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Critical information exchange in supplier involvement product development

Master of Science Thesis in Quality and Operations Management

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Abstract

The purpose of this thesis has been to review Volvo's information exchange in supplier involvement product development (SIPD) and to identify important information required to perform effective and efficient product development projects when suppliers are involved.

The project was carried out at the Volvo Group which is a leading global supplier of commercial vehicles. Volvo Group is from here referred to as Volvo. The research was conducted as a qualitative study and the researchers conducted in total 38 interviews with employees who work with SIPD in the different organizations within Volvo. The theoretical framework in this project evolved simultaneous as the empirical data collection. Therefore, it is developed with regard to inputs from both the empirical fieldwork and literature review.

One major delivery of this thesis is a model of critical information in SIPD. This model is based on the theoretical framework. The model highlights critical elements which must be addressed and clearly defined in all SIPD projects, also the sequence in which the elements should be addressed. This model has been used to analyze the current situation in Volvo and in the report we present our conclusions and recommendations concerning all the elements of the model.

Keywords: critical information, product development, product development process, SIPD, supplier involvement, supplier involvement in product development, Volvo

Acknowledgement

We are gratefully to our supervisor, David Loid, and our examiner, Sverker Alänge, in the division of Quality Sciences at Chalmers University of Technology. Sverker and David's broad knowledge and experience of the thesis subject has improved the quality of our thesis.

Moreover, we want to take this opportunity to thank David Haglund and Mats Leijon at Volvo. Their supervision and commitment has been a great help for the project and has helped to make our report more understandable. In addition, we want to thank Volvo for the assistance we were provided and all employees who contributed to our project and report.

List of Contents

List of abbreviations

AE	Advanced Engineering
BA	Business Areas
BU	Business Units
GDP	Global Development Process
PCR	Product Change Request
RFQ	Request for Quotation
RnD	Research and Development
SIPD	Supplier Involvement Product Development
SOW	Statement of Work
VPS	Volvo Production System
VPS-PDP	Volvo Production System for Product Development Processes

Part I: Presentation of research

The first part of the report aims at introducing the research area and method. First, a background description and a short problem formulation of the project are given which lead up to the project's purpose and research questions. Finally, the research methodology is presented.

1 Introduction

Rising global competition, more rapid technical change and the need for faster development of products with higher quality and reliability have forced technology-intensive industries such as the commercial vehicle industry, to focus on their core competencies (McIvor, Humphreys et al. 2006). The last couple of years, companies have strategically involved suppliers early on in the product development process, and jointly developed products to be able to meet the rising global competition.

According to Wagner and Hoegel (2006), the involvement of suppliers in product development processes is significant. However, there exists evidence that not all such efforts are successful. There are several problems that may arise and must be overcome where one main source of these problems is inadequate communication which can hinder the effectiveness of the collaboration.

Volvo has lately had an increase of joint product development with suppliers. There have been successful projects but also less successful projects. A part of the strategic business plan for the year of 2011 was to strengthen the supplier delivery assurance (Volvo 2011) and this thesis will contribute by investigating the information exchange between Volvo and its suppliers in order to find areas that could improve the current situation.

1.1 Background – The Volvo Group

The Volvo Group is a leading global supplier of commercial vehicles; the company manufactures products such as trucks, buses and construction equipment (Volvo 2011).

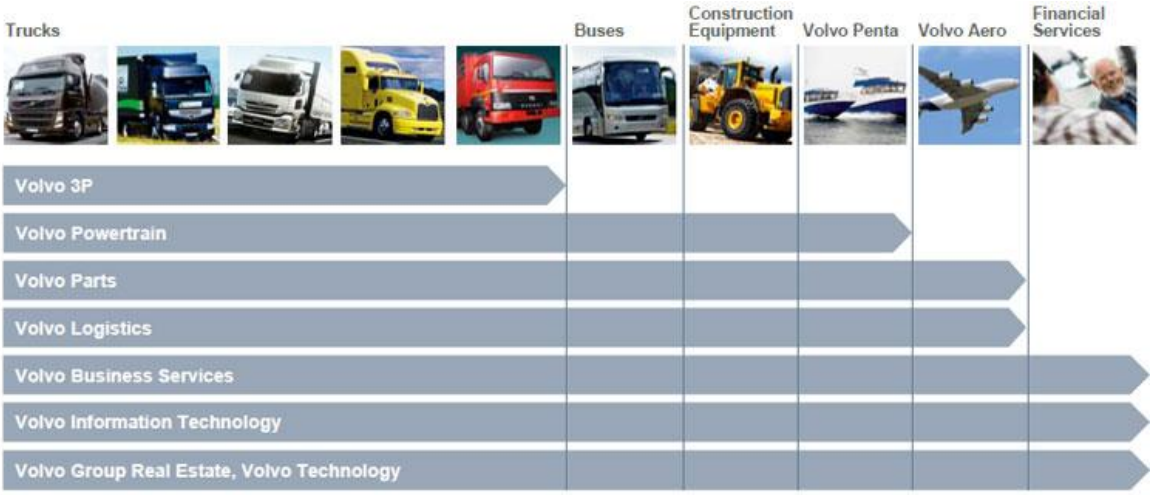

Figure 1: Illustration of the Volvo Group's business areas and business units (Volvo 2011)

Volvo has around 90,000 employees, production facilities in 19 countries and sales in approximately 180 countries. The company has sales through wholly owned and independent distributors and a global service network to provide customers' needs for spare parts and other services. The company's operations are totally divided into six business areas (BA), see the horizontal axes in Figure 1, and seven business units (BU) to support the company's business areas, see the vertical axes in Figure 1 (Volvo 2011).

1.2 Volvo Production system

Volvo Production System (VPS) is common for all business areas and business units in Volvo. It contains principles, tools and techniques for the company to improve its operations and to reach operational excellence. The ultimate goal is to meet and to exceed customers' expectations as well as to reach 100 percent resource utilization in all operations. VPS will help Volvo to measure, analyze and improve their process in a structured way. It is visualized and communicated in the form of a pyramid as can be seen in Figure 2.

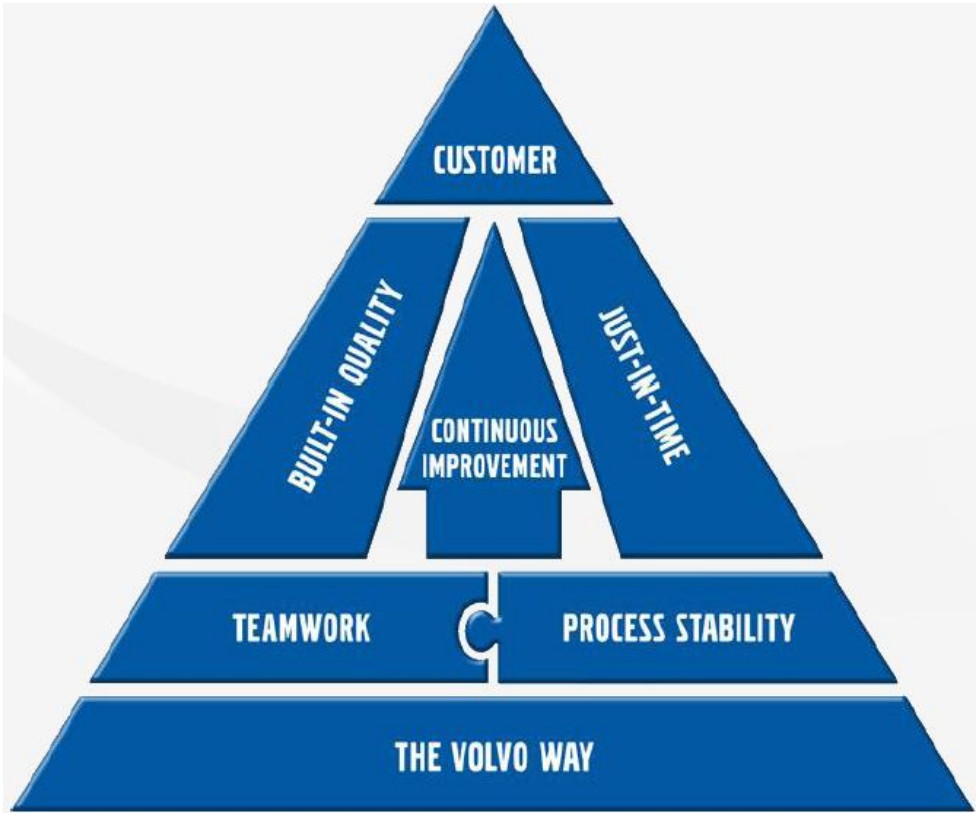

Figure 2: Volvo Production System model

VPS is based on The Volvo Way which is the company's values, culture and leadership. On top of the pyramid is the customer since creating value for the customer is the most important mission for the company. The customers expect products with good quality delivered on time, which is achieved through the principles Built-in quality and Just-in-time. The principles show the way for everyone and includes the tools and practices to reach the goal. Built-in quality is doing the right thing from the beginning and strives for zero defects. Just-in-time implies doing what is expected, in the right amount, when it is needed and with the shortest possible lead time. In order to deliver good products in time it is important to have good teamwork and stable processes. Teamwork is to create a good organization where everyone is involved in the improvement work and contributes with knowledge and experience. Process stability is having constant and predictable production flows and also to be able to reduce variation and waste. Continuous improvement refers to constant improvement of process and products. It is placed in the center of the pyramid and it is an important principle in VPS that creates a culture to never stop improving. VPS are the way Volvo will be the world's leading supplier of commercial transport vehicles (Volvo 2011).

1.3 Volvo Production System for Product Development Processes

Volvo Production System for Product Development Processes (VPS-PDP) is an extension of VPS to product development, the goal is to improve Volvo by "enhancing Volvo Group's profitability, improving product development process effectiveness and efficiency, and cultivating a learning organization through continuous improvement" (Najafi and Iqbal 2009).

VPS-PDP has the role to define and document VPS-PDP tools and methods to be implemented within the Volvo Group. VPS-PDP shall also look for new practices and new principles that can boost Research and Development (RnD) efficiency within the company.

Volvo has developed a model called the VPS-PDP Operating model which is used to analyze product development processes and stresses the importance of knowledge growth, portfolio management and resource management. Product development is divided into advanced engineering (AE) phase, concept engineering phase and industrialization phase. In the AE phase the work is driven by business benefits and technology push, in the concept engineering phase a concept is selected based on facts, finally in the industrialization phase the project prerequisites should be realized in a standard way of working. It is very important that knowledge is gained and preserved in all phases for Volvo to become a learning organization.

1.4 The RnD30 Project

The goal with the RnD30 project is to become 30% more cost efficient in product development. The project will accomplish its goals by implementing VPS-PDP in all business areas/business units working in the product development process. The aim is to reach this goal by the end of 2012 (Volvo 2011).

1.4.1 RnD30/VPS-PDP Cornerstones

In order to be more efficient in the product development process, wastes has to be eliminated. Ten cornerstones have been defined based on the VPS-PDP model and will be the engine in the transformation process, where one of them is Lean supplier involvement. Figure 3 summarize the cornerstones (Volvo 2011).

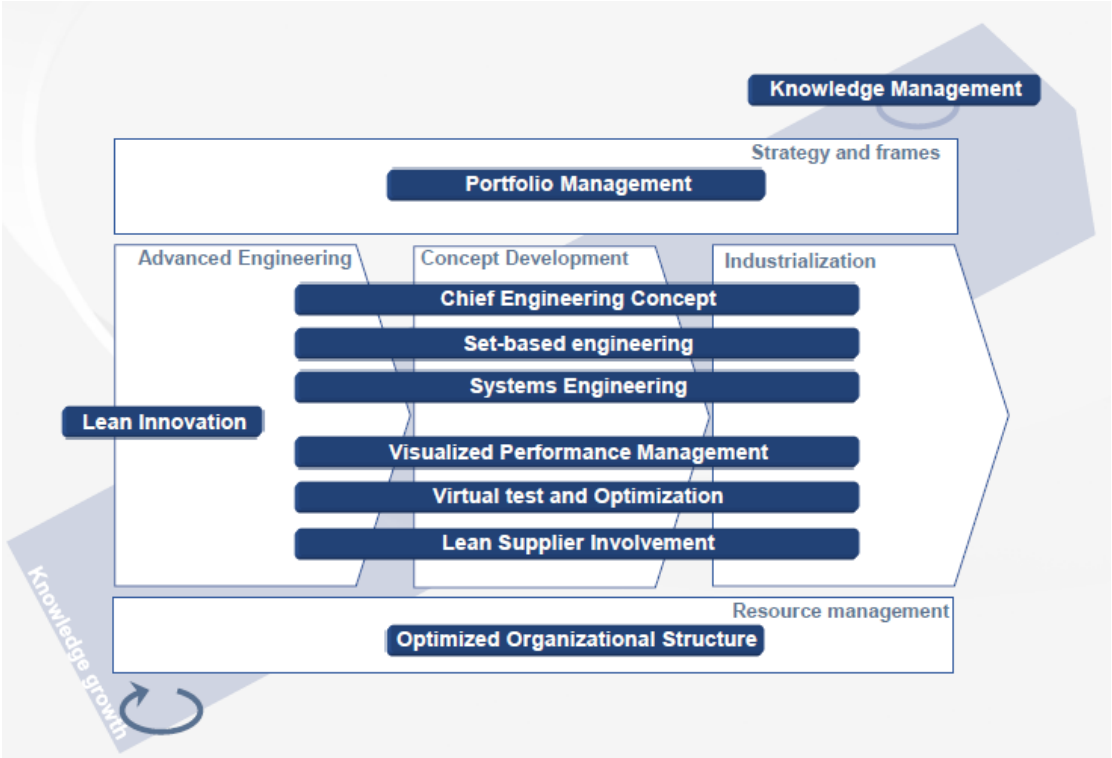

Figure 3: RnD30/VPS-PDP Cornerstones

1.4.1.1 Lean supplier involvement

One of the cornerstones in the RnD30/VPS-PDP cornerstones framework is lean supplier involvement. The aim of the cornerstone is to achieve a cross-functional process with clear internal and external information flows. Clear internal information flows will enable fact based decisions on what to ask suppliers to develop, which together with clear external information flows will enable early involvement of suppliers in concept and design phases. Clear internal and external information flows will reduce misunderstandings and increase the understanding of both the BU/BA internally, and the suppliers. A common view of the functional and technical requirements will be achieved as well as common view of each other's expectations (Volvo 2011).

1.5 Global Development Process

The Global Development Process (GDP) is divided into six phases where each phase intends to indicate a certain focus on the project work.

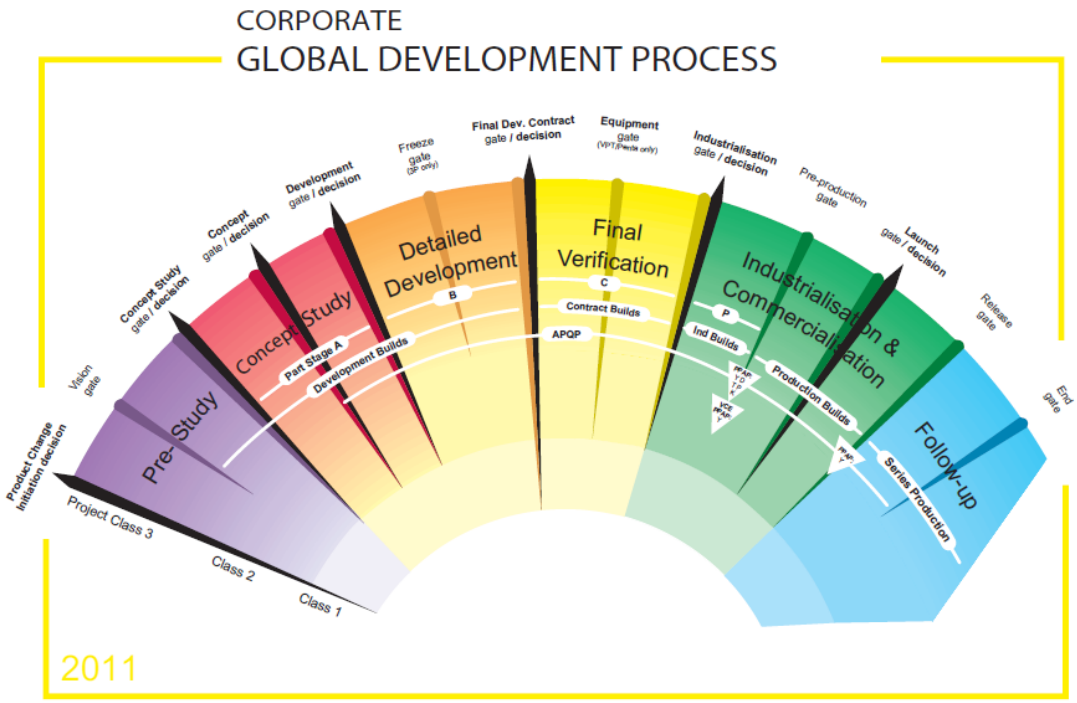

Figure 4: General Development Process model

The first phase is the "pre-study" phase where the scope of the project is defined by establishing several project conditions, developing requirements and alternative solution concepts. The second phase is called the "concept-study". In this phase several alternative concepts are analyzed and one is selected for development. In the "detailed development" phase the solutions to be implemented and the project's delivery from all areas, are defined and approved. The next phase is called "final verification" where the product solution is built, verified, validated and refined. The "industrialisation & commercialisation" phase aims to install, prepare and verify the industrialisation system. The last phase is the "follow-up" phase where the project is handed over to the line organisation. The project target fulfillment is followed up, the experience is summarised and finally the project is closed (Volvo 2011).

1.5.1 Gates & Project Decision Points

In each phase of the GDP there is at least one gate. The gates can be seen as check-points where the project management confirms that the different gate criteria are met for each gate. Preparations to the next gate should be demonstrated and the project prediction of final delivery and associated risks should be updated. Whether the gates are to be opened or closed is decided by a group called the project steering committee (Volvo 2011).

During the development process there exist particular project decision points where the appropriate decision body approves funding for the project up to the next decision point. Both gates and gate criteria can be combined, added or deleted to suit the unique needs of each project. The updates off the criteria are approved by the steering committee (Volvo 2011).

1.6 Supplier Involvement Product Development

Supplier Involvement Product Development (SIPD) is a complement for the GDP. The purpose of SIPD is to increase the product development output by combining the resources available internally with the suppliers' development resources. The SIPD process shall be used in development projects where suppliers are involved in the development of products, i.e. categories 2-3 in Figure 5.

