within the scope of the IS/IT investment. (OGC, 2007)

Appendix 3

VM focus

BASIC QUESTIONS

1. *Describe your Career, background, etcetera.*
2. *What is your employee position/role/job?*

IT INVESTMENTS WITHIN THE PD DOMAIN

3. *What are the most common barriers to achieving business value of IT investments?*
4. *What criteria do you consider is the most important in the evaluation of IT investments project?*
5. *What are the biggest difficulties of IT investment projects?*

PD AND THE PDp

6. *What is your view of PD for a business?*
7. *What is your view of the use of IS/IT within the PDp?*
8. *Can you describe the PDp and it's sub-processes in general terms and phases?*
9. *What do you think are critical success factors within the PDp, what is important for an efficient and productive PDp e.g.? (Regarding Organization, Team, Culture, Leadership and Strategy)?*

VM

10. Can you describe **how PD was before and after** the use of VM within the following areas:
    a. The PDp
    b. Organization and Culture
    c. Use of IT and Information
    d. Project team; team member
    e. Role and Commitment of Senior Management
    f. Communication
    g. Strategy Planning
    h. Resource Planning

11. What would have happened if a change never would occur, no use of VM e.g.?

BENEFITS OF VM

12. In what way does the concept of VM contribute to a company's current goals for IT investments?
13. What sorts of *business* benefits have been identified from the concept of VM?
14. In what way does the concept of VM have an impact…
    a. …on the PDp?
    b. … on the rest of the organization?
15. In a broader perspective. Who else have an impact on VM? How? (Suppliers, customers, etcetera)? In what way?

OTHER EFFECTS

16. Were there any negative effects from the use of VM?
17. How did you handle these negative effects?

MEASURE

18. Are there any difficulties monitoring and measuring the effects from the concept of VM?

TIME TO BENEFIT

Most IT investments have a long term perspective and are implemented step by step. This might become a problem during an evaluation of an investment.

19. In what order are these benefits realized in relation to time, e.g. what is time to benefits? Is there any benefit that takes longer time to be realized than others?

COST OF BENEFITS

20. Can you describe the cost for these benefits that comes from VM, what are the mayor costs from an investment in VM e.g.?

OTHER QUESTIONS

21. What do you think is the most important factors that need to be fulfilled in order to implement the concept of VM successfully? (Organization, technology, knowledge, resources etc.)
22. *Are there any problems noticed with the concept of VM?*
    a. *How is it possible to solve these problems?*
23. *What do you think of the future of VM …*
    a. *… within the PD domain?*
    b. *… for the Industry?*
24. Is there any other questions that you think is of importance that we have not asked?

PD focus

BASIC QUESTIONS

1. Describe your career, background, etcetera.
2. What is your employee position/role/job?

IT INVESTMENTS AND IT EVALUATION

1. What is *business benefit* for you?
2. What is your view of the relation between *business value* and *benefits*?
3. Can you tell us anything about how IT investments managed in your business?
4. Who are involved in this process and what are their responsibilities?
5. Is there a process or model for managing the benefits in an IT/IS investment and if so how do does it manage the benefits?
6. What criteria do you consider is the most important in the evaluation of IT investments project?

*Benefits can be view in many ways and it is possible to categorize benefits into **direct benefits** (benefits that directly creates profit), **indirect benefits** (benefits that needs further investments to be able to be realized), **economical benefits** and **qualitative benefits** (benefits that are difficult to quantified and are intangible, for example better decision-making, better strategy planning, higher quality, better working environment)*

7. Can you tell us something about your view of the following benefits during an IT investment? In what way are they considered?
    a. *direct benefits*
    b. *indirect benefits*
    c. *economical benefits*
    d. qualitative benefits

PD and the PDp

8. What is your general view of PD for a business?
9. What is your view of the use of IS/IT within the PDp?
10. Can you describe the Product Development process and it's sub-processes?
11. What do you think are critical success factors within the PDp (and within each sub-process/phase), what is important for an efficient and productive PDp e.g.? *(regarding Organization, Team, Culture, Leadership and Strategy)?*
12. Can you give an example of an IT investment that have a mayor impact on the PDp?
13. How did this IT investment affect the PDp?
14. What was changed within the PDp during this IT investment?
15. What were the significant effects from these changes?

Most IT investments have a long term perspective and are implemented step by step. This might become a problem during an evaluation of an investment.