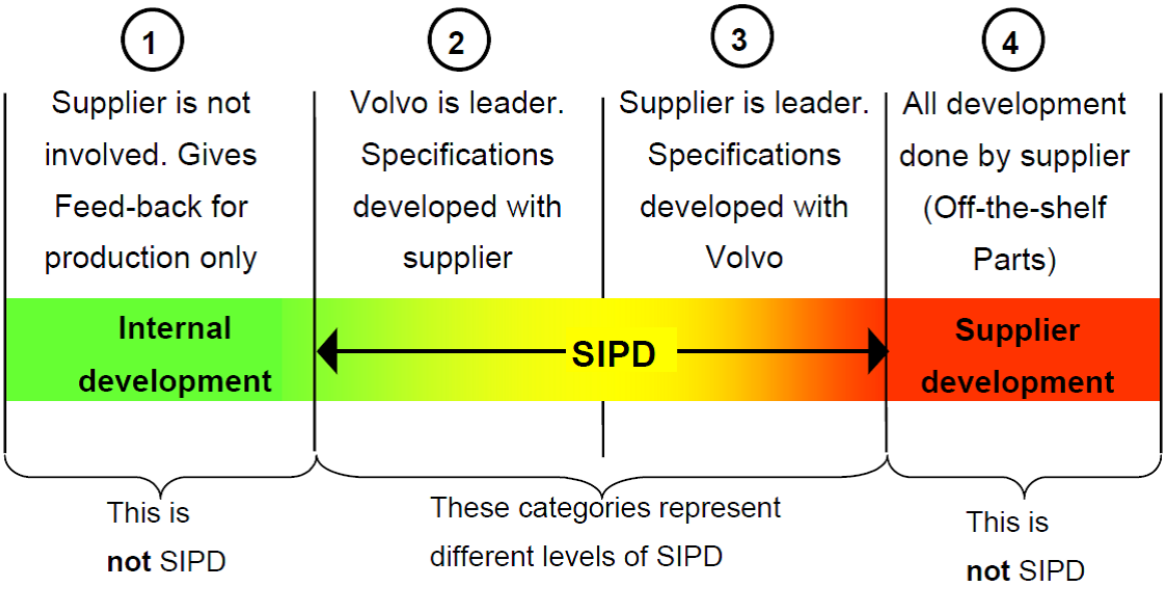

Figure 5: SIPD – different forms of collaboration between Volvo and the suppliers

Full SIPD is achieved when the supplier takes an extensive development responsibility (i.e. category no. 3, in Figure 5. Category no. 2 in Figure 5 is also SIPD but Volvo has more influence on the development work in this category, compared with category no. 3 in Figure 5 (Volvo 2011).

1.7 Problem analysis

In order to frame the focus for this study and explain how the research purpose and main research questions were selected, a short problem analysis is given below.

1.7.1 Supplier involvement product development

As mentioned in the introduction, companies have the last couple of years begun to involve suppliers early on in the product development process (McIvor, Humphreys et al. 2006). With regard to supplier involvement, several well-recognized authors within the subject have found that involving suppliers in the product development process is critical to accelerating the pace of product development (Misgra and Shah 2009). Misgra and Shah (2009) argue that suppliers also are more likely to identify potential problems such as contradictory specifications or unrealistic designs, early in the design process. Supplier involvement has been shown to have a positive effect on measures of performance such as shorted development cycles, lowered development costs, improved design for manufacturability and enhanced product quality (Misgra and Shah 2009). However, in addition to the above mentioned advantages, researchers also have found potential problems regarding such collaborative initiatives. For instance, such collaborations can be overdone easily and employees, in response to collaborative initiatives, may begin to participate in extraneous meetings in which nothing of substance is accomplished (Misgra and Shah 2009). Other problems include infringement of intellectual property rights for participating firms once the collaboration period is over and behavioral misjudgments that can occur during team interactions (Misgra and Shah 2009). Despite these disadvantages, the benefits from collaboration far outweigh its potential costs (Misgra and Shah 2009).

In order to establish a successful supplier integration, the focal firm need to integrate externally with their suppliers and internally across different functions (Misgra and Shah 2009). The integration involves a wide range of parameters such as; tier structure, degree of responsibility for design, specific responsibilities in the requirement setting process, when to involve suppliers in the process, inter-company communication, intellectual property agreements, supplier membership on the project team, and alignment of organizational objectives with regard to outcomes (Handfield, Ragatz et al. 1999). The list can be extended further, and this thesis will discuss critical parameters for an effective and efficient information exchange in supplier involvement product development projects.

1.8 Purpose

The purpose of this thesis is to review Volvo's information exchange in supplier involvement product development (SIPD) projects and to identify important information required to perform an effective and efficient SIPD project in order to achieve a more competitive joint product development.

1.9 Research Questions

The first research question aims to build a theoretical framework from previous research within the subject but also if possible extend the theoretical framework with new findings. The second research question aims to map Volvo's information flow in SIPD and compare the results with the first research question. The differences will be highlighted and recommendations for improvements will be presented.

The research questions follow:

- *Which parameters are critical in order to establish an efficient and effective information exchange in SIPD projects?*

- *How can the current state of information exchange be improved in SIPD projects?*

1.10 Delimitations

The research is limited to the information exchange in the SIPD process. Hence, suppliers and internal functions not involved in the SIPD process will not be considered in depth.

Volvo group is a huge corporation with multiple BA/BU; this research will not cover all BA and BU. The focus is directed towards chosen BA/BU. The selected BA/BU can be seen in Table 1.

Top Priority	Volvo Bus	Volvo 3P	Volvo Powertrain
Secondary Priority	Volvo Construction Equipment	Volvo Penta	

Table 1: Priority of this report considering BU/BA at Volvo

2 Methodology

The purpose of this section is to orient the reader of how the research was conducted and also to describe the methods used for the data collection and analysis.

2.1 Research strategy

Research strategy implies the general orientation to conduct a business research. There are two major research strategies; qualitative and quantitative research. A major difference between these two research strategies is that quantitative research emphasizes quantification in the collection and analysis of data and qualitative research instead of quantification emphasizes words and their meaning in the collection and analysis of data. However, there are suggestions for deeper difference between quantitative and qualitative research. The suggestions are that both strategies differ in their epistemological and ontological orientation (Bryman and Bell 2007). The differences are summarized in Table 2.

	Quantitative	**Qualitative**
Principal orientation to the role of theory in relation to research	Deductive, testing of theory	Inductive, generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

Table 2: Fundamental differences between quantitative and qualitative research strategies (Bryman and Bell 2007)

A quantitative research is suitable for testing of theories since it entails a deductive approach to the relationship between theory and research. However, a qualitative research entails an inductive approach to the relationship between theory and research therefore is more suitable for generation of theories. In terms of epistemological orientation a quantitative research incorporates the practices and norms of the natural scientific model and of positivism in particular. Conversely qualitative research distinguish in this area by rejecting the practices and norms of the natural scientific model and of positivism in particular and instead emphasizes how individuals perceive their social world. Regarding ontological orientation a quantitative research embodies a view of social reality as an external objective reality when in qualitative research the view of social reality is seen as a constantly shifting emergent property of individuals' creation (Bryman and Bell 2007).

The research strategy chosen for this project is qualitative research. Qualitative research strategy is more appropriate for this project since the project will not test an existing theory, rather it is hoped to generate a theory based on the current situation in Volvo and in the literature.

2.2 Method used for this study

In this part, the methods used in this research will be presented. Figure 6 shows the different phases of the project. Below all the different phases of the project will be described separately.

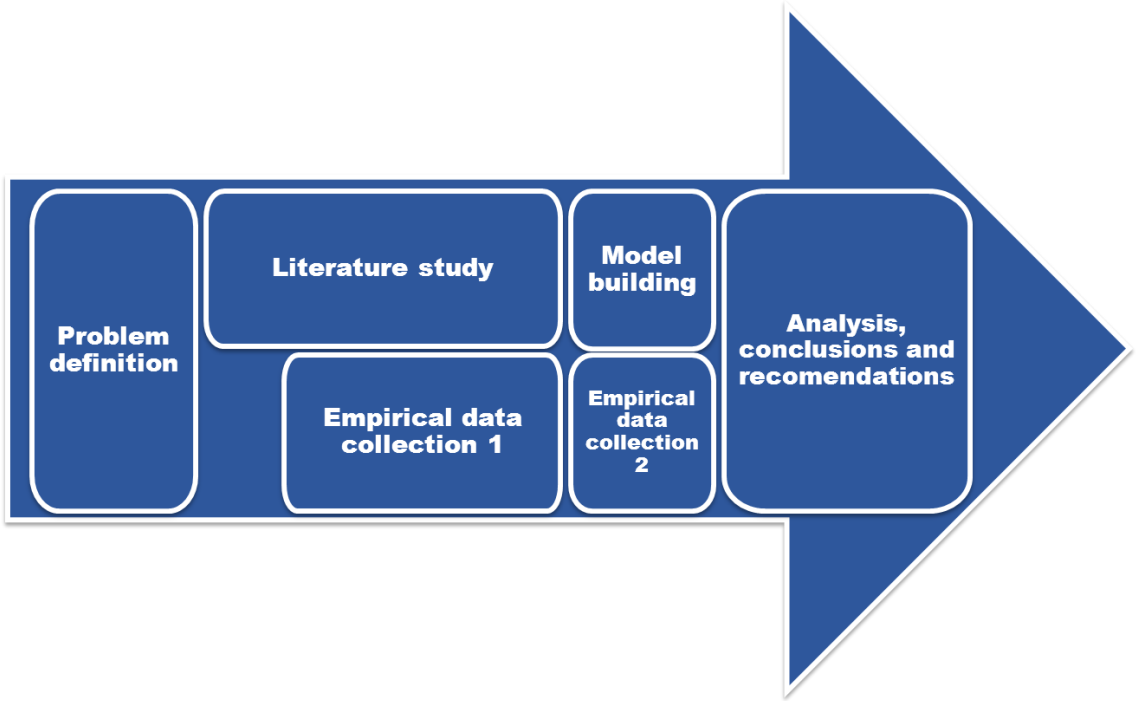

Figure 6: Working logic

2.2.1 Problem definition

The research started with a problem formulation which was carried out together with our supervisors at Volvo. In this phase, the purpose of the project was determined and the research questions were developed. There were also discussions with the supervisor at Chalmers regarding the problem and possible solutions.

2.2.2 Literature study

A literature study was conducted during the project to create an understanding of the problem and how to solve it. The literature study answered the first research question and the result

was later used to analyze the current situation at Volvo. The literature study began with guidance from the supervisors at Chalmers who recommended both theories and experts within subjects relevant for the project. The recommended theories were studied and the experts were interviewed who gave further recommendations of theories. When the empirical data collection began, the researchers were provided with more keywords and theories from experts and internal documents at Volvo. The theoretical framework of this project is a result of an extensive literature review and this literature review was guided by both consultations with experts and studies of internal documents at Volvo. Therefore, the theoretical framework has been generated by inputs from both the empirical data collection and the literature study. This working process resembles with "systematic combining" which is described in Dubois and Gadde (2002). According to Dubois and Gadde (2002), in systematic combining the theoretical framework, empirical fieldwork, and case analysis evolve simultaneously. Dubois and Gadde (2002) argue that the continuous movement between the empirical world and theory expands the researchers understanding of both the theory and empirical phenomena. The analytical framework evolves over time depending on what is discovered through the empirical fieldwork, analysis and interpretation of data. According to Dubois and Gadde (2002), systematic combining is useful for the development of new theories. In the literature study, books and scientific articles related to the subject have been studied. Google Scholar and databases in Chalmers's library have been the main source for searches of scientific articles and books. Brainstorming was used as a tool for further consideration of theories beyond the usual framework of SIPD.

2.2.3 Empirical data collection

The empirical data collection started later than the literature study because the researchers needed time to learn about the subject. Thereafter the empirical data collection was carried out simultaneously as the literature study. When the empirical data collection began, the researchers had the opportunity to interview experts in the field of SIPD and employees who were currently working with SIPD. These individuals helped to identify problem areas and additional theories which were later considered in the literature review. In the empirical data collection, internal documents were studied which contributed with additional theories and keywords. These were later reviewed in the literature study.

The empirical data collection was conducted in two phases. The first phase commenced with reading of internal documents in order to enable a deeper understanding of the SIPD process in Volvo. This information, together with theoretical information which was known from the

literature study was used to develop research interview questions that will help to answer the second research question. Subsequently, research interviews with employees at Volvo were started. The second phase began after the model building commenced and was carried out until the completion of model building. This data collection phase was mainly a validation of the model but it also provided an opportunity to further investigate some of the elements in the model.

The researchers conducted in total 38 interviews with employees who work with SIPD. The respondents were employees from Volvo 3P, Volvo Buses, Volvo Penta, Volvo Powertrain and Volvo Construction Equipment. The distribution of interviews between the different organizations included in the study was 47 percent with employees who work in Volvo 3P and 53 percent with employees who work at the remaining organizations. The reason to conduct more interviews at Volvo 3P was that Volvo 3P is the organization which has the most experience of SIPD at Volvo.

In qualitative research, interviews are the most popular data collection method since interviews are less structured and more flexible than survey questionnaires. In qualitative research, the researchers is more interested in the interviewee's ideas and own perspective. In quantitative researches the interviewees are supposed to answer certain questions. In qualitative research, the researchers are interested to extract the information that the interviewee sees as relevant and important. The researchers can deviate from its interview guide, vary the order of questions and also follow up on the interviewee's replies in order to get richer and more detailed answers. The researchers can also interview the same person several times (Bryman and Bell 2007).

There are two types of qualitative interviews; unstructured interview and semi-structured interview. Unstructured interview is like a conversation where the researcher has a subject and asks some questions and the interviewee can respond freely. In a semi-structured interview as opposed to the unstructured interview the researcher has a guide or a list of questions that he or she wants to cover. The researcher does not need to follow the list of questions exactly and can ask new questions that come up during the interview and deemed relevant. The interviewees have as in an unstructured interview also great freedom in their answers (Bryman and Bell 2007).

In this project, semi-structured interviews were conducted. The semi-structured interviews were chosen; since the researchers had a clear focus in this research, to ensure comparability

of results, and to reduce the risk that the discussions are long-lasting and differs significantly from important issues.

2.2.4 Model building

After the literature study, a model for critical information in SIPD was created. The model is based on our theoretical framework and therefore it started after the literature study. In order to answer the second research question, the researchers found it useful to categorize the information which was found in the first research question. The categories which in this report are also referred as elements make it easier to compare literature results with the empirical results and find opportunities for improvement.

Through the literature study several types of information which is important for successful SIPD projects were identified. These identified types of information were used to create different categories, in which the empirical results later could be fitted in.

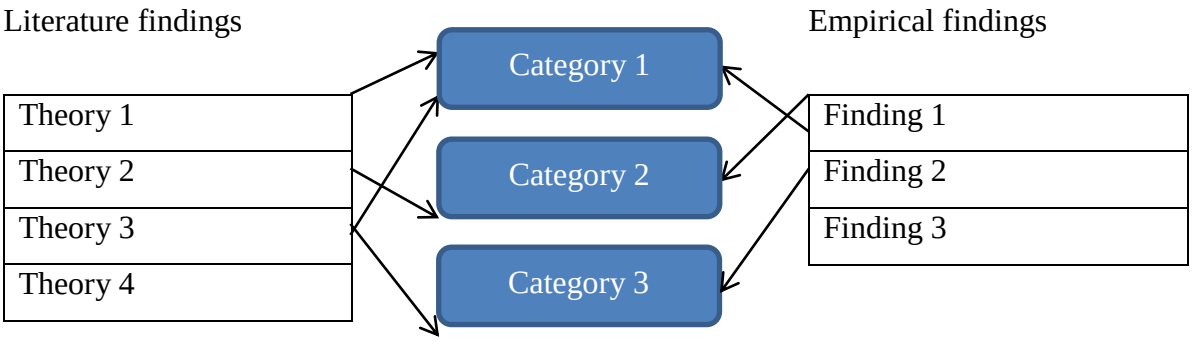

Figure 7: Solution method

Figure 7 shows a general example of the solution method which was used for the creation of the model. The solution method began with the literature study which in this example, four different theories were found. These theories were later allocated to category one, two or three, depending on the subject of the theory. Findings from the empirical data collection were also allocated to the various categories depending on the subject of the empirical finding. A real case example in the project is the SIPD leader's background, this theory was placed on the category “roles and responsibility”. In the same category, there are also empirical findings regarding the SIPD leader's background at Volvo. The various categories together form our model, which contain all the different types of critical information in SIPD.

In our model, see, there are eight elements, this means that the researchers created eight different categories which is derived from the literature study. Relationship, trust and commitment are one category in the model because they are closely related. All the eight categories in the model include different theories and empirical results which were analyzed in the analysis phase of the project.

The original idea with the solution method was if any empirical finding could not be fitted into one of the existing categories a literature search was conducted once more to cover the empirical finding. Finally if there were categories in which there are literature findings but lack empirical findings it would mean that there is important information for SIPD projects which are absent on Volvo and must be added. In addition, if there were existing empirical findings that differ from what is stated in the literature, it would indicate an opportunity for improvement. This solution method was chosen to ensure that this research would not miss any critical information. In this research, the researchers found no categories which lacked empirical findings, but there were several empirical findings which differed from the literature findings.

2.2.5 Analysis, conclusion and recommendation

The final phase of the project was the analysis, conclusion and recommendation for Volvo. In this phase our empirical findings were analyzed and compared with the theoretical framework. In the analysis section, the empirical results are presented next to the literature findings for each element of the model. In this way, the differences between the literature findings and the empirical findings are presented to the reader in a clear way. Subsequently, in the following section of the report the conclusions and recommendations for each element of the model are presented.

2.3 Trustworthiness

According to Bryman and Bell (2007), trustworthiness can be used to assess the quality of a qualitative study. Trustworthiness consists of these four criteria; Credibility, Transferability, Dependability, and Confirmability.

2.3.1 Credibility

Credibility refers to ensuring that the researchers have correctly understood the world they are studying (Bryman and Bell 2007). The interviews were recorded and annotations were made during interviews of important statements and key-words which were stressed by the

respondent. After the interview, the recording was listened to and codified in a document. Finally, the empirical data were categorized in the different elements of the model. Important statements highlighted by the respondents are presented with quotation exactly as the respondents stated it. A validation of the model was done during the second part of the empirical data collection. In addition, a workshop was conducted in Volvo where the model was presented and discussed.