16. In what order are these benefits realized in relation to time, time to benefit e.g.?
17. Is there any benefit that takes longer time to be realized than others?
18. What are the most common difficulties when you make an investment within the PD-domain?
19. How could these problems be solved?

VM

20. Can you tell us anything about the *business benefits* from the concept of VM?
21. Can you describe how PD was before and after the use of VM within the following areas:
    a. The complete PDp
    b. Organization
    c. Culture
    d. Use of IT and Information

e. Project team; team member
f. Role and Commitment of Senior Management
g. Communication
h. Strategy Planning
i. Resource Planning

22. Can you tell us anything about these changes regarding any of the phases of the PDp?
23. What would have happened if a change never would occur, no use of VM e.g.?
24. Were there any negative effects from the use of VM?
    1. How did you handle these negative effects?
25. Are there any difficulties monitoring and measuring the effects from the concept of VM within the PD-domain?
26. Can you tell us anything about the time-to-benefit, regarding an investment in the concept of VM?
27. Are there any differences about the time-to-benefits for each phase of the PDp?

COST OF BENEFITS

28. Can you describe the cost for these benefits that comes from VM, what are the mayor costs from an investment in VM e.g.?

OTHER QUESTIONS

29. What do you think is the most important factors that need to be fulfilled in order to implement the concept of VM successfully? (Organization, technology, knowledge, resources etc.)
30. How can you improve your businesses considering:
    a. IS/IT investments?
    b. How should they be performed?
    c. What needs to be changed?
31. IS/IT Evaluation?
    a. How should they be performed?
    b. What needs to be changed?
32. Is there any other questions that you think is of importance that we have not asked?

IS/IT investment and IS/IT evaluation focus

BASIC QUESTIONS

1. Describe your career, background, etcetera.
2. What is your employee position/role/job?

BUSINESS VALUE

3. What is business value for you?
    a. What are important aspects of business value of IT/IS to consider
4. What is business benefit for you?
    a. What is your view of the relation between business value and benefits?

IT-INVESTMENTS

5. Can you describe the investment life-cycle in your business?
6. Who are involved in this process and what are their responsibilities?
7. Is there a process or model for managing the benefits in an IT/IS investment?
    a. How do these processes or models identify and quantify these benefits, puts them into value e.g.?
8. How do you monitor and realize these benefits?
    a. Is anyone responsible for monitoring and realizing these benefits?

Benefits can be view in many ways and it is possible to categorize benefits into direct benefits (benefits that directly creates profit), indirect benefits (benefits that needs further investments to be able to be realized), economical benefits and qualitative benefits (benefits that are difficult to quantified and are intangible, for example better decision-making, better strategy planning, higher quality, better working environment).

9. Can you tell us something about your view of the following benefits during an IT investment? In what way are they considered?
    a. direct benefits
    b. indirect benefits
    c. economical benefits
    d. qualitative benefits

10. What are the biggest difficulties of handling benefits in a n IT investment?

EVALUATION

An evaluation can be performed at different stages of an investment cycle; pre-evaluation, during and ex-post (after) evaluation.

11. What sorts of evaluations are performed?
12. How are they carried out?
13. Why are they performed?
14. In which stage is it possible to perform the most reliable evaluation?
15. Who are involved in these evaluations and who are affected of them?
16. What criteria do you consider is the most important in the evaluation of IT investments project?
17. What are the biggest difficulties of IT evaluations?
18. What variables for measure are important when evaluating an IT investment?
19. Are there any variables that are difficult to measure?

PD AND THE PDp

20. What is your view of PD for a business?
21. What is your view of the use of IS/IT within the PDp?
22. Can you describe the Product Development process and it's sub-processes in general terms and phases?
23. What is important for creating an efficient and productive PDp with the use of IS/IT? (Regarding:

Stakeholders, Team, Culture, Role and Commitment of Senior Management and IT and information)?

VM

24. Can you tell us something about your view of the concept of Virtual Manufacturing?
25. Can you describe how PD was changed before and after the use of VM or an important IT/IS-investment within the following areas:
    a. The PDp
    b. Organization and Culture
    c. Use of IT and Information
    d. Project team; team member
    e. Role and Commitment of Senior Management
    f. Communication
    g. Strategy Planning
    h. Resource Planning
    i. Operation and Support

OTHER

26. How can you improve your businesses considering:
    a. IS/IT investments?
    b. How should they be performed?
    c. What needs to be changed?