2.3.2 Transferability

Transferability refers to the extent in which the findings can be useful in other context or the same context at another time (Bryman and Bell 2007). The model presented in chapter 4, is a model for SIPD. This model illustrates important elements which must be addressed and defined in SIPD projects. The model is generated through a theoretical study and empirical investigation in Volvo. Volvo is a company which consist of big and smaller organizations in different industries. The researcher's ambition was to develop a generalized model which would be appropriate for all organizations in Volvo. Two weaknesses in this project are that no suppliers were interviewed, and the empirical data collection was only done in Volvo.

2.3.3 Dependability

Dependability refers to documentation of problem formulation, selection of research participants, data collection, analysis and findings in order for other researches to review the work (Bryman and Bell 2007). To meet this criterion, the researchers describe in the methodology part; the research strategy, the different phases of the project, the data collection methods, which companies participated in the research and the analysis of data.

2.3.4 Confirmability

Confirmability refers to the extent, the researchers allow their personal opinions influence the result (Bryman and Bell 2007). In other words, how well the findings are supported by the collected data. Unfortunately, it is impossible to entirely eliminate the risk of personal opinions influencing the findings. There is always the risk of misunderstanding between people, wrong interpretation of data and inconsistency in answers. To mitigate these risks, the most valuable recordings were listened more than once.

Part II: Theoretical framework

The aim with the second part of the report is to present the theory that has guided the data collection and analysis.

3 Supplier involvement product development

Today companies in many industries are focusing on their core business and are outsourcing other activities to suppliers. This new trend is a result of increased global competition, rapid technological development, reduced product development time, and increased quality requirements from end customers (McIvor, Humphreys et al. 2006).

SIPD is a topic which has received much attention in the academy and in the industrial world (Wynstra, Weele et al. 2001; Mikkola and Skjoett-Larsen 2003). The driving force for the attention and dedication are the advantages of successful involvement of suppliers in the buying companies' product development processes. Supplier involvement can vary from consulting with suppliers on design ideas to give suppliers full responsibility for the design of components or systems (Petersen, Handfield et al. 2003).

Wynstra, Weele et al. (2001) state there are examples where Japanese companies have taken help of suppliers to develop cars with lower development time, higher technology and with fewer engineers. Successful integration of suppliers is therefore important since it may help buying companies to improve product development efficiency, effectiveness and to access more innovation and technological expertise (Wynstra, Weele et al. 2001; Ragatz, Handfield et al. 2002; Mikkola and Skjoett-Larsen 2003; Morgan and Liker 2006; Wagner and Hoegl 2006). Companies with efficient and effective product development, and product quality which meets or exceeds their customer's expectation, have a significant competitive advantage on the market (Wheelwright and Clark 1992; Wu and Ragatz 2010).

By building a good and long term relationship with the supplier, they become more willing to share new ideas and emerging technologies with the buying company. In a good and long term relationship with suppliers, manufacturing companies may influence suppliers in the technology they invest in (Handfield, Ragatz et al. 1999; Wynstra, Weele et al. 2001). Petersen, Handfield et al. (2003) state that integration of suppliers in product development process can help buying companies identify potential problems early, and improve problem solving activities.

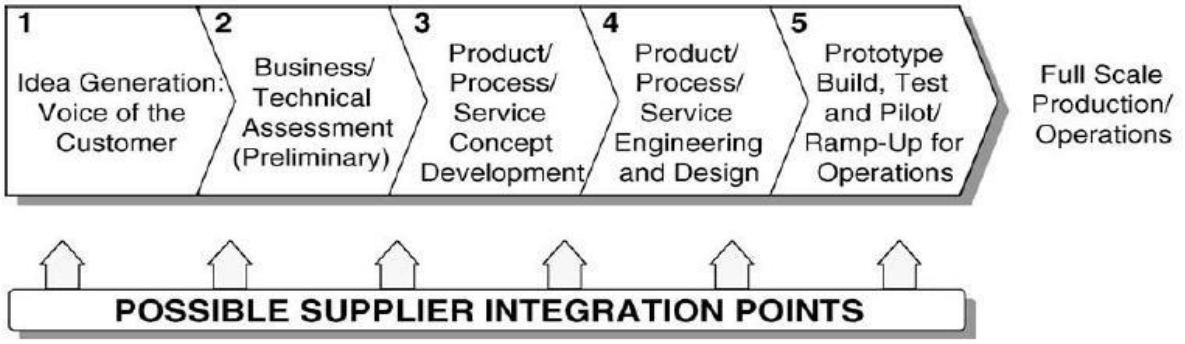

Figure 8: Possible supplier integration points in the product development process (Petersen, Handfield et al. 2005)

Figure 8 describes possible supplier integration points found by Petersen, Handfield et al. (2005). In any of these integration points suppliers can provide technologies and expertise that can improve the outcome (Handfield, Ragatz et al. 1999).

3.1 Trust, commitment and relationship

According to Morgan and Hunt (1994), trust is a willingness to rely on an exchange partner in whom one has confidence. Ganesan (1994) discuss two distinct components of trust; credibility, if one partner thinks the other partner have the competence to complete the job effectively and reliably, and benevolence, if one partner thinks the other partner has good intentions and motives for the relationship. According to Ganesan (1994), trust is the degree one partner thinks the other partner is both credible and benevolent.

According to Mohr and Spekman (1994), commitment is the willingness of partners to work with their relationship and with common goals. This means the parties have a relationship which does not show opportunistic behavior and can withstand unexpected problems. Long term achievement are prioritized before short term problems. According to the authors, commitment is connected with partnership success. Commitment refers to one partner's confidence in the current relationship with another partner is so important that it is worth maximum effort to preserve it (Morgan and Hunt 1994).

According to Morgan and Hunt (1994), the existence of commitment and trust are important for successful relationships. Commitment and trust in relationship are important factors since both inspire partners to work at preserving relationship investments, to resist attractive short-term alternatives in favor of the expected long-term benefits and subsequently be able to take higher risks since the partners will not act opportunistically (Morgan and Hunt 1994). According to Mohr and Spekman (1994), trust and commitment are factors which contribute

to collaboration success. Wagner and Hoegl (2006) found substantial evidence how good relationship with suppliers affect the success of involving supplier in product development.

Trust is essential for partners to exchange critical information and to achieve long-term objectives (Whipple and Frankel 2000). According to Wynstra, Weele et al. (2001), the absence of trust will make parties see large risks and therefore endanger collaboration. Trust must exist between the buyer and supplier in order to share new emerging technologies with each other (Ragatz, Handfield et al. 1997). Trust facilitates conflict resolution and assists partnership in a changing environment (Kelly, Schaan et al. 2002).

Any actions both buyers and suppliers intend to take in order to improve both trust and commitment will lead to greater benefits out of the relationship. Both trust and commitment is by increased information sharing (Nyaga, Whipple et al. 2010).

According to Modi and Mabert (2007), communication and information sharing is important for an effective inter-company relationship. Effective communication between partners is according to Mohr and Spekman (1994) important to achieve in order to benefit from collaboration. Close ties between parties results in more frequent and relevant information exchange. Honest and open lines of communication are also important factors in a good collaboration (Mohr and Spekman 1994).

The best way to establish an effective communication between parties in collaboration is face-to-face communication (Kelly, Schaan et al. 2002). According to Carr and Kaynak (2007), advanced communication technology should not replace face-to-face communication, instead they provide more opportunities to share information. Companies should invite people involved in the collaboration to a joint planning session where they can establish face-to-face interaction and begin to create an interpersonal relationship. This can be a good investment when initiating cooperation (Kelly, Schaan et al. 2002).

According to Holland, Gaston et al. (2000), communication between two people decreases rapidly with the distance and will fall below 10% at an office separation of 10 meters. Separation and long distance between people lower the chance of meetings, delays decision making, and make face-to-face communication inconvenient. Co-location of cross-functional product development teams has demonstrated to improve communication.

3.2 Risks and uncertainties

In projects, unexpected events occur which may result in the project to deviate from the project plan (Ahmed, Kayis et al. 2007). There is a need for organizations to establish the probability of something going wrong, and prevent the team from completing the project successfully (Park 2010).

One objective of risk management is to minimize the negative impacts on project performance. For a company, the negative impacts on project performance can be the cause of delayed time-to-market, missed sales opportunities, increased production costs and unsatisfactory product quality in the market (Park 2010).

According to Cervone (2006), all risk can be:

- Reduced or eliminated by including problem remediation activities into the project plan
- Transferred to other activities or other responsible parties, such as an outside vendor
- Absorbed or pooled by simply planning for them
- Avoided by putting quality control practices and procedures into place

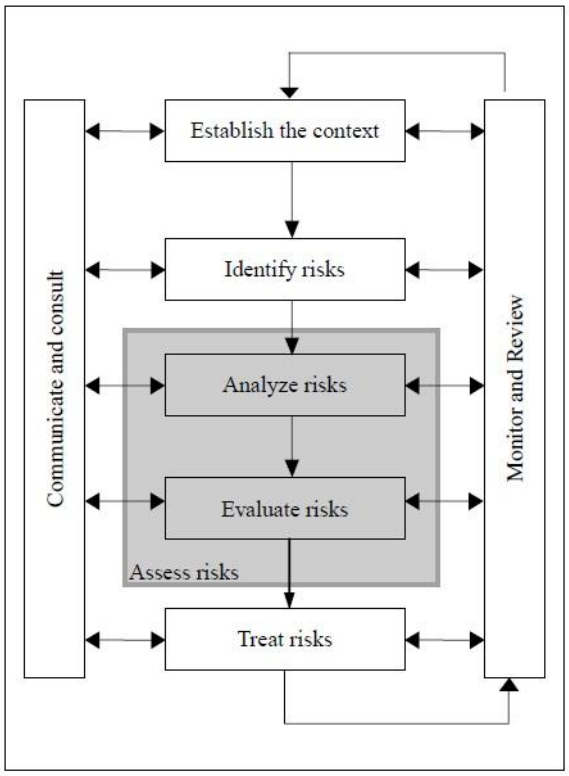

Figure 9: The risk management process (Ahmed, Kayis et al. 2007)

According to Simister (2004), to manage risk is to manage uncertainty and vice versa. To manage uncertainty efficiently a process that can sort out uncertain areas is required (Simister 2004). According to Ahmed, Kayis et al. (2007), the risk management process refers to discover weaknesses in methods used in product development in order to initiate appropriate mitigation actions to avoid risk, reduce risk likelihood or reduce risk impact. The process, see Figure 9, consists of seven iterative processes; risk identification, risk analysis, risk assessment, communication between various stakeholders and monitoring and control of risk events.

3.2.1 Technical uncertainty

Galbraith (1973) defines task uncertainty as "the difference between the amount information required to perform the task and the amount of information already possessed by the organization". Based on Galbraith (1973) definition Yan (2011) defines technical uncertainty as "in a manufacturer-supplier collaborative product development context, as the total task uncertainty faced by project members from the two firms while developing the product".

According to Petersen, Handfield et al. (2003), companies are more likely to share information with suppliers when technical uncertainty was present. Petersen, Handfield et al. (2005) support this and state that technical uncertainty can be mitigated through openly sharing cost and technology information with suppliers. Engineering tools such as failure mode and effect analysis, design for assembly and design for manufacture minimize risk (Templin 2010). According to Yan (2011), the sources contributing to technical uncertainty is reduced; if different designers exchange design information continuously, if the suppliers have access to product architecture information, and also thought high level of coordination and management of interdependencies in product development.

3.2.2 Relational uncertainty

Yan (2011) defines relational uncertainty as "the difference between the information that members from one company need and the information that they have in anticipating actions of members from the other company." Further Yan (2011) divides the relational uncertainty into two factors that affect the information gap; shared cognition and opportunistic behaviors. According to Yan (2011), shared cognition reduces the information gap, while opportunistic behaviors increase it. In other words, shared cognition reduces relational uncertainty and opportunistic behaviors increase relational uncertainty. According to Kelly, Schaan et al. (2002), trust reduces opportunistic behavior and according to Petersen, Handfield et al. (2005) commitment can lead to integration which reduces opportunism.

3.3 Roles and responsibilities

Anderson, Havila et al. (1998) describe a role as what the focal actor does in a relation with other actors. Stevenson (2011) defines responsibility as "the state or fact of having a duty to deal with something".

This section will present theoretical aspects of roles and responsibilities in two categories. First, internal roles and responsibilities which refers to roles and responsibilities of the

members included in the internal cross-functional product development team and second, inter-company roles and responsibilities which refers to roles and responsibilities between the buying company and the supplier.

3.3.1 Internal roles and responsibilities

The literature has a consensus that an effective implementation of cross-functional teams is critical to a successful product development (Griffin 1997; Holland, Gaston et al. 2000).

Holland, Gaston et al. (2000) define a cross-functional team as "a group of people who apply different skills, with a high degree of interdependence, to ensure the effective delivery of a common organizational objective".

However, there exist several cross-functional obstacles. Holland, Gaston et al. (2000) have summarized them as conflicting organizational goals, competition for resources, overlapping responsibilities, conflicting personal goals, no clear direction or priorities and lack of co-operation, These obstacles has to be managed in order to implement cross-functional teams effectively (Holland, Gaston et al. 2000).

The primary problem in cross-functional teams is according to Holland, Gaston et al. (2000), the problem of leadership. A highly debated issue is whether the leadership should be RnD or marketing lead. Holland, Gaston et al. (2000) suggest using a manager outside the traditional functional hierarchy of the organization instead.

According to Smith (1990), the choice of the project team leader is the most important one management will make in the life of the project. The cross-functional team leader must be able to pull together a diverse group of people in support of team goals (Holland, Gaston et al. 2000), and according to Smith (1990) the leader should make sure to incorporate all key disciplines and professional skills when selecting team members.

The team members should have clear roles and responsibilities since role formalization enhances inter-functional integration by clarifying responsibilities for concerned disciplines and highlighting the dependencies between them (Holland, Gaston et al. 2000). Formalization is also positively related to perceived effectiveness, and in conclusion it reduces confusion and fosters productive relationships (Holland, Gaston et al. 2000).

3.3.2 Inter-company roles and responsibilities

According to Karlsson, Nellore et al. (1998) there is a need to define the role of the supplier and it is important to identify who should be involved; who should provide the information, and in what form the information should be presented.

Kamath and Liker (1994) argue that not all suppliers are equal and define four different supplier roles. According to Kamath and Liker (1994) different roles depend on buyer-supplier relationships considerably in closeness and intensity. Reliant on the supplier's role, the responsibility also varies. For instance, one role could be responsible for an entire subsystem while another role could only be responsible for simple assembly (Kamath and Liker 1994).

Helander and Möller (2006) have in their study identified a need to define different roles for system suppliers. In a similar way as Kamath and Liker (1994), Helander and Möller (2006) describes the different roles and discuss these associated to different responsibilities.

Henderson and Clark (1990) distinguish between component knowledge and architectural knowledge. According to Henderson and Clark (1990), there is a differentiate these two levels of knowledge regarding the ability to take certain RnD responsibilities. Component knowledge involves the design and manufacture of one component for the buying company's product, but not the product itself. In such case, the supplier only requires RnD and design knowledge of the component (Henderson and Clark 1990). If a supplier possesses architectural knowledge, it has the ability to integrate and coordinate knowledge, capabilities, activities, or products from other suppliers and the focal company (Henderson and Clark 1990).

Kamath and Liker (1994) make an argument that depending on the characteristics of the project, the supplier also has fundamentally different responsibilities during product development. Petersen, Handfield et al. (2005) present a model of supplier's level of responsibility, see Figure 10. The model conceptualize whether the buying company or the supplier has relatively more responsibility for product development decisions (Petersen, Handfield et al. 2005).

According to Kelly, Schaan et al. (2002) "an understanding of partner roles and a definition of responsibilities is the foundation of a manageable alliance". Kelly, Schaan et al. (2002) suggest that partners should document clearly how roles and responsibilities are best allocated.

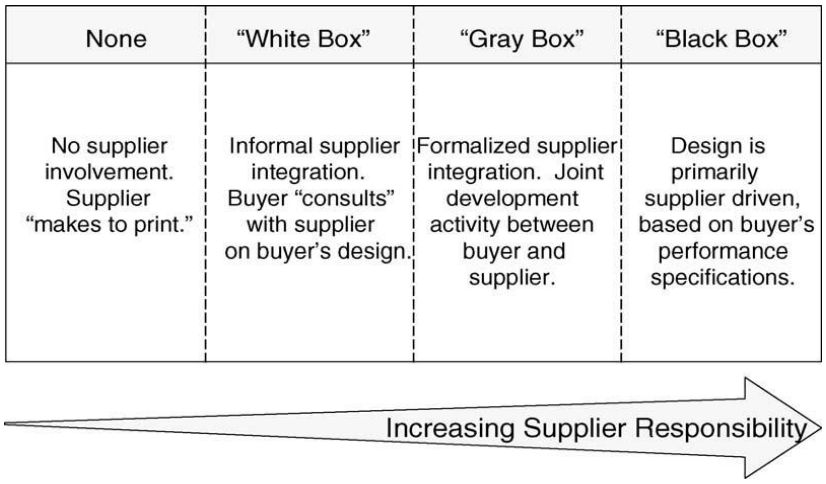

Figure 10: Responsibility depending on project characteristics

Kelly, Schaan et al. (2002) discuss difficulties that arose from either lack of definition of partner's roles and responsibilities or a poor understanding of who was responsible for what function or activities in their study. The lack of definition of partner's roles and responsibilities or poor understanding of who was responsible for what function or activities led to confusion, uncertainty and conflicts over control of specific activities or accountability for performance (Kelly, Schaan et al. 2002). According to Kelly, Schaan et al. (2002), confusion regarding the role could lead to finger pointing and acrimony. Role ambiguity could according to the same authors, cause paralysis and conflict in an alliance as people trip over or blame each other. Lack of definition of partner's role and responsibilities also create unnecessary opportunities or miscommunication about who does what (Kelly, Schaan et al. 2002)

3.4 Goal Congruence

According to Yan (2011), goal congruence among collaborating units taken as a whole, is positively associated with performance in the literature. Without sharing the same goal, product development performance cannot, according to Kahn (1996), be improved even if different functions meet and share information with each other regularly. This section will present theoretical aspects of goal congruence in two categories. First, on an internal level which refers to goal congruence within the product development team and second, on an inter-company level which refers to goal congruence between the buying company and the supplier.

3.4.1 Internal goal congruence

Within a product development team, goal congruence among members is found to improve communication and help transform tacit knowledge owned by individual team members into collective knowledge shared by everyone in the team (Yan 2011).

Low frequency of conflicts regarding goals is found to be associated with higher product performance in product development projects and shared priorities enhance single-minded direction that a team is moving toward (Yan 2011).

According to Henke JR. and Zhang (2010), it is common in the commercial vehicle industry to have different objectives between different corporate functions. When a company's internal functional areas do not internally communicate goals and targets or are in competition, the supplier do not know which information to rely on. This positions the supplier in a stressful situation which can have negative impact on the supplier's willingness to bring innovative ideas to the buyer (Henke JR. and Zhang 2010).

Smith (1990) states a definition of leadership which follows "leadership is the ability to transform vision into result" and argue that it is the leader's role to have a broad, integrated, and focused vision of the product and be able to communicate the vision to the remaining team members.

Superordinate goals shared by members in a product development team help structure tasks, and in doing so, facilitate cooperation toward a common task outcome. Establishing team goals have been proven to improve project outcomes by improving cross-functional cooperation (McDonough 2000).

3.4.2 Inter-company goal congruence

Success in an alliance requires both the buying company and the supplier to have a common vision and an establishment and execution of clearly defined goals (Whipple and Frankel 2000). Inter-company goal congruence and agreement on objectives improves cooperative competency among partners, which ultimately increases project performance (Yan 2011).

Yan (2011) discusses goal congruence on an inter-company level and states that goal congruence among partners promotes cooperation in alliances. Diverging expectations drives the companies to spend more efforts in coordination than needed, which diverts the product developing company from actual core design work and hence reduces the product development productivity (Yan 2011). Lack of goal congruence lowers commitment from

both the buying company and the supplier and creates conflicts among inter-company interactions, which ultimately results in reduced design quality and design efficiency (Yan 2011).

Petersen, Handfield et al. (2005) found in their study that involving the supplier in the determination of appropriate technical metrics and targets for the projects, and jointly agreeing with the supplier on these targets was shown to be a key element in product development team effectiveness.

3.5 Technical content

A product development process starts with a requirement statement. This involves defining the product performance and its constraints. There may be different kinds of requirements in a product development (Murthy, Rausand et al. 2008).

First of all there are *customer requirements*. These are requirements expressed by the customer regarding their expectation related to the product attributes (Murthy, Rausand et al. 2008). There are *corporate requirements* that are related to business aspects of the product life cycle which is of concern to different groups within the manufacturing company (Murthy, Rausand et al. 2008). There are *regulatory requirements* which relate to safety/health, environmental/ecological, disposal and/or political issues (Murthy, Rausand et al. 2008). Finally there are *technical requirements* which include engineering principles, material properties and physical law (Murthy, Rausand et al. 2008).

According to Murthy, Rausand et al. (2008), all these requirements have to be addressed. In product development these requirements are documented in specifications and Murthy, Rausand et al. (2008) define a specification as "a set of statements about an object derived during the pre-development stage to achieve some desired performance".

Karlsson, Nellore et al. (1998) suggest dividing the design process into two parts in order to reduce the development lead time. The two design process parts follows:

- The functional concept, the product technology that will solve the functional problem that the buyer presents.
- The dimensional definition, that consists of the dimensions and the form of the component.

According to Karlsson, Nellore et al. (1998) the buying company should ensure that all internal functions first agree on the specification outline and later involve the supplier. According to Holland, Gaston et al. (2000) the extent which team members release and use incomplete, uncertain and/or ambiguous information has been shown to be positively linked to product development project outcomes. To be able to act upon provisional information and treating decisions as tentative, renders teams more flexible in responding to problems (Holland, Gaston et al. 2000).

3.6 Changes in technical content

Changes in technical content have been divided into two categories; early changes in technical content which refers to changes in technical content before specifications are frozen, and late changes in technical content which refers to changes in technical content after specifications are frozen.

3.6.1 Early changes in technical content

According to Karlsson, Nellore et al. (1998), it is not unusual the various specifications are seen as one relatively fixed document by the design engineers in the supplier companies. However, according to other studies the specifications always needed further interaction with the buying company, cross-functional consultants inside the supplier companies, and often the advice of experts such as sales engineers or research staff (Karlsson, Nellore et al. 1998).

Changes could be necessary due to various reasons, such as mistakes, no harmony between various demands within the buying company's different technical centers, and the need for interaction in the functional system (Karlsson, Nellore et al. 1998). It is not unusual that the reason behind changes in the specifications is not mentioned to the suppliers, which makes it even harder for the suppliers to adapt and optimize component characteristics, and understand the implications that the changes might lead to in relation to the evolution of a system (Karlsson, Nellore et al. 1998).

3.6.2 Late changes in technical content

Another aspect of changes in technical content is late changes in technical content. Henke JR. and Zhang (2010) describe in their study how late changes affect the product development. During late changes, the supplier could be subjected to enormous stress, as its personnel could need to be pulled off other project in order to meet the customer's needs within the time limits of the original project (Henke JR. and Zhang 2010). Such demands often results in additional

costs which according to Henke JR. and Zhang (2010) not always may be recoverable from the buying company. Nor may there be enough time to test and validate the change for the buyer's benefit (Henke JR. and Zhang 2010). Hence, late specification changes can create such stress that no one is pleased, even though the deadline is met (Henke JR. and Zhang 2010).

Negative financial impact on the supplier is not the only result of late changes in technical content, it could also cause resentment towards the buying company (Henke JR. and Zhang 2010). Suppliers could interpret late changes in technical content as selfish behavior since the buying company in such case pays little concern for the impact on the suppler and its resources (Henke JR. and Zhang 2010). Subsequently, any supplier commitment to its working relations with the buyer will be diluted, as well as the supplier's willingness to transfer innovation to that buyer (Henke JR. and Zhang 2010).

Late changes in technical content are according to Henke JR. and Zhang (2010) often a symptomatic of systemic issues within a company. The problem is not capable of being resolved without fundamental changes in processes and procedures that over time have become firmly entrenched in the company's operation (Henke JR. and Zhang 2010). Even if a company is making progress in reducing the frequency and intensity of these late changes in technical content, the corrective time frame is long (Henke JR. and Zhang 2010). In the meantime, the buying company must strengthen its collaborative actions (Henke JR. and Zhang 2010), by doing so relational stress will be mitigated and supplier willingness to invest in the relationship and in innovation activities will remain at a high level (Henke JR. and Zhang 2010).

Verganti (1999) discuss the dilemma of making decisions in the early phases of the product development process. On one hand it is very important to make the right decisions since these are unlikely to be changed before they are implemented. On the other hand, early analysis and problem solving is a difficult task because of the high uncertainty that characterizes the early phase of the project (Verganti 1999). To handle the dilemma, Verganti (1999) focused on two classes of capabilities: anticipation capabilities which refers to the capabilities to anticipate information in the early phase and reaction capabilities which refers to the capabilities to introduce changes late in the process at low cost and time. Corporations working with stage-gate systems (such as Volvo's GDP) calls according to Verganti (1999) for remarkable anticipation capabilities. However, Verganti (1999) suggest corporations to work with

planned flexibility which is a combination of reaction and anticipation. The concept aims to build flexibility into the development process by early identification of the specific critical areas of a given project and early planning for reaction measures (Verganti 1999). In other words, Verganti, (1999) suggest companies to implement anticipation of problems and reaction plans instead of decisions.

3.7 Project planning

Slack, Chambers et al. (2001) define project planning as "The management of a one-off set of activities with a defined beginning and end". Experience in project management has shown that an integrated project plan and schedule is the single most important factor in a successful project (Haugan 2002). Insufficient project planning is one of the most common causes behind failed projects (Herroelen 2005; Ahamed 2010). According to Douglas (2004), research has shown that results in projects are significantly higher when project planning is conducted successfully. Project planning is extremely important in projects where the level of complexity is very high. The interrelationship between tasks, resources and time may lead to seriously overloaded resources in complex projects, if they are not carefully planned (Slack, Chambers et al. 2001).

People who are part of project planning develop some of the ownership of the results. This is seen as constructive and builds a strong project team with a desire to have a successful project (Haugan 2002). According to Douglas (2004), the project management organization, the project leader and the project team members have a responsibility to develop a good project plan. The project team has to be involved early and continuously in project planning and it is the project leader's responsibility to involve the team members in the planning process. The same author states that project planning should be performed jointly by all project participants since it clears communication channels and increases the participant's involvement and commitment in the project (Douglas 2004).

According to Douglas (2004), no matter the size of the project it is important to develop a plan and there must exist adequate time and resources for project planning. In the planning phase organizations must determine if the project can be successfully staffed, and when resources will be available (Douglas 2004). It is significant that the schedule is seen as credible by the entire project team (Ulrich and Eppinger 2000). Both human resources and assets such as land, facilities and needed equipment must be identified and secured. All project members need to be aware of desired participation, understanding and commitment to

the project (Douglas 2004). According to Douglas (2004), the project leader must negotiate commitments from the leadership of all team members, equipment and assets in order to support planning and the project. Successful planning efforts will improve the potential for successful project execution (Douglas 2004).

According to Handfield, Ragatz et al. (1999), concept and design engineering phases of product development accounts for a small amount of the overall development cost but these phases commit or lock in around 80 percent of the total cost of the product. Decisions made early have great impact on product cost, quality and cycle time therefore it is important to bring product, process, and technical expertise as early as possible in product development process.

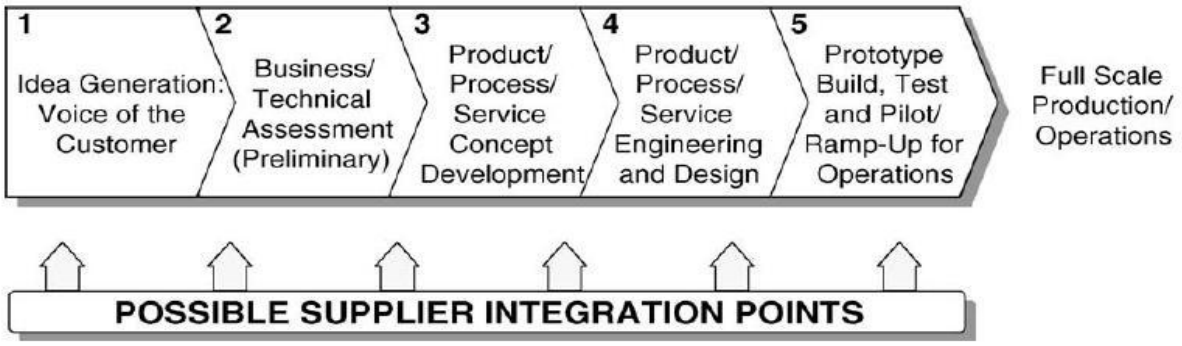

Figure 11: Possible supplier integration points in the product development process (Petersen, Handfield et al. 2005)

Earlier	Later
• Suppliers of complex items	• Suppliers of simpler items
• Suppliers of systems or subsystems	• Suppliers of single components
• Suppliers of critical items or technologies	• Suppliers of less critical items or technologies
• Strategic alliance suppliers	• Non-allied suppliers
• Black box suppliers	• White box suppliers

Table 3: Integrate suppliers at different stages (Petersen, Handfield et al. 2005)

Despite these comments that the sooner supplier integration, the better. According to Petersen, Handfield et al. (2003), when to involve suppliers is clearly dependent on technology uncertainty and Handfield, Ragatz et al. (1999) propose a framework, summarized in Figure 11 and Table 3, to assist in the assessment of when to involve suppliers. According to Handfield, Ragatz et al. (1999), it depend on two major factors, the rate of technology

change and the level of supplier expertise. If the rate of technology change is significant supplier involvement should be delayed to later stages. If the suppliers design expertise is significant, the suppliers should be involved earlier in the development stages (Handfield, Ragatz et al. 1999).

3.8 Cost and agreements

Cost may be one of the most important factors in a product or a service in many of today's industries (Roy 2003). In order to compete, companies must reduce cost and at the same time improve their quality, flexibility, novelty and product or service variety (Roy 2003). A company, which cannot perform detailed and meaningful cost estimates early in the product development process, has according to studies a significantly higher proportion of delays and development costs (Roy 2003). According to Marion and Meyer (2011) understanding production cost early in product development is linked with lower product and indirect costs. Companies increasingly want to understand cost of potential design early in design stage. This allows them to decide on a project before it is too advanced and any change could result in additional costs. For this task larger companies hire cost estimators (Houseman, Coley et al. 2008).

Cost engineering is a methodology that can be used to help companies in predicting, forecasting, and/or estimating cost of activities in product development (Roy 2003). Cost engineering is needed during product design since most of the product cost is determined during the design phase and the product cost has huge effect on market competition. Many product designers have little knowledge regarding cost management and as a result, cost engineering is not used successfully in product design (Zhao, Feng et al. 2001). According to (Nicholas and Steyn 2008), cost estimating, budgeting, and cost control should be of concern to everyone involved in projects and project members should be involved in the estimating and budgeting process. Cost engineers should be involved in technical projects, with the task to track and assess both technical and financial aspects of the projects and provide advice to project managers (Nicholas and Steyn 2008). With good cost estimates, it is easier to evaluate the work efficiency and determine the project costs but accurate cost estimation is a difficult task when the project is not well defined or when there is not much information available (Nicholas and Steyn 2008). The cost engineers must consider changes in technology which may occur during product development (Roy 2003). Since cost estimating is not an easy task, cost engineers are supported with several state-of-the-art techniques and processes to simplify cost estimation and are in need of a company-wide cooperation and assistance (Roy 2003).

The main reason to enter into contracts is to minimize the uncertainties in the agreement but it is impossible to plan for all events which may occur. In product development, situations can be very risky and complex. Hence, it is important to be strict and detailed when writing contracts and to include legal, financial and technical aspects of the outcome and the working process. The greater the uncertainties are, the more difficult it becomes to be detailed in contracts (Lindquist and Yhlen 2011). According to von Branconi and Loch (2004), contracts have an impact on the success of a project since these shape the behavior of the parties involved. According to Bragg (2006), contract negotiation is an important step in the outsourcing process. When developing a contract, the services to be provided must be clearly defined, otherwise the buying company may perceive the supplier to provide an inadequate level of service. On the other hand, the supplier may perceive the buying company to be demanding too much. Hence, it is important to confirm that all possible information in the outsourced area is included in the contract, and also that the one responsible for each task, is clearly defined in the contract (Bragg 2006).

According to Nicholas and Steyn (2008), the Statement of work (SOW) is a document which describes a project. It is used in contracted projects or contract work. The SOW contains information about project; objectives, scope, work tasks, major deliverables, schedules, costs, payment schedules, impact, justification, management, handling of changes, responsibilities and liabilities. It must be must be written in language and terminology understandable to all parties who are going to work with the SOW. The SOW must clearly state under what conditions the results will be accepted by the buying company. Failure to specify these conditions can lead to later arguments and delays in project completion (Nicholas and Steyn 2008).

Bragg (2006) states; a company which outsources an area covering product design or operations research should consider their right to keep intellectual property rights. A supplier can use the company's intellectual property to do business with competitors, therefore it is important to address this matter in the contract (Bragg 2006).

Part III:
Model of critical information in supplier involvement product development

The aim with the third part of the report is to present a model of critical information in supplier involvement product development and to discuss interactions between its consisting elements.

4 Model of critical information in supplier involvement product development

In SIPD, technical and relational uncertainty will always exist to some extent. In the beginning of a SIPD project, both the technical and relational uncertainties are according to our model considered as high in relation to trust and commitment. These uncertainties can make the relationship unstable if not managed properly. Relationships are based on trust and commitment and hence, uncertainties can be reduced by enhanced trust and commitment. The relationship is central in our model since without it, the collaboration would be unlikely to succeed. Relationship is surrounding all the elements included in the model since the relationship will have an impact on all these elements and the other way around.

The model is divided into two iterative phases; the ground setting phase and the product development phase. The ground setting phase consists of the two elements; Roles and responsibilities, and Goal congruence. The element Roles and responsibilities refer to roles and responsibilities for all parties involved in the project on both an internal and inter-company level. Goal congruence implies that all parties agrees on and share the same goals in the project on both an internal and an inter-company level. The element Roles and responsibilities have direct impact on Goal congruence since a SIPD team is a cross-functional product development team where the members most likely will have divergent interests. These interests have to be balanced and aligned in order to meet the customer requirements in an efficient and effective product development process. The two elements in the ground setting phase form the foundation of future product development work by ensuring clear roles, responsibilities and goals. It is very important to ensure all parties are satisfied before moving from the ground setting phase to the product development phase. Hence, the ground setting phase is an iterative process.

The product development phase consists of the four elements; Technical content, Changes in technical content, Project planning and, Cost and agreements. The results of the ground setting phase provide the basis for the product development phase, since Technical content will include the aligned requirements from all roles represented in the SIPD team. The element Technical content is defined in this report as the technical and functional specifications for product development. These specifications are used as the foundation for the negotiation of planning, cost and agreements. Hence, the information in Technical content will affect the elements Project planning, and Cost and agreements. Project planning is

defined in this report as the management of a single set of activities with a defined beginning and end. The element Cost and agreements refers to information regarding costs and contracts. In turn; Project planning will affect Technical content due to the time horizon of the project. Cost and agreements will affect the Technical content due to limitations of product development cost in the project. If necessary, the specifications in technical content can be changed later on in the product development process thus Technical content has a direct impact on Changes in technical content.

Changes in technical content are divided into early and late changes in technical content which refers to changes in technical content before respective after the specifications are frozen. For obvious reasons, Changes in technical content have a direct impact on Technical content. A change in technical content may also impact on Project planning, and Cost and agreements since changes may require more or less time and cost. However, planning changes may lead to new costs and planning can also restrict possible changes due to time limitations. Therefore Project planning may have an impact on Changes in technical content and, Cost and agreements. Restrictions in Costs and agreements have an impact on Project planning since the amount of resources invested affect the time frame of the project. In the same way, restrictions of Cost and agreements have an impact on Changes in technical content thus these restrictions may prevent certain changes.

In the product development phase, any changes in the different elements may affect each other. This phase is as mentioned earlier an iterative process which can continue until the product development work is complete. Significant changes in technical content may cause the project goals to take another direction which changes the previous Goal congruence. Hence, it may be necessary to return to the ground setting phase.

In the early stages of a project, risks and uncertainties are high. Therefore it is important to begin to discuss and define the elements in the model. This is called the investigating stage. As the project proceeds and the elements in the model are discussed and defined, Trust and commitment will start increasing and thereby reduce the Risks and uncertainties in the project. This is called the defining stage. Finally, the delivering stage is when all the elements in the model are well defined in this stage Trust and commitment are very high in relation to Risk and uncertainties.