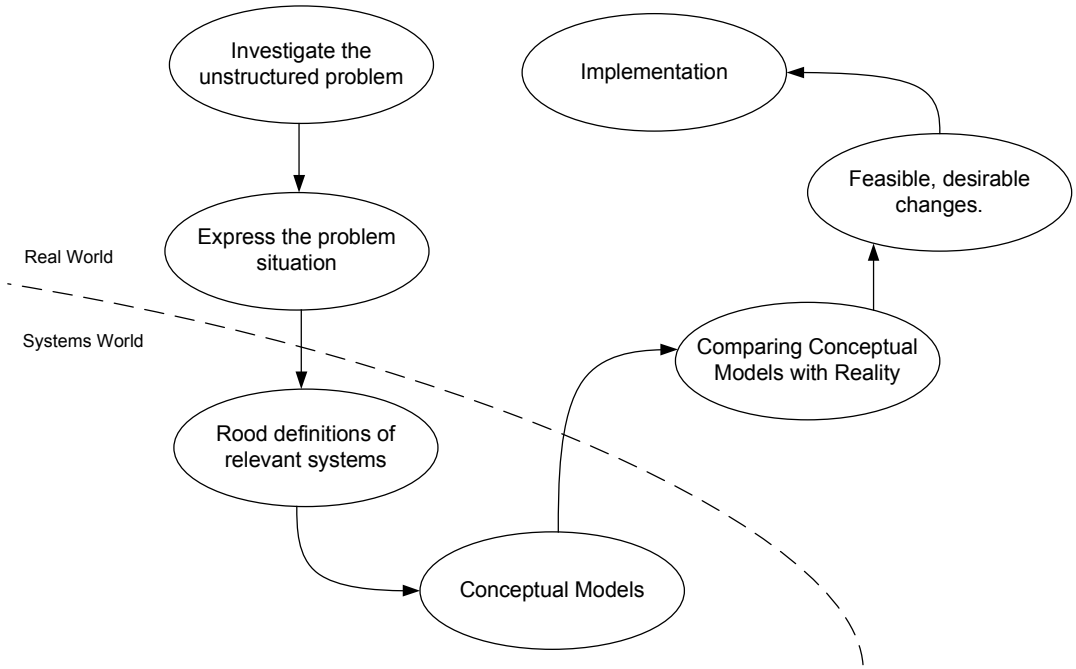
27. IS/IT Evaluation?
    a. How should they be performed?
    b. How should they be performed
    c. What needs to be changed?

28. Is there anything that you think is important that we have forgotten to ask?

Appendix 4

Soft Systems Methodology (SSM) is influenced by interpretivism and defines systems by both artifacts and human activities. In comparison with other methodologies, SSM deals with problem situations which involve high social, political and human activity. This distinguishes it from other more technology-oriented methods. Checkland (1985) defines this mythology as an iterative seven stage-process (see figure X).

Figure X ***Checklands Soft Systems Methodology (1985)***



Stage 1: Investigate the unstructured problem.

During the initial stage the main activities consists of collection of information about the problem situation, which is assumed to be perceived differently among the different problem owners

Stage 2: Express the problem situation

In order to express the problem situation “Rich Pictures” can be used to capture as much information as possible. The rich pictures can get new information from: observations, interviews or workshops.

Stage 3: Rood definitions of relevant systems

The purpose of the root definition is to express the key purpose of the most important identified entities of a system. By doing this each entity is described so their relation to each other can be understood. A good way to do this is by using the mnemonic CATWOE.

C	Customer	Everyone who gain benefits from a system is considered as a customer of the system. Disbenefited entities also counts as a customer.
A	Actor	The actors perform the activities defined in the system.
T	Transformation process	This can be expressed in terms of input and output within the human system
W	Weltanschauung	This is the German expression for "*world view*". This world view makes the transformation process meaningful in its context.
O	Owner	Every system has its owner who has the power to start up and shut it down. These are defined as the owners of the system
E	Environmental constraints	The Environmental constraints are the external context, which influence the system. These constraints include organizational policies as well as legal and ethical matters.

Stage 4: Conceptual Models

When the rood definition is defined, a conceptual model can be drawn. This model shows the human transformation activities that changes input to output.

Stage 5: Comparing Conceptual Models with Reality

This stage takes us back in the real world. The conceptual model is now compared with the reality so possible changes can be made.

Stage 6: Feasible, desirable changes

At this stage feasible and desirable changes are defined.

Stage 7: Implementation

At this final stage the decided changes are implemented in order to improve the problem situation.