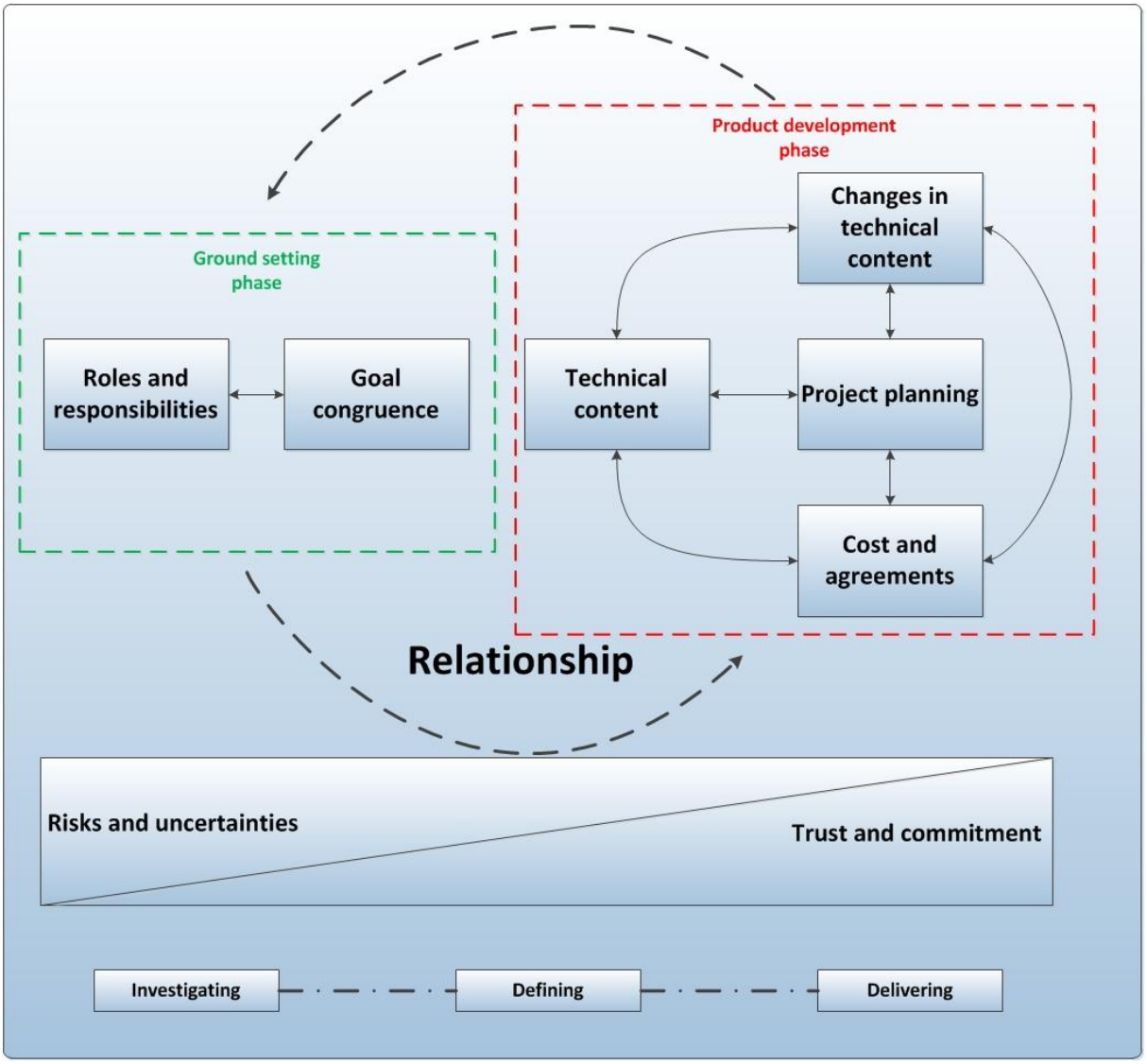

Figure 12: Model of critical information in supplier involvement product development

Part IV: Results

The aim with the fourth part of the report is to present the results from the interviews and studies of internal company documents in a clear and organized way, but still objective in the sense that no comparison is made between the results.

5 Empirical findings

The results presented here are summarized outcomes from the interviews and studies of internal company documents.

5.1 Trust, commitment and relationship

All our respondents did consider trust and commitment between parties as extremely important for proper functioning SIPD projects. The respondents also considered face-to-face communication as the best way to improve relationships between parties. According to the respondents, it is common that cooperation begins before the parties involved in the project will have a chance to meet each other physically and communicates face to face. Regarding suppliers, Volvo meet them face-to-face before cooperation starts and afterwards every now and then. According to many respondents, Volvo is aiming for long-term relationship with its SIPD suppliers. One respondent stated; "when selecting an SIPD supplier the goal is to use them as production supplier as well, but the supplier must first demonstrate that they can cope with all the requirements we put in our production suppliers". According to one respondent, relationship concerns trust and commitment and it is important to discuss intellectual property rights early in projects in order to have a good relationship.

Many of the respondents stated that they invest a significant amount of time and money in suppliers and therefore do not want to change suppliers too often. According to another respondent, it is easier to maintain a supplier in comparison to recruit a new supplier. It is also easier to work with existing suppliers which already have established good relationship with Volvo. One respondent stated; "relationship building is very important and if it does not work, the project cannot be successful".

According to most respondents, frequent and structured communication improves relationship in collaborations and trust is essential since it is the supplier which makes the development work. Increased trust is gained by critical information sharing, frequent cooperation and being open and honest with each other. According to one respondent, signing long-term contracts with the suppliers will increase trust.

According to one respondent, "it is important to be open regarding the rules from the beginning. For example, if the supplier is one of three candidates competing to get the contract, then they should know this. It is also important to respect the commitments you take, if you promise something you have to keep it, otherwise it will undermine the trust".

According to one respondent, the relationship in the SIPD team is very important. It is important for purchasing and engineering department to have frequent communication, and for these two departments to trust, support, and exchange critical information with each other. The same respondent claims they have a good relationship in their SIPD team, and the reason may be because purchasing and product development are placed close to each other. Another respondent also mentioned they have a good internal relationship in SIPD projects since product development and purchasing are placed close to each other and can fast resolve any misunderstandings.

According to one respondent, the most important thing to do in order to have good relationship in SIPD projects is to set the framework clearly from the beginning, and also to state what to expect from each other. In order to build and maintain a good relationship, it is important to keep promises. Transparency, straightforward and honest communication are critical factors in a good relationship. The same respondent stated; "to enhance trust in SIPD projects it is critical to initiate and maintain close cooperation and frequent communication between project members. Trust and commitment fits together, one does not go without the other".

5.2 Risks and uncertainty

All the respondents were aware of the importance to manage risks. According to an internal template found on Volvo 3P's intranet, Volvo requires the supplier to develop and maintain a risk management plan which describes the overall risk management strategy, scope, methods, roles and responsibilities, milestones, tracking, reporting, escalation procedures and contingency. It is the supplier's responsibility to monitor and report the areas of risk to concerned Volvo personnel at a frequency agreed with Volvo. One respondent helped the supplier by summarizing previous experience and communicate it to the supplier in order to better manage risks. All project team members are responsible for minimizing the risk in their areas of responsibilities and interfaces with other areas. Risk register template is an excel file with multiple sheets which facilitates the documentation and communication of risks in projects.

The most discussed risk was the uncertainty to not meet quality requirements and the time plan. One respondent discussed the impact of not getting the agreements signed in time and concluded it increased the risks. Overall, it was the respondents' comprehension that risks

were managed through open discussions and one respondent said that risks were managed by demanding improvements at the supplier.

There were four different answers regarding the question how to reduce the technical uncertainty; having a wide range of technical solutions, have close communication and be well integrated with the supplier, increasing the knowledge of the concerned technology and through the use of failure mode and effect analysis. One respondent stated "in the beginning of a SIPD project, you do not have a clear picture of what to do or how to do it". Another respondent suggested having a back-up plan in technical uncertain projects. There was according to the latter respondent common with late changes due to poor developed technical requirements.

Regarding relational uncertainty, the answers were mainly focused on some supplier's opportunistic behavior concerning increased cost due to late changes. To reduce the relational uncertainty the respondents focused to increase trust, commitment and communication. One respondent had the opinion that it was very important to involve cost engineers when late changes are required.

One respondent expressed a need to increase the effort regarding risk management, risk assessment and risk action plan. The respondent had the opinion that these activities were not fully included in project management. According to internal documents, Volvo's risk management process is a six step process and starts with risk management planning which defines how project risk management should be carried out in each specific project. The next step in the process is risk identification which is the activity that results in the documentation of the risks and their characteristics in the risk register. The third step is risk assessment and this activity evaluates the probability and impact associated with the risks which were identified in the previous step and prioritizes the risks as "high", "medium" or "low". The fourth step is risk action planning, in this activity, options and actions to reduce or eliminate risks are developed. Strategies for risk action planning can be: accepting the risk, avoid the risk, transfer the risk, and mitigate the risk. The final step, risk monitoring and control is the process of tracking the identified risks, identifying if new risks have emerged, closing the risk, executing risk action plans and continuously evaluating the effectiveness of the actions in the life cycle of the project.

5.3 Roles and responsibilities

In order to align with the structure from the theoretical framework, our empirical findings regarding roles and responsibilities are divided into the same two categories; internal roles and responsibilities and inter-company roles and responsibilities.

5.3.1 Internal roles and responsibilities

According to the respondents, the SIPD team is a cross-functional team led by a SIPD leader. The team includes members from purchasing, design, quality, manufacturing, logistics, cost, and aftermarket. Cross-functional integration is considered very important to avoid misunderstandings in SIPD, however, several participants mentioned that cost, logistics and manufacturing engineers were not involved in the early stages of the project. One respondent expressed "what works worse today with SIPD is that operations, quality, finance and aftermarket do not participate a lot. It is mostly purchasing and product development who is involved". A similar opinion was expressed by another respondent who stated "purchasing and design is called the core team and they are the ones who work the most. The others will be there when needed, but there must be someone selected to contact when necessary. It is the SIPD leader's responsibility to communicate important information to everyone in the group". A third respondent did not know who represented logistics in the team and had the opinion that there was an opportunity for improvement in terms of involving everyone early in the project. A fourth respondent mentioned that a cost engineer was included in the team but did not feel like a part of the team. This differentiates from our finding in an internal document where it is clearly stated that it is crucial that all concerned functions are involved in the early phases of SIPD.

All respondents considered role descriptions as important in SIPD. According to one part of the respondents there exist documents with role description for all members of the SIPD team but the other part of the respondents expressed a need for descriptions of SIPD members' roles and responsibilities. During searches for role descriptions, a SIPD leader role description was found on the internal SIPD homepage which describes the SIPD leader's responsibility, authority and important skills needed for the role. A few respondents were familiar with the SIPD leader role description while the majority of the respondent had not seen the document. No other role descriptions were found on the webpage or during our searches on Volvo's intranet.

Regarding the process of creating the SIPD team, the following process was described in an internal document; after identification of SIPD cases the product development project manager (PDPM) will send a request to the concerned section manager in product development who will appoint an SIPD leader. Often the lead engineer for the component is the SIPD leader but in some cases it could be someone else that is appointed as SIPD leader. However, this requires an approval from the Vice Presidents on the concerned functions.

The PDPM will send a team member request to the concerned project manager in purchasing, product development, manufacturing, aftermarket, quality, logistics and product finance. The product managers are responsible to appoint a team member from their organization to be involved in the SIPD team. Finally, all the team members will be filled in the SIPD plan. The SIPD plan template is available on the SIPD homepage.

The SIPD leader is often a person from product development but we found diverse opinions concerning whether this was best solution or not. In an interview, one respondent expressed "the key competence of the SIPD leaders is not their technical skills, but rather the ability to view all departments' needs and balance it towards one goal, to have a holistic view and good project management qualities". Another respondent had the opinion that it was "crucial for the SIPD leader to have good and detailed technical knowledge".

5.3.2 Inter-company roles and responsibilities

Volvo has two SIPD levels, i.e. level 2 and 3 in Figure 13. Level 1 and 4 in Figure 13 are not considered SIPD. What differentiates level 2 from 3 is the amount of influence Volvo has in the project. In level 2, Volvo has more influence than the supplier on the development work and in level 3; the supplier has more influence than Volvo in the development work. According to one respondent, the determination of the SIPD level is based on the in-house expertise in the field of the project. Another respondent stated "when choosing whether a supplier should be level 2 or 3 supplier, an assessment if the supplier has the ability to take an overall responsibility for the development work is made. There is currently no good process for such assessment".

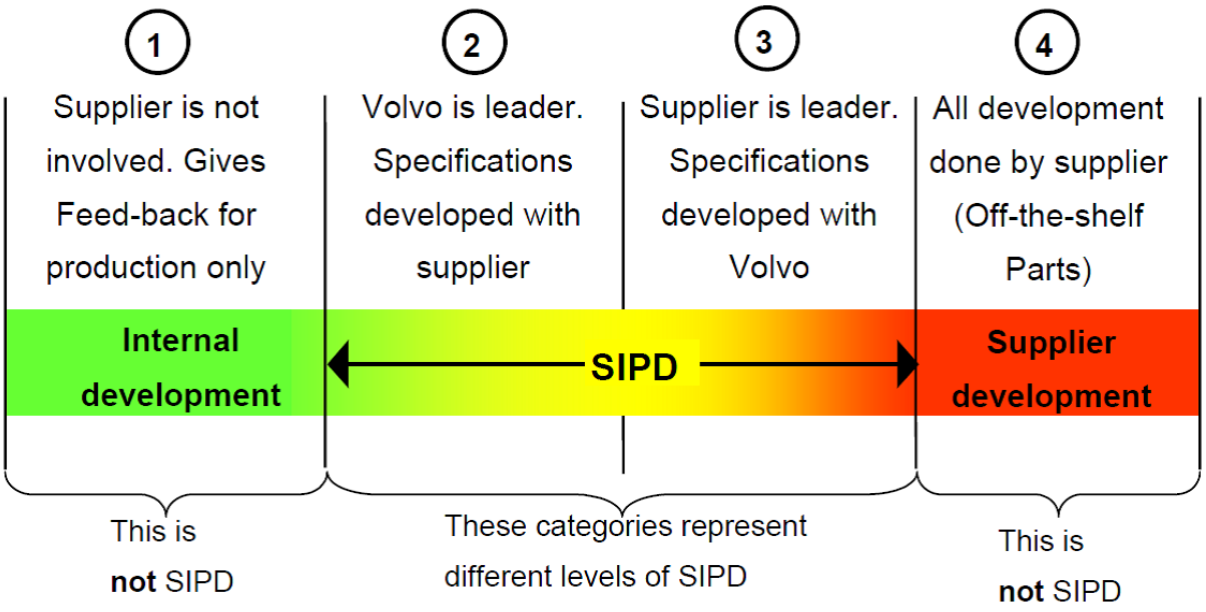

Figure 13: SIPD levels

According to one respondent, it is crucial to have role descriptions and responsibility definitions on an inter-company level, since the collaboration would not work without it. In the beginning of a SIPD project, a project organization and contact list is made. There is a template available on the SIPD homepage for the project organization and contact list. The template is used to document both internal and external members that have been appointed for the project. Also a SIPD product steering committee is formed. The steering committee includes members from both the buying company and the supplier and their main tasks are to follow up and direct the work in the project and to make decisions when certain problems have not been resolved within the project. A template is available on the SIPD homepage for the SIPD product steering committee as well.

During meetings, a tool called action list is used as an agenda which include delegation of certain tasks. A more detailed description of responsibility split between Volvo and the supplier's is defined in a tool called job and responsibility split. The job and responsibility split is a matrix which states the responsibility for the development work and other project activities between Volvo and the supplier. This is done for each project and the SIPD leader is responsible for doing this, however all the other members in the SIPD team should support the SIPD leader in this task. Volvo provides the matrix to the supplier and the supplier must read and agree with Volvo before signing the development agreement. The matrix includes all the major activities within the project. The job and responsibility split are seen by respondents as a well-working tool which fulfilled its purpose. No respondent could comment about any

problems regarding the responsibility split between Volvo and its suppliers. A template for the job and responsibility split is available on the SIPD homepage.

5.4 Goal Congruence

All respondents were aware of the importance of goal congruence, both internally and on an inter-company level. Our empirical findings will be presented in the same two categories as the theoretical framework; internal goal congruence and inter-company goal congruence.

5.4.1 Internal goal congruence

Regarding the internal goal congruence the respondents were aware of the diverse interests by different departments and the importance to align these interests. The respondents discussed mostly about the diverged interests between purchasing and product development but other departments were also discussed such as the manufacturing and aftermarket. To have an internal kick-off meeting was proposed by several respondents. Kick-off meetings existed according to the respondents in some extent but varied and were not performed to a desired extent.

According to the respondents it is the SIPD leader's role and responsibility to balance the team members' goals and communicate a vision to the team. One respondent stated it was important for the SIPD leader to "communicate the common goals and make sure everyone is committed to these goals, if not the communication will be inefficient".

According to the respondents, it exist problems to communicate goals and targets toward the supplier due to lack of internal goal congruence. The problem occurred when the team contacted the supplier before the team had achieved goal congruence. According to one respondent this problem was more common in projects of larger characteristics and the respondent further discussed a need for more internal discussions and better developed specifications before contacting the supplier. Another respondent had a similar opinion and stated there was a need to achieve internal goal congruence earlier in order to communicate common goals and targets to the supplier. According to the latter respondent, it exist cases where different departments had communicated different goals and targets to the supplier which had been very confusing for the supplier.

5.4.2 Inter-company goal congruence

According to the respondents, external goal congruence with the supplier enhances the communication and makes the cooperation more efficient. To be able to deliver a good

product, inter-company goal congruence was considered very important since lack of inter-company goal congruence could result in late changes. One respondent expressed a need of goal congruence to develop trust, commitment and relationship. The same respondent had the apprehension that a project would fail without inter-company goal congruence.

Goals are communicated towards the supplier according to the consulted commercial department through the request for quotation and according to the technical department through the development contract. In these documents goals and targets regarding quality, delivery, cost and features are communicated. The supplier commits to these goals by signing these contracts.

The vision was during the project secured by frequent meetings and discussions. One respondent stressed the importance of information exchange, clarity and transparency to achieve goal congruence. Some of the respondents brought up the need of a kick-off meeting in order to increase goal congruence in the beginning of a project. Kick-off meetings were carried out to some extent, but it was the team's own choice to include it or not. According to one respondent kick-off meetings were especially important for project of larger characteristics. The same respondent said that the kick-off meetings contributed to both goal congruence and team spirit. Several respondents commented the importance of team spirit during SIPD since it reduced opportunistic behavior by the supplier. However, one respondent commented that the supplier received payment when the goals were fulfilled; hence it was of interest for the supplier to understand the goals.

5.5 Technical content

The initial requirements developed by the SIPD team are communicated to the supplier through a request for quotation (RFQ), which could be described as a business proposal. The aim is to continue developing the specifications together with the supplier, once the collaboration is agreed upon. The specifications are divided into a functional and a technical specification. The functional specification describe how the product is supposed to work, and technical specification describe in words and sentences, what the product must meet in terms of material, environment, geometry and legal requirements. According to an internal document found at Volvo's intranet, the functional specification tells what the required functionality of the product is. It shall not tell what technical solution to be applied. When developing the functional specification all concerned corporate functions should be involved.

It is important to take all stakeholders' requirements including involved suppliers into consideration.

According to one respondent, suppliers must evaluate all of Volvo's requirements in the functional and technical specification, and accept if they can deliver these requirements. If the supplier cannot deliver the requirements, the supplier must inform Volvo. A re-evaluation of the requirements is performed by Volvo in order to determine if it is possible to change concerned requirements or not. According to one respondent, Volvo's specifications are occasionally unrealistic, which often do not get noticed until the testing phase and hence results in late changes, which delay the project. The respondent stressed the need for all stakeholders to go through all the requirements before the RFQ is sent. If this is done properly the respondent had the opinion of a reduction of late changes.

A last finding is regarding the process of gathering information about requirements from different corporate functions. One respondent expressed a problem to get inputs early on in the project. According to the respondent, the functions did not provide inputs early on in the project since it was easier to provide input later on in the project.

5.6 Changes in technical content

In order to align with the structure from the theoretical framework, our empirical findings regarding changes in technical content are divided into the same two categories; early changes in technical content and late changes in technical content.

5.6.1 Early changes in technical content

Early changes in technical content are common and could be due to various reasons according to all respondents. At Volvo, the specifications are seen as documents in progress and hence changes are a part of the SIPD processes. One respondent expressed the need of trust to make the process of changes effective. Another respondent explained early changes in technical content as a result of technical uncertainty. "Volvo does not always have the knowledge to specify everything, hence the need of additional specifications and early changes of existent specifications", the respondent expressed. According to the same respondent it was very important to keep an opened mind to early changes in technical content.

One respondent had the impression that early changes in technical content would be more common in the future since the aim was to involve the supplier earlier in the process. The

amount of early changes in technical content is related to the initial specification and is depending of Volvo's knowledge of the product according to one respondent.

One respondent commented regarding the importance of informing the supplier of environmental changes affecting the component. The same respondent also stressed the importance of continuous information exchange of early changes in technical content to minimize rework. According to the majority of the respondents, early changes in technical content usually resulted in an increased cost. There were diverse perceptions whether early changes in technical content increased lead time or not since it depended on the characteristic of the change.

Two respondents made comments regarding problems that had arose due to suppliers' lack of knowledge of the purpose of a change. The outcomes had been problems in the production, development of products that could not be produced cost efficient and in the worst case problems had occurred in the field.

5.6.2 Late changes in technical content

Late changes occurred due the knowledge of various requirements was observed late in the process. Almost every respondent commented that the late changes were seen as an opportunity for the supplier to increase costs.

For late changes, there is a process called Product Change Request (PCR). In the PCR, Volvo describes the change and the supplier respond with a time plan and a cost. According to internal documents found on Volvo's intranet Volvo should always have the right to initiate changes in the development work specification and/or development plan. Prior to introducing changes, the parties shall jointly identify and agree upon all consequences of such changes. Both parties should dedicate sufficient resources to review technical and commercial revisions suggested by the other party. The supplier may not prior to Volvo's written approval change the technical specification. If a product is facing the need of a change, in development phase as well as in maintenance phase, the supplier should present a written change request which is to be approved or rejected by Volvo. An impact analysis shall be documented for all changes.

Regarding the PCR process all of the respondents had positive response regarding the existence of the process. However, a few respondents had comments regarding the heavy documentation and long lead time of it. One respondent approved its existence for larger

project but questioned it for smaller projects. Another respondent had the opinion that the PCR process was as efficient it could be and the lead time could be reduced to a large extent if it was managed properly. Regarding the suppliers attitude towards late changes, one respondent commented “as long as the one responsible for the cost is clear, there is usually no problem, however if conflict occurs it can be a bit problematic”. This problem is according to the same respondent tied to the relationship with the supplier. Late change could also have an impact on the quality since there was less or even no time to validate the product.

5.7 Project planning

All respondents agreed that project planning and schedule is an important part of SIPD. According to the respondents, it is important to plan since product development often involves complex relationships which cannot be realized without planning. Planning is extremely important because it is a way to ensure that everyone has the ability to deliver on time. Planning makes sure that everyone involved is working with the same plan and goals. And in the end it is everyone's responsibility to achieve the stated objectives within the time frame.

According to the respondents, scheduling is carried out together with suppliers, major activities and milestones are communicated to the supplier, and the supplier creates a schedule and sends it back to Volvo. Volvo will examine the schedule to ensure all key milestones can be met. One respondent stated; “the supplier returns with how much time they need for the development work but it is a negotiation and sometimes it is possible to speed up the process by offering more pay”.

In most cases, the SIPD leader, the SIPD members from product development, purchasing and the supplier participates in the project planning process. According to one respondent, it is the Chief project manager, SIPD leader, the SIPD members from product development, purchasing, quality, and the supplier who are involved in the project planning process. According to another respondent, SIPD members from product development and purchasing participate in project planning. The same respondent mentioned that they are working to involve aftermarket earlier in project planning. Another respondent stated; “the SIPD leader together with everyone involved in the project participate in project planning”.

According to one respondent, the SIPD member representing purchasing department occasionally has too many items and does not have the time required for the project. In the respondent’s case, they have solved this problem within the team by delegating simpler

purchasing tasks to the SIPD leader. According to another respondent, the SIPD member representing aftermarket does not have enough time for the project.

According to most respondents, the tool for project planning works well, in cases when there occur problems in the plan it is because of mistakes or things that cannot be controlled. However, there were some respondents who mentioned problems related to planning. One respondent believed their main problem with planning is that they underestimate the lead time, and target resources late rather than early in projects. According to another respondent, there occasionally is a need to increase the supplier's resources to reach certain milestones, which means increased costs. According to some respondents, the employee turnover or maternity leave have caused problems with the project planning.

Regarding integration of suppliers in product development, several respondents stressed the importance of involving suppliers as early as possible. However, according to one respondent, they do not have much time to negotiate with the suppliers, if they start involving suppliers earlier then there will be more time for the negotiation process. According to another respondent, it is better to involve suppliers as early as possible. However, it is not always possible due to the lack of information of requirements. There were some respondents who did not think that it always was important to involve suppliers early. According to one respondent, the rush in to selecting a supplier has resulted in a selection of wrong supplier.

5.8 Cost and agreements

According to the respondents, information regarding costs and agreements are important. One respondent stated; "it is extremely important to be cost conscious and to develop a product at a fair price". According to another respondent, it is very important to have a view of the target cost, to communicate the target cost to the suppliers, and to acquire a detailed cost breakdown from the suppliers.

According to most respondents, there exist employees within the company who have the competence to calculate the product cost. A few other respondents argued that cost engineering is something which must be improved in Volvo. According to one respondent, Volvo has not made as much progress in the field of cost engineering as the automobile industry has done.

A product cost breakdown is included in the RFQ, but according to a few respondents some suppliers refuse to present a product cost breakdown. One explanation could be that the

supplier attempts to hide their profit margins. According to another respondent, the problem with some suppliers who refuse to present a breakdown of product costs will vanish since the same respondent believes it is a ripening process. It is very important for Volvo to have its own expertise which is capable of determining whether the costs are reasonable or not. The same respondent believed that this expertise is weak within the company today.

According to some respondents, Volvo is not very strict regarding signing the contracts according to the time plan. One respondent mentioned Volvo in general does not stop the process when the contracts are not signed in time. According to another respondent, signing contracts is an extensive activity which is very time consuming. One respondent stated, "if the contract is not signed on time you may end up in a dilemma because you have to decide whether to continue working with the supplier or not. If the supplier knows they have a unique competence or solution which Volvo wants, they know they have a strong negotiating position and are able to let the time pass". According to the same respondent, Volvo has no remedy against this problem than to systematically scan for other potential suppliers.

SOW is a document included in the development agreement where all responsibilities and working procedures are described, a template for SOW exist in the SIPD homepage. No respondent believed that there is something important missing in SOW but according to several respondents, SOW is a heavy and difficult document to work with. Some of these respondents mentioned they are currently not using everything which is included in SOW. One respondent stated, "SOW can become a huge document if all the appendices are included however the supplier should be familiar with most of the appendices if they are a serious company within the industry". According to one respondent, much of the information in today's SOW is only relevant for electricity and therefore it takes time to adjust SOW in other projects. But there were some respondents who had the opinion that SOW was an excellent tool. One respondent mentioned that according to one supplier, SOW was a tough way to initiate cooperation, but once it was done it was world class.

According to internal documents in Volvo, it is important to protect Volvo's interest through patents and other solutions for the protection of intellectual property rights. The ownership of intellectual property rights is covered in the development agreement and it shall be clearly stated who is or will be the owner of new ideas, solutions, products and know-how. Requirements and information regarding intellectual property rights is included in specifications.

Part V:
Analysis, conclusions and recommendations

The sixth part of the report aims to compare the theoretical framework with the empirical findings in order to summarize the conclusions from the research and from that give recommendations.

6 Analysis

The following text is a comparison of the empirical findings and the theoretical framework.

6.1 Trust, commitment and relationship

According to our empirical findings, Volvo is aiming for long-term relationship with its SIPD suppliers. It is easier to maintain a supplier compared to recruit a new supplier. It is also easier to work with existing suppliers which already have good relations with Volvo. There also is a finding that Volvo invests a significant amount of time and money in suppliers and therefore do not want to change suppliers too often. According to our theoretical framework, good relationships with suppliers are crucial for successful supplier involvement (Wagner and Hoegl 2006) and the existence of commitment and trust are important factors for good relationships (Morgan and Hunt 1994). Trust and commitment reduce opportunistic behavior and inspire partners to preserve relationship investments (Morgan and Hunt 1994). Trust is important for partners in order to exchange critical information (Whipple and Frankel 2000), and to share new emerging technologies with each other (Ragatz, Handfield et al. 1997). Trust facilitates conflict resolution and will help the collaboration in a changing environment (Kelly, Schaan et al. 2002). Any actions both parties take to improve trust and commitment will result in an improved relationship (Nyaga, Whipple et al. 2010).

According to our findings, the best way to improve relationship between parties is through face-to-face communication. It is common for the internal SIPD team to start cooperating before they meet each other physically and communicates face to face. However, when it comes to suppliers, face-to-face communication will always take place before cooperation is initiated. Trust and commitment were considered very important in a buyer-supplier relationship. According to our respondents, trust and commitment are improved through; cooperating a lot and being open and honest with each other, critical information sharing, frequent and structured communication. To respect commitments were also seen critical by the respondents in order to not undermine trust. According to our theoretical framework, face-to-face communication is the most effective means of communication (Kelly, Schaan et al. 2002). Trust and commitment is increased by improved information sharing (Nyaga, Whipple et al. 2010). Closer collaboration results in more frequent and relevant information exchange and honest communication improves the collaboration (Mohr and Spekman 1994).

According to our empirical findings, a kick-off meeting is an excellent opportunity to start a relationship. According to Kelly, Schaan et al. (2002), people should meet in a planning

session before cooperation starts. The planning session gives the team members a chance to establish face-to-face interaction and begin to create an interpersonal relationship.

Our empirical findings indicate the internal cross-functional teams have a good relationship when they are placed close to each other. According to our theoretical framework, communication between people decreases rapidly with distance since long distance lower the chance of meetings, delays decision making, and makes face-to-face communication more inconvenient. Co-location of cross-functional product development teams can improve communication in the team (Holland, Gaston et al. 2000).

6.2 Risks and uncertainties

According to our empirical findings, Volvo requires the supplier to develop and maintain a risk management plan which describes the overall risk management. The supplier is responsible to monitor and report on the areas of risk to concerned Volvo employees as agreed with those Volvo employees. Further, all project team members have a responsibility for minimizing risks in their areas of responsibilities and interfaces with other areas. Overall, risks are managed through open communications and by demanding improvements at the supplier. Another finding is regarding the very comprehensive risk management process which comprises risk management planning, risk identification, risk assessment, risk prioritization, risk action, risk monitoring and control. Unexpected events occur in projects which may result in a deviation from the project plan (Ahmed, Kayis et al. 2007). According to Park (2010), there is a need for organizations to identify the likelihood of something negative to occur, and minimize the negative impacts on the project performance. Otherwise these impacts may cause delayed time-to-market, missed sales opportunities, increased production costs and unsatisfactory product quality (Park 2010). All risk can be; reduced or eliminated, transferred to other activities or parties, absorbed or pooled, and avoided (Cervone 2006). According to Ahmed, Kayis et al. (2007), a risk management process should include key steps as risk identification, risk analyzing, risk evaluation, risk treatment, risk monitor and review.

In our empirical research we found that technical uncertainties in projects are reduced through; having a wide range of technical solutions, have close communication and be well integrated with the supplier, increasing the knowledge of the concerned technology and the engineering tool failure mode and effect analysis. According to our theoretical framework, sources of technical uncertainty can be mitigated though sharing cost and technology

information with suppliers (Petersen, Handfield et al. 2005), continuously exchange of design information between different designers, granting the supplier access to information regarding the product architecture, high level of coordination and management of interdependencies in product development (Yan 2011) and also though engineering tools such as failure mode and effects analysis, design for assembly and design for manufacture minimize risk (Templin 2010).

According to our empirical findings, it is important to increase trust, commitment and communication in SIPD projects in order to reduce the relational uncertainty. This aligns with our theoretical framework which states that the relational uncertainty can be reduced by increased trust (Kelly, Schaan et al. 2002) and commitment (Petersen, Handfield et al. 2005).

6.3 Roles and responsibilities

In this section, a comparison between the theoretical framework and the empirical findings of first, internal roles and responsibilities and second, inter-company roles and responsibilities will be presented.

6.3.1 Internal roles and responsibilities

According to our findings, the SIPD team is a cross-functional team including; purchasing, design, quality, manufacturing, logistics, cost and aftermarket. Cross-functional integration was considered very important in order to avoid misunderstandings in SIPD. The SIPD process instruction clearly stresses the importance to involve all concerned departments early in the project. However, there are cases were representatives from various departments are involved too late in the SIPD project. Also the participation from the representatives, besides from purchasing and product development, was not considered frequent enough. The overall opinion of the respondents were that there was no need to include all departments in every meeting but it always should be someone assigned and informed from each department to the project. According to Smith (1990), it is important to incorporate all key disciplines and professional skills needed when forming a cross-functional product development team. Also an effective implementation of cross-functional teams is critical to product development success (Griffin 1997; Holland, Gaston et al. 2000).

According to our findings, the SIPD team is led by an SIPD leader which generally has a background from product development. According to an internal document, the SIPD leader should be from the product development department. In some cases, the SIPD leader could be

from another department but it required the vice presidents from the concerned function's approval in such case. We found two opinions of this matter. The first opinion was that it was not optimal to have a person from product development as a SIPD leader. This since the key competence of the leader is not their technical skills, but rather the ability to consider all representatives' requirements, balance these towards a common goal and to have good project management skills. The second opinion was that the SIPD leader should have a background from product development since the SIPD leader had to have a good and detailed technical knowledge. According to Holland, Gaston et al. (2000), a common discussion is whether the leader of a cross-functional team should be marketing led or product development led. One solution mentioned is to appoint a leader who is nor from marketing or product development and instead appoint a leader to a project manager outside the traditional functional hierarchy of the organization. However, the team leader should incorporate all key disciplines and professional skills and also be able to pull together a diverse group of people in support of team goals (Holland, Gaston et al. 2000).

In our empirical findings some respondents lacked role descriptions for all team members of the group while others stated that they possess these role descriptions. One part of respondents mentioned that they do not have these descriptions and are in need of descriptions of SIPD member's role and authority. The only role description we found in Volvo's intranet was intended for the SIPD leader but this description was not known by all respondents. Role descriptions for remaining team members may exist but in any case, these role descriptions are poorly communicated. According to Holland, Gaston et al. (2000), roles and responsibilities should be clear for every member of the team since role formalization enhances inter-functional integration by clarifying responsibilities for concerned disciplines and highlighting the dependencies between them. Formalization is also positively related to perceived effectiveness and reduces confusion and fosters productive relationships.

6.3.2 Inter-company roles and responsibilities

According to our empirical findings, Volvo has two levels of SIPD. The difference between the levels is basically dependent of the influence on the development work the supplier will have in the project. According to one respondent, the choice of SIPD level is dependent whether the supplier has the ability to take an overall responsibility for the development work or not. The same respondent expressed a lack of a good system in order to make such judgement. According to Kamath and Liker (1994), different roles rely on the supplier's responsibility. Different roles could depend on buyer-supplier relationships considerably in

closeness and intensity (Kamath and Liker 1994). A second aspect of role definition is due to different levels of knowledge regarding the ability to take certain RnD responsibilities (Henderson and Clark 1990). A third aspect is due to the characteristics of the project (Kamath and Liker 1994).

According to our empirical findings a project organization and contact list is made in the beginning of a SIPD project, where both internal and external project members are documented. Also a SIPD product steering committee is created, including members from both Volvo and the supplier. A tool called Job and responsibility split is used to divide responsibilities and tasks between Volvo and the supplier. This tool lists all the major activities which have to be performed during the development work. The responsibilities for certain activities are then divided between Volvo and the supplier. According to our respondents these tools work well and fulfill their purpose and no commented about any problems regarding roles and responsibility between Volvo and the supplier. According to Karlsson, Nellore et al. (1998), there is a need to define the role of the supplier and it is important to identify who should be involved; who should provide the information, and in what form the information should be presented. Kelly, Schaan et al. (2002) suggest that partners should document clearly how roles and responsibilities are best allocated.

6.4 Goal congruence

In this section a comparison between the theoretical framework and the empirical findings of first internal goal congruence and second inter-company goal congruence will be presented.

6.4.1 Internal goal congruence

According to Henke JR. and Zhang (2010), it is common in the commercial vehicle industry to have different objectives between different corporate functions. Hence, internal goal congruence has to be reached. Lack of internal goal congruence could be dangerous if a diverse set of goals and targets are communicated to the supplier. In such case, the supplier will be positioned in a stressful situation since the supplier will lack knowledge of which information to rely on and hence reduce their commitment (Henke JR. and Zhang 2010). In our research we found diverse interests by different departments. We also found cases were a diverse set of goals and targets had been communicated to the suppliers. The reason mentioned by the respondents were lack of internal goal congruence and the respondents expressed a need for more internal discussions and further developed specifications before contacting the supplier.

According to Smith (1990), it is the product development leader's role to have a broad, integrated and focused vision of the product and be able to communicate the vision to remaining team members. Also superordinate goals shared by members in a product development team improve project outcomes by improving cross-functional cooperation (Yan 2011). Our empirical findings align with the theoretical role of the product development leader. We found that it was the SIPD leader's role and responsibility to weight the team members' goals and communicate a common vision to the team (i.e. superordinate goals). This will according to (Yan 2011) improve cross-functionality and hence ultimately improve the project outcomes.

The last finding regarding internal goal congruence was a demand of internal kick-off meetings. According to the respondents, kick off meetings were carried out occasionally, but the overall comprehension was that it was not carried out as often as desired. One could argue an internal kick-off meeting would improve cross-functional integration due to the fact a kick-off meeting would force early selection of team members.

6.4.2 Inter-company goal congruence

According to (Yan 2011), inter-company goal congruence among partners promotes cooperation. Divergent goals drives the companies to spend more efforts in coordination than needed, which diverts the product developing company from actual core design work and hence, reduces the product development productivity (Yan 2011). At Volvo, we found that inter-company goal congruence enhance the communication and makes the cooperation more efficient. It was of the respondent's comprehension that inter-company goal congruence was crucial in order to be able to deliver a good product since lack of inter-company goal congruence could result in late changes.

In our empirical study we found that goal congruence with the supplier was secured by frequent meetings and discussions. According to Petersen, Handfield et al. (2005), involving the supplier in the determination of appropriate technical metrics and targets for the project, and jointly agreeing with the supplier on these targets was shown to be a key element in project team effectiveness.

Also on an inter-company level, kick-off meetings were demanded. In comparison with internal kick-off meetings, one additional benefit was highlighted. Increased team-spirit on an inter-company level was important since it reduced opportunistic behavior.

6.5 Technical content

According to our findings, Volvo communicates the initial requirements to the supplier through a RFQ with the intention to later continue develop the specifications. According to Murthy, Rausand et al. (2008) there are customer, corporate, regulatory and technical requirements that have to be addressed. Karlsson, Nellore et al. (1998) suggests dividing the specification process into two parts, a functional concept and a dimensional definition. At Volvo, customer, corporate, regulatory and technical requirements are specified first into a functional specification which subsequently is technical specified in a technical specification.

Murthy, Rausand et al. (2008) clearly state that all previously mentioned requirements have to be addressed and documented in specifications. According to our empirical findings, all stakeholders' requirements including involved suppliers should be taken into consideration. However, occasionally Volvo's specifications have been unrealistic, which have not been noticed until late in the product development process. Hence, a need of late changes in the specifications occurred which in turn have resulted in delays. According to one respondent, there is a need for all stakeholders to go through all requirements before the RFQ is sent to the suppliers. In chapter 5.3.1 we present a finding of late/lack of involvement of several corporate functions. This finding could affect the initial specifications. We also found that it could be problematic to get early inputs, which also could affect the initial specifications and that better developed initial requirements would decrease the amount of late changes. According to Holland, Gaston et al. (2000), the extent which team members release and use incomplete, uncertain and/or ambiguous information has been shown to be positively linked to product development project outcomes.

6.6 Changes in technical content

In this section a comparison between the theoretical framework and the empirical findings of first early changes in technical content and second, late changes in technical content will be presented.

6.6.1 Early changes in technical content

According to our findings, changes in technical content are common at Volvo. The specifications are seen as documents in progress and changes are a part of the SIPD process. According to Karlsson, Nellore et al. (1998), it is not unusual that the specifications are seen as one relatively fixed document by the design engineers in the supplier companies. However, there is a chance that it is only from Volvo's perspective that the specifications are documents

in progress. In our study, we have not had the opportunity to verify the supplier's view of the specifications, but it is although worth mentioning that there is a possibility that the view of the specifications could be diverse.

There were cases were problems during the product development had occurred due to insufficient information regarding the purpose of a change. Karlsson, Nellore et al. (1998) state that this is not unusual and it makes it harder for the suppliers to adapt and optimize component characteristics, and understand the implications that the changes might lead to in relation to the evolution of a system.

6.6.2 Late changes in technical content

Regarding late changes in technical content, these changes were according to our empirical findings a result of new requirements was thought of late in the process which could be a result of insufficient cross-functional integration. Another reason could be due to the process of decisions during early stages in the development process. Verganti (1999) discusses the dilemma of decisions in the early phases of the product development and suggest the concept planned flexibility. According to Verganti (1999) companies working with stage-gate systems calls for remarkable anticipation capabilities. However, as mentioned above, Volvo has according to our empirical findings insufficient cross-functional integration and hence is unlikely to have remarkable anticipation capabilities. Since Volvo has the opinion that late changes in technical content is not problematic as long as the one responsible for the cost is aware of it and there is enough time to implement the change and properly validate the product, it is likely that Volvo possess reaction capabilities to some extent.

For late changes, there is a process called PCR at Volvo. We found in our study that Volvo's comprehension of the supplier's attitude to late changes were not problematic as long as the one responsible for the cost was aware of it. This problem was tied to the relationship with the supplier. Late changes in technical content could also have an impact on the quality since there was less or even no time to validate the product. According to Henke JR. and Zhang (2010), late changes could subject the supplier to enormous stress. Late changes in technical content could also result in additional costs which the supplier not always is able to recover from the buying company. Nor may there be enough time to test and validate the change for the buying company's benefit. Hence, late specification changes can create such stress that no one is pleased, even though the deadline is met. Henke JR. and Zhang (2010) further discuss late changes as a symptomatic of systemic issues within a company and are not capable of

being resolved without fundamental changes in processes and procedures that over time have become firmly entrenched in the company's operation.

6.7 Project planning

According to our empirical findings, there are occasionally situations where the SIPD members do not have the time required for the project. In one case, the buyer in the SIPD team lacked the required time for the project. In another case it was aftermarket's representation in the SIPD team, who lacked the required time for the project. According to Douglas (2004), it is important for organizations to determine the level of resources which will be needed in the project and to ensure there are sufficient with resources to successfully complete the project. The project leader must negotiate enough resources to complete the project successfully. It is also important for all team members to understand the importance of their participation and commitment to the project.

According to our empirical findings, in most cases, it is the SIPD leader and SIPD members from product development, purchasing and quality who participates in project planning process. Represents from the suppliers are always involved in project planning, the suppliers creates a plan based on the milestones which were communicated to them. However, the remaining members of the SIPD team do not always participate in project planning. According to Haugan (2002), people who participate in project planning, develops ownership of some of the results. Participation in project planning is constructive and builds a strong project team. According to Douglas (2004), the project leader has to involve the team members in the planning process and all members should be involved early and continuously in project planning. Other benefits of joint planning according to the theory are clearer channels of communication and that it will increase participants' commitment and dedication to the project's success (Douglas 2004).

In our empirical study we found that there is an interest to involve suppliers earlier in product development process. According to Handfield, Ragatz et al. (1999), decisions made early in product development phases have a significant impact on product cost, quality and cycle time. For this reason, it is important to bring product, process, and technical expertise as early as possible in product development process. The decision of when to involve suppliers is dependent on two major factors, the rate of technology change and the level of supplier expertise. If the rate of technology change is important, supplier involvement should be delayed to later stages. Instead if it is the suppliers design expertise which is significant, then

the suppliers should be involved earlier in product development process (Handfield, Ragatz et al. 1999).

6.8 Cost and agreements

Given our empirical findings in roles and responsibilities regarding cross-functional integration, cost engineers does not seem to be involved early enough in projects. According to most respondents, there exist employees within Volvo who have good skills in cost engineering but a few other respondents argued that cost engineering is something which must be improved in Volvo. According to Nicholas and Steyn (2008), cost engineers should be involved in technical projects to provide advice to the project manager on both technical and financial aspects of the project. With detailed and meaningful cost estimates early in the product development process, the company will have a significantly lower proportion of delays and development cost (Roy 2003). Most of the product cost is determined early in product development therefore cost engineering is needed during design phase. Unfortunately, many product designers have poor knowledge regarding cost management, which in these situations implies that the cost engineering is not being used successfully in product design (Zhao, Feng et al. 2001).

According to our empirical findings, SOW is an excellent tool which describes all responsibilities and working procedures in the development work. We also found that SOW is considered by many respondents to be a major time consuming activity. According to one respondent, much of the information in SOW is only relevant for electricity development and hence irrelevant for remainder projects which have to filter the SOW. Some respondents mentioned they are currently not using everything which is included in SOW. But there were some respondents who did not had any problems with SOW and had the opinion that SOW was an excellent tool. According to Bragg (2006), in outsourcing situations, the services to be provided must be clearly defined and all relevant information must be taken into account. It is important to be strict and detailed when writing contracts (Lindquist and Yhlen 2011). The SOW must clearly state the conditions under which the results will be accepted by the buying company, otherwise there may be arguments and delays later in the project (Nicholas and Steyn 2008).

In our empirical findings we found that Volvo is not very strict regarding signing the contracts according to the time plan and in general does not stop the process when the contracts are not signed in time. According to one respondent, if the contract is not signed on

time it may cause problems if the supplier knows they have something unique which Volvo wants. In this situation, the supplier knows they have a strong negotiating position and are able to let the time pass. There is no remedy against this problem than to systematically scan the market for other potential suppliers. According to Lindquist and Yhlen (2011), the reason to enter into contracts is to minimize the uncertainties. One respondent concluded that the risks increase if the contract is not signed on time.

Bragg (2006) state that it is important to consider the rights of intellectual property in the outsourcing of an area covering product design or operations research. According to our empirical findings, the ownership of intellectual property rights is covered in the development agreement.

According to our empirical findings, a product cost breakdown is included in the RFQ, but some suppliers refuse to present it to Volvo. The reason could be that the supplier attempts to conceal their profit margins. One respondent believes this problem is a ripening process and will vanish with time. The issue depends on the relationship between Volvo and the supplier. If the relationship between the parties improves, the supplier will be more willing to present a product cost breakdown to Volvo. According to Morgan and Hunt (1994), trust and commitment inspire partners to resist opportunistic behavior.

6.9 Model of critical information in supplier involvement product development

In a SIPD project, it is important to have clearly defined roles and responsibilities between all parties, then ensure there is both internal and external goal congruence. Goal congruence between all parties leads to better initial specifications which will reduce the amount of future changes in specifications. A SIPD project will not succeed; in the absence of a plan which everyone follows, if there is no information or estimates of cost, if there is no development agreement, and if it is not possible to handle specification changes in a good and satisfactory manner for all parties. In our model, when risks and uncertainties are high in relation to trust and commitment, the relationship is negatively affected. Similarly in cases where risks and uncertainties are low in relation to trust and commitment, the relationship is positively affected. All these parameters are important and can affect the relationship both positively and negatively. This is the reason why the relationship surrounds all the elements in our model, see Figure 14. We argue that the relationship is very important in a SIPD project since it will

affect the performance of the project. Below we present examples of empirical arguments which support all the interactions in the model.

According to our respondents, it is important for the supplier to understand what is expected from them and to be aware of their responsibility and vice versa. For a good relationship in the project team it is very important the team members know each other well and are aware of each other's responsibilities.

Goal congruence with the supplier enhances communication and therefore improves the relationship. Goal congruence is also seen as a necessity in order to develop trust, commitment and relationship.

The time plan is something which the parties must agree on and commit to. If the supplier does not deliver according to the agreed time plan it may result in a lower confidence for the supplier which will affect the relationship between the parties negatively.

The supplier must evaluate all of Volvo's requirements in the functional and technical specification, and finally commit to deliver the requirements according to the specification if they choose to sign the contract. If later in the development process the supplier fails to deliver according to the agreed specification, the relationship between the parties will be affected negatively.

Changes in specifications were seen as an opportunity for suppliers to increase cost. The increased cost can lower the relationship between the parties.

In order to have a good relationship it is important to discuss intellectual property rights early. Signing long-term contracts with the suppliers will create trust and with an increased trust, the relationship will improve. Increased trust and commitment reduces uncertainties.

The arguments above indicate, by implementing improvements in Roles and responsibility, Goal congruence, Project planning, Technical content, Changes in technical content, Cost and agreements it is possible to improve relationships in SIPD projects. An improved relationship entails an increased Trust and commitment which results in reduced Risks and uncertainties. However, it is important to consider the big picture of the model and not just the individual elements separately. For example, it is not enough to simply make improvements in the element Roles and responsibility if goal congruence between all parties is low. Nor will goal congruence be achieved if there are weaknesses in the element Roles and responsibilities.

Even if Roles and responsibilities are well defined and there are goal congruence between all parties, problems in the project will occur if important agreements are absent.

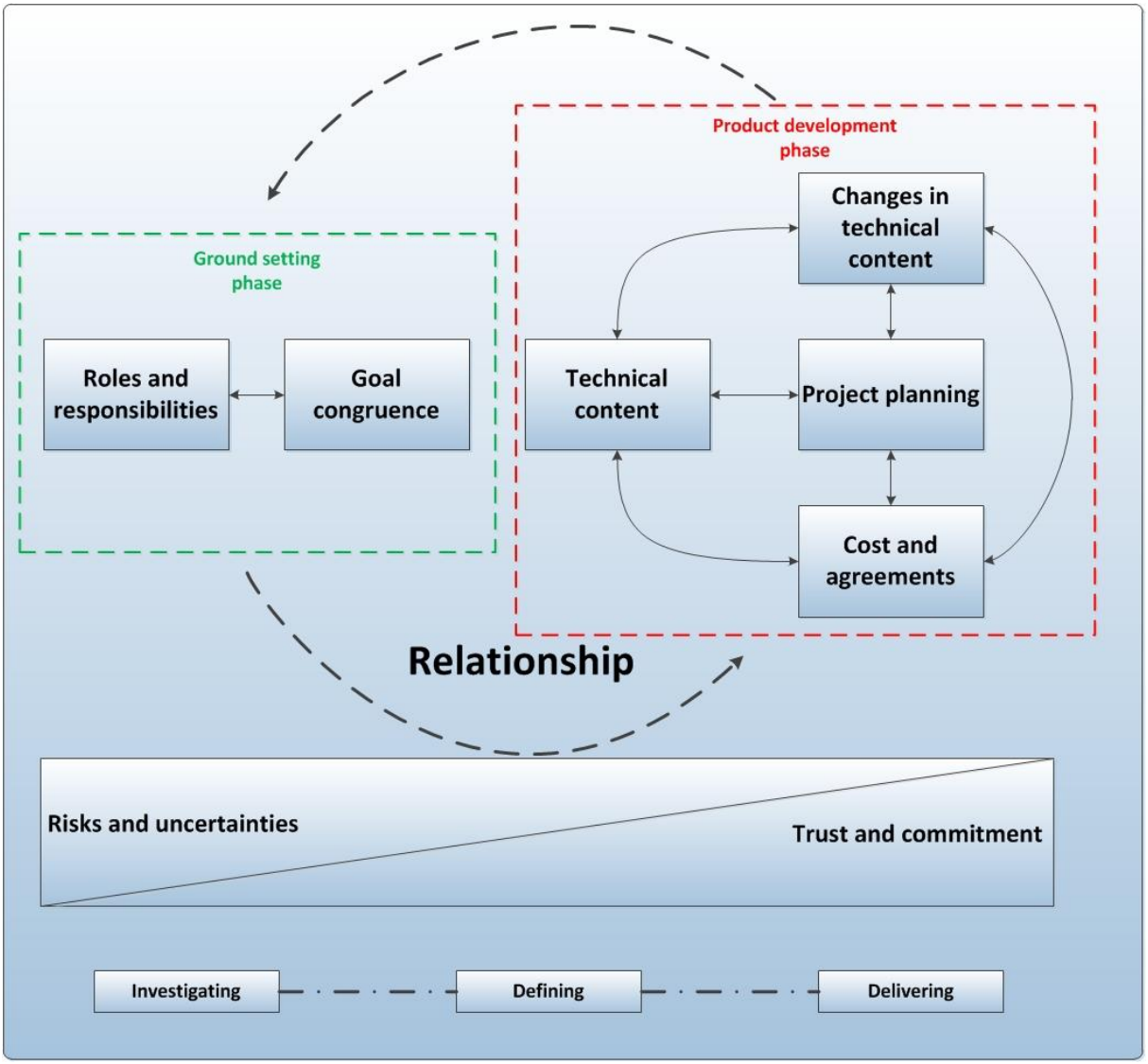

Figure 14: Model of critical information in supplier involvement product development

7 Conclusions and recommendations

This section will present our conclusions and recommendations for each element in the model.

7.1 Trust, commitment and relationship

In our research we found that Volvo is aiming for long-term relationship with its SIPD suppliers. In order for Volvo to maintain these relationships it is very important for both parties to care for and continuously improve trust and commitment, which according to the theory are crucial elements in relationships. In our research we found that Volvo is working to improve trust and commitment through; respecting commitments, cooperating a lot, being open and honest with each other, critical information sharing, frequent and structured communication. According to our theoretical framework, these actions will improve trust and commitment in relationships. Hence we conclude that Volvo understands the importance of trust and commitment in relationships and strives to improve trust and commitment with actions which according to our theoretical framework improves trust and commitment in relationship.

According to our empirical findings, the best way to improve relationship between parties is through face-to-face communication and this is consistent with the literature. Another finding is that there is a need to implement kick-off meetings. According to our respondents, it is common for the internal SIPD team to start cooperating before they meet each other physically and communicates face to face. However, when it comes to suppliers, face-to-face communication will always take place before cooperation is initiated. Kick-off meetings are according to the literature an excellent opportunity where the team members can establish face-to-face interaction and begin to create an interpersonal relationship. Hence, we conclude that the relationship in SIPD projects will improve if the SIPD members meet in person before they start cooperating. We recommend a kick-off meeting in all projects. Furthermore, it would be an improvement if employee who work in the same building, try to visit each other instead of calling or sending email when they need to communicate. In this way, they will improve their relationship through more face-to-face communication.

The empirical results indicate the internal cross-functional teams have a good relationship when they are placed close to each other. According to the literature, communication decreases rapidly with distance since distance lower the chance of meetings, delays decision making, and makes face-to-face communication more inconvenient. We conclude that in

projects where distance is creating communication problems, co-location of people will improve communication. Good communication is important for successful relationships in SIPD projects.

7.1.1 Recommendations

• Implement kick-off meetings in all projects to improve interpersonal relationship in SIPD projects
• Co-locate SIPD members when distance creates communication problems

7.2 Risks and uncertainties

In our empirical findings, there were no comments regarding problems in risk management. In SIPD projects, the suppliers have a responsibility to monitor and report on the areas of risk to Volvo. In addition to that, all project team members are responsible for minimizing the risk in their areas of responsibilities and interfaces with other areas. We also found a comprehensive risk management process which is in accordance with the theory.

Regarding management of technical uncertainty, we found no problems concerning risk management, but in our empirical framework, we do not have enough information to draw conclusions on Volvo's efforts to reduce the technical uncertainty. We believe this is because the supplier does most of the development work and thus most of the technical risk analysis. According to our empirical findings, technical uncertainties are reduced through increased communication and be well integrated with the supplier. These actions should decrease technical uncertainties but we still recommend a more detailed examination on how technical uncertainties are managed in SIPD projects.

According to our empirical findings, relational uncertainty is reduced thought increased trust, commitment and communication in SIPD projects. This is consistent with the theory which states that relational uncertainty is reduced by increased trust and commitment. Therefore there is no need for recommendations in management of relational uncertainties.

7.2.1 Recommendations

• Examine how technical uncertainties are managed in SIPD projects

7.3 Roles and responsibilities

In this section, conclusions and recommendations regarding first, internal roles and responsibilities and second, inter-company roles and responsibilities will be presented.

7.3.1 Internal roles and responsibilities

According to the literature, it is important to incorporate all key disciplines and professional skills needed when forming a cross-functional product development team and an effective implementation of the cross-functional team is crucial to the success of the product development. Our conclusion is that it is common with late cross-functional integration and there is low participation of departments besides from purchasing and product development in Volvo's SIPD projects.

A SIPD leader role description was found on 3P's SIPD homepage which were not known by all respondents. No other role descriptions were found although a part of the respondents claimed they possessed role descriptions. Our conclusion is that the SIPD leader role description is poorly communicated and role descriptions for remaining team members is either very poorly communicated or do not exist.

According to our empirical findings, the SIPD leader is generally from product development and in order to assign someone outside product development as a SIPD leader, approval from the vice presidents on concerned function is required. According to the literature, the SIPD leader should be able to have a holistic view and ensure to incorporate all competencies. We argue that it is more important that the SIPD leaders possess the right skills rather having a background from product development. The existing SIPD leader role description includes required skills which we concur with.

7.3.2 Inter-company roles and responsibilities

Volvo has two levels of SIPD which is dependent of the influence on the development work the supplier will have in the project. This could be seen as two different roles of the supplier. However, there is no formal process to determine which SIPD level a project should be defined as. According the literature, the role of the supplier could be determined dependent of several aspects such as earlier experience of the relationship, the supplier's knowledge and the project's characteristics. Our interpretation is depending of the circumstances of the project, different aspects are more or less important. However, these aspects are today considered in

an informal way when determining the SIPD level of the project and hence we conclude a need for a formalized process to determine a project's SIPD level.

In the beginning of a SIPD project, all people involved in the project should be defined and documented. The job and responsibility split determines the responsibility between the two companies. No one had any comments regarding problems or suggestions for improvements regarding roles and responsibility split between Volvo and the supplier. According to the literature, the role of the supplier is important to define and identify who should be involved; who should provide the information and in what form the information should be presented. We conclude that the job and responsibility split fulfills its purpose and hence there is no need for improvements regarding the responsibility split between Volvo and its supplier.

7.3.3 Recommendations

• Ensure cross-functional integration in early phases of SIPD projects
• Ensure to communicate the SIPD leader's role and responsibility description to the whole SIPD team.
• If not already existing, develop role description for the remaining SIPD members. Ensure to communicate role and responsibility descriptions to the whole SIPD team
• Prioritize the SIPD leader's skills rather than background
• Formalize a process to determine a project's SIPD level

7.4 Goal congruence

In this section, conclusions and recommendations regarding both internal goal congruence and inter-company goal congruence will be presented.

7.4.1 Internal goal congruence

According to both the literature and our empirical findings, it is the SIPD leader's role to weight the remaining SIPD member's goals and communicate these as a common vision of the project. This is in accordance with our theoretical findings. However, there are cases of insufficient internal goal congruence in SIPD projects. The lack of internal goal congruence has resulted in diverse communication of goals and targets towards the supplier. It is very important to internally agree on goals and targets before contacting the supplier since diverse communication of goals and targets will lower the supplier's commitment. A suggested

solution by our respondents was to implement kick-off meetings in SIPD projects. Although we do not have any theoretical support, we argue that a kick-off meeting has several benefits; the kick-off meeting will increase goal congruence, team spirit and force the organizer to include all concerned departments which in turn has to appoint a member to the SIPD team early on in the project. Hence, we conclude a kick-off meeting will increase both cross-functional integration and internal goal congruence.

7.4.2 Inter-company goal congruence

Both the literature and our empirical findings agree on the importance of inter-company goal congruence. At Volvo, inter-company goal congruence is secured by frequent meetings and discussions which align with the literature. An inter-company kick-off meeting were demanded by several respondents. An inter-company kick-off meeting will have the same benefits as an internal kick-off meeting with an additional benefit of decreased risk of opportunistic behaviour.

7.4.3 Recommendations

• Ensure internal goal congruence before involving suppliers to prevent the problems caused by diverse information
• Implement kick-off meetings both internal and inter-company

7.5 Technical content

Volvo divides their specification process into two parts, first a functional specification is conducted and subsequently a technical specification is determined. In those specifications customer, corporate, regulatory and technical requirements are included. The literature suggests dividing the development process into a functional concept and then determining dimensional specification. Customer, corporate, regulatory and technical requirements have to be addressed and documented in specifications. Since Volvo specifies according to the literature's suggestion and includes all requirements, we have no recommendation for improvements in this matter.

However, we found cases were the specifications have been unrealistic and a need for further developed specifications. We conclude that this is caused by late/lack of cross-functional integration and hence insufficient review of the specifications. We also conclude that the fact that it is problematic to get early inputs have a negative impact on the initial specifications.

7.5.1 Recommendations

• Ensure all stakeholders go through the requirements in the specifications before sending it to the supplier in order to ensure well-developed initial specifications.
• Increase the use of preliminary information during the development process

7.6 Changes in technical content

In this section, conclusions and recommendations regarding both early changes in technical content and late changes in technical content will be presented.

7.6.1 Early changes in technical content

Since our respondents stated the specifications were documents in progress and the literature state the specifications often are seen as relatively fixed documents by the suppliers, we want to emphasize the fact that there is a chance of diverse perception of the specifications between the buying company and the supplier. Hence, it important to be clear in this matter and ensure that the supplier knows that the specifications are under development.

Since there are examples were problems due to insufficient information exchange regarding the purpose of a change have occurred, we conclude that there is a need of ensuring to always inform the supplier of the reason for a change.

7.6.2 Late changes in technical content

Late changes in technical content occur occasionally, however Volvo has the opinion that it is not problematic as long as the one responsible for the cost is aware of it and there is enough time to implement the change and properly validate the product. However this is not always the case according to our empirical findings which align with our theoretical framework. We conclude there really is a need to take actions in order to reduce the frequency of late changes in technical content. In order to reduce the frequency of late changes we suggest Volvo to increase cross-functional integration in the SIPD teams and improve their anticipation capabilities as well as their reaction capabilities in order to utilize planned flexibility.

7.6.3 Recommendations

• Ensure that the supplier knows that the specifications are under development
• Ensure to always inform the supplier of the reason for the change.
• Take actions in order to reduce late changes

7.7 Planning

Occasionally there are situations where the SIPD members do not have the time required for the project. This problem indicates deficiencies in the project resource planning which could result in delays, lower quality, and higher costs. It can also result in mistrust, lower motivation and lower internal relationship in the team. The literature states it is important to make sure there are sufficient with resources to successfully complete the project and all team members have to recognize the importance of their commitment to the project. We conclude that this is a problem which Volvo must address and improve. The SIPD leader has to ensure enough resources for the project and the SIPD members must understand the importance of their participation in the project.

We found that not all SIPD members participate in project planning. Mostly it is the SIPD leader, and representations from product development and purchasing together with representations from the supplier who participates in project planning. The remaining members of the SIPD team do not always participate in project planning. This finding is consistent with the finding in roles and responsibility of low internal cross-functional integration early in projects. We conclude that this is an improvement opportunity since the literature states all project members should be involved early and continuously in project planning. Participation in project planning is found to be constructive and builds a strong team. In addition, participation in project planning should increase the SIPD member's involvement and commitment to the project. The SIPD leader has the responsibility to involve everyone in project planning.

According to our empirical findings, there is an interest to involve suppliers earlier in the product development process. This is understandable since according to the theory, decisions made early in product development phases have a significant impact on product cost, quality and cycle time. Suppliers can bring technical expertise early in the development phase which can improve quality or lower the costs. But the theory also states, the decision of when to

involve suppliers depends in rate of technology change and the level of supplier expertise. If the suppliers design expertise is the most important they should be involved early and if it is the rate of technology change which is the most important they should be involved late. The conclusion is that it is advantageous to involve the suppliers earlier but it is also important to consider the rate of technology change and the level of supplier expertise when making the decision.

7.7.1 Recommendations

• Review project resource planning to ensure there are enough resources before initiate an SIPD project.
• Increase participation of all SIPD members in project planning if possible.
• Consider if it is the suppliers design expertise which is the most important or if it is the rate of technology change which is the most important before decide on when to involve suppliers.

7.8 Cost and agreements

We found that cost engineers are not involved early in SIPD projects. We also found two opinions on the competency in cost engineering. While most respondents believed there are people within the company with good knowledge in cost engineering, a few respondents believed the competency needs to be improved. Our interpretation is that the large organizations in Volvo have good skills in cost engineering while smaller organizations are in need of improvement. According to the theory, detailed and meaningful cost estimates early in the product development process lowers the proportion of delays and development cost. Most of the product cost is determined early in product development therefore cost engineering is important early in the design stages. Our conclusion is to involve cost engineers earlier and later continuously in SIPD projects and examine the competency of cost engineering in the company and improve where it is needed to improve. In situations where the product designers have little knowledge regarding cost management, the involvement of cost engineers is more important.

We found that many respondents find the SOW as a major time-consuming task that takes a lot of time in certain projects. This is because the SOW is intended for product development in the electricity and needs to be adjusted in projects outside the electricity development. The

SOW was also found as an excellent tool which describes all responsibilities and working procedures in the development work. There is no need to improve the information in the SOW but there is a need to reduce the time required for the handling of SOW in some projects. Our recommendation is to develop several versions of the SOW which is more appropriate in other types of projects. Another solution is to add recommendations in the current SOW on how to deal with SOW in a variety of projects. With these changes the team can spend less time on SOW and more time on the development work. Although the SOW is perceived as a difficult document to work with it is also a very important document which can facilitate much of the work if problems arise.

The literature states that it is important to consider the rights of intellectual property in SIPD. In our empirical findings we found that the ownership of intellectual property rights is covered in the development agreement. Therefore we conclude that there is no need for recommendations in this subject.

We found that in SIPD projects, Volvo is not strictly in getting the contract signed before the development work begins. The development work begins even if the contract is not signed. The matter can become problematic if the supplier knows they have a unique competence which interests Volvo and could let the time pass. According the theory, it is important to enter into contracts in order to minimize the uncertainties. We conclude that the contract must be signed before the development work begins. By not signing contracts on time the risks increase.

We found that a product cost breakdown is included in the RFQ, but some suppliers refuse to present it to Volvo. We believe that the issue depends on the relationship between Volvo and the supplier and the problem should vanish if the relationship is improved. According to our theoretical framework, an improved relationship should reduce opportunistic behavior. Our recommendation is to improve the relationship with the suppliers to avoid this problem. In situations where the suppliers refuse to present a product cost breakdown, it is especially important for Volvo to have its own expertise capable of determine whether the costs are reasonable or not.

7.8.1 Recommendations

• Involve cost engineers earlier in SIPD projects
• Examine the competency of cost engineering in the company and improve where it is needed to improve
• Develop several versions of SOW for different types of projects or at least there should be recommendation on how to handle SOW in different types of projects.
• Ensure to always get the contract signed before the development work begins.
• Improve the relationship with the suppliers to increase cost transparency

7.9 Model of critical information in supplier involvement product development

The conclusion is that by implementing improvements in the elements on the ground setting phase and the product development phase it is possible to improve the relationship in SIPD projects (see Figure 15). A better relationship in SIPD projects entails an increased trust and commitment which in turn reduces risks and uncertainties. When working with SIPD, all the elements in the ground setting phase must first be well defined before starting defining the elements in the product development phase. Ambiguity in any element is a risk in the project. If one element is not working as it should, it can cause problems in the project which may worsen the relationship of the project team. For this reason, it is important to have a holistic perspective when working with the model. It is important to understand that it is not enough to only seek improvements in some of the elements. All the elements on the ground setting phase and the product development phase must be improved before it is possible to gain a better relationship in SIPD projects.

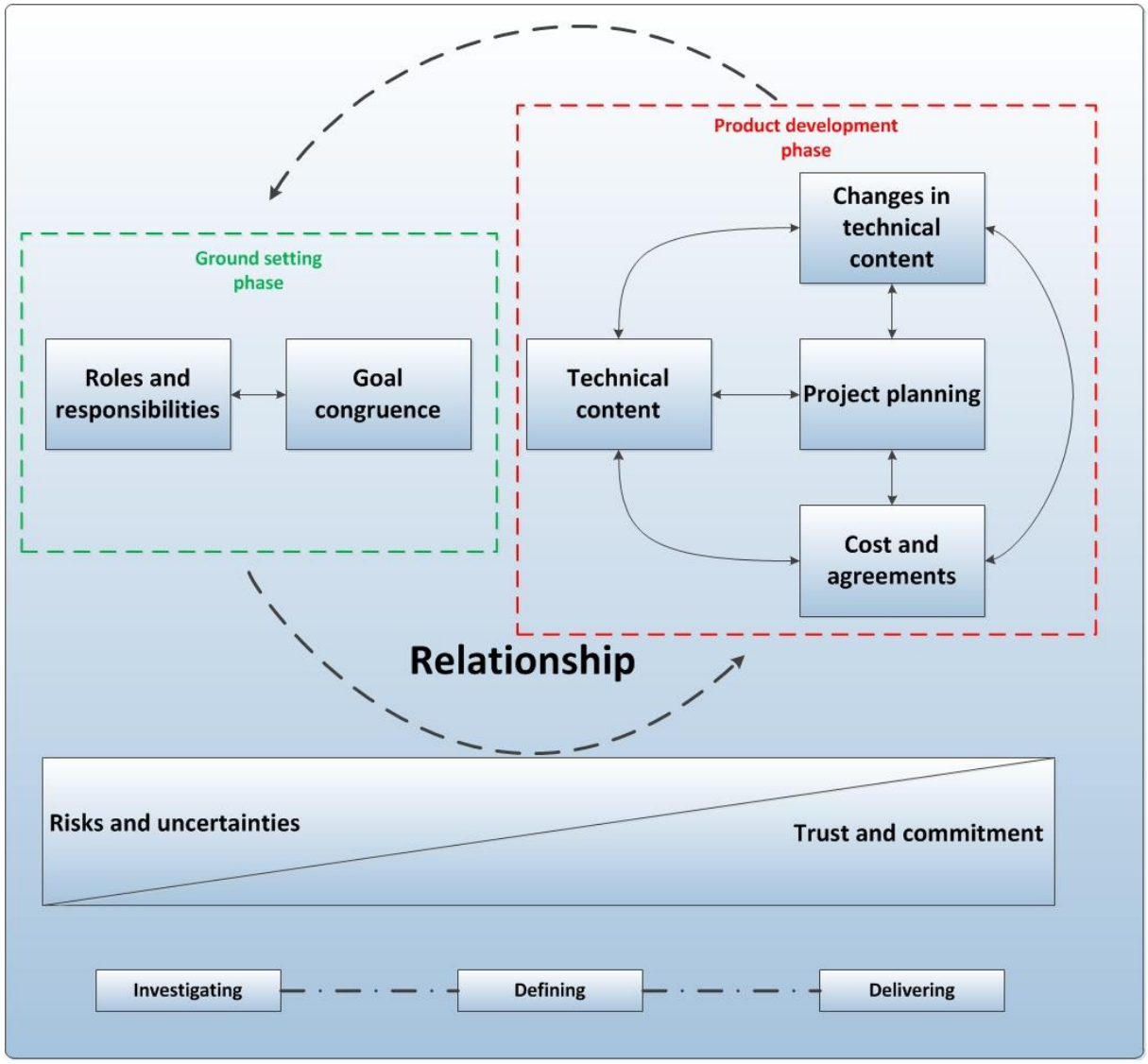

Figure 15: Model of critical information in supplier involvement product development

8 Final reflections and suggestions for further research

The model which is presented in this project is a model for SIPD. This model, clearly illustrates important elements which must be addressed and defined in SIPD projects and also the sequence in which the elements should be addressed. One important aspect which is not illustrated in the model is the concept of continuous learning. This is left for further development of the model. Continuous learning is important in order to be successful in today's fast evolving world. Therefore it is important to acquire and develop knowledge and skills frequently through continuous learning.

We want to emphasize the importance of a holistic view when working with the elements in the model. As mentioned earlier, it will not be enough to only focus improvement in one or a few elements in order to achieve better results in SIPD projects. When working with SIPD all the elements in the model are equally important.

The model has been developed through both an empirical study in Volvo and a literature review. No other companies and no suppliers have participated in the empirical data collection. This can be seen as a weakness regarding the model's potential to be generalized outside the boundaries of this research. We argue that the model has the potential to be generalized outside Volvo. In our model we define different types of activities which have to be performed, how these activities should be performed is left for the concerned organization. Future research may be to determine how these activities should be performed in the most efficient and effective way.

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