Supplier Involvement by SMEs

by

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Last but certainly not least, a big thanks to my girlfriend for her unconditional support, putting up with my quirky behavior, and of course for keeping me alive this last week by providing delicious food.

This is it then, the final words I will add to this master thesis. I cannot think of a more suitable manner to finish this journey than quoting The Hitchhiker’s Guide To The Galaxy (highly recommended reading):

‘So long and thanks for all the fish’
This research is dedicated to the involvement of suppliers in the innovation projects of SMEs. Suppliers have been widely acknowledged to be able to contribute valuable knowledge into innovation projects. However, the current supplier involvement literature has been written from the perspective of the large powerful manufacturer (Johnson, 2009). Even though SMEs might especially benefit from the involvement of supplier in their innovation project because they have limited internal resources.

In this research following research question has been investigated: how can SMEs maximally benefit from the knowledge of suppliers during an innovation project? To investigate this research question the research model as shown below was synthesized from the literature.

![Figure a, simplified research model](image)

The research framework aims at predicting the innovation performance of an innovation project by the knowledge that is shared with suppliers. Knowledge sharing with suppliers is conceptualized to originate from supplier involvement. In other words, supplier involvement is hypothesized to create the medium through which the knowledge is shared. In turn supplier involvement is hypothesized to originate for the existing relationship between the focal SME and suppliers. Lastly, the research model expects the impact of knowledge sharing on the innovation performance to be stronger in the beginning of the innovation project than in the end of the innovation project.

**Research Methodology**

To investigate the research model a survey was distributed among the members of three network organizations. This resulted in 52 valid responses, 37 of which had finished an innovation project and in 27 of these innovation projects suppliers were involved. Based on these responses the research framework was analyzed using partial least squared structural equation modeling. Moreover, a polynomial regression with surface response analysis was conducted to gain a deeper insight into the
relationship between knowledge sharing and innovation performance. The results of these analyses will be presented in the following section.

Conclusions

This research has shown that a significant number of SMEs involve suppliers in their innovation project because involvement of suppliers was necessary for the completion of the project. These suppliers might contribute specialized resources to the innovation project that complement or supplement the base of resources available within the firm. Other SMEs have reported to have involved suppliers in their innovation project for other reasons, of instance speeding up the innovation project. Both of these reasons can, and have, led to successful innovation projects. Showing that suppliers have valuable resources to contribute to the innovation projects of SMEs.

When one has decided to involve suppliers in an innovation project a pressing question is how much responsibility to give these suppliers. This research has distinguished between three types of supplier involvement that give increasingly more responsibility to the suppliers; informally consulting suppliers (i.e. white box), collaboratively working on a component or part (i.e. grey box), and the subcontracting of the development of a component, product, or part to a supplier (i.e. black box). These three types of supplier involvement are not mutually exclusive, nor are the borders between these types of supplier involvement always clear. Moreover, these different types of supplier involvement result in different kinds of knowledge sharing.

Informally consulting suppliers does not lead to a significant amount of knowledge sharing, nevertheless informally consulting with suppliers is correlated to the timely completion of the innovation project. Collaboratively working on an innovation project is correlated to explorative knowledge sharing, this is knowledge sharing that is most valuable in the longer term and maybe even outside the scope of the innovation project. Subcontracting parts of the innovation project to suppliers is strongly correlated with exploitative knowledge sharing and to lesser extend to explorative knowledge sharing. Exploitative knowledge sharing is aimed at gaining results within the scope of the innovation project. However, the recommendation of these types of supplier involvement is more nuanced. Because the different kinds of knowledge sharing have different relationships to the innovation performance, which were in this study defined as project planning, financial performance, and quality of the end product. Increasing the quality and financial performance requires equal amount of explorative and exploitative knowledge sharing, the
more the better. However, sticking to the project planning requires as little explorative knowledge sharing is possible. This creates a trade-off.

In the relationship with suppliers strong personal relationships are important (i.e. trusting and long term relationship), especially when it is desired that suppliers get more responsibility in the innovation project. Contracts have not been shown to influence supplier involvement. However, contracts might have other important functions in the relationship, for instance; showing a commitment.

Lastly, the timing of supplier involvement was not found to have a significant effect on the outcome of the knowledge sharing with suppliers in the innovation project. Therefore, concrete guidelines cannot be given and what remains is stating the obvious; managers should consider involving suppliers when they are needed. For the majority of innovation projects this will at least be the engineering and design phase of the innovation project.
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1 INTRODUCTION

This first chapter will introduce the background of the research and further outline of the thesis. Firstly, chapter 1.1 will introduce the background of the research topic; supplier involvement in the context of small or medium sized enterprises (hereinafter SMEs). Introducing collaborations during innovation projects in general and arguing why collaborations might be especially important for SMEs, followed by an introduction of suppliers as collaboration partners during innovation projects of SMEs. During this description of the research background gaps in the literature will be identified and described. Secondly, chapter 1.2 will provide a comprehensive outline of the rest of this thesis.

1.1 Research Background & Research Problem

In today’s world innovation and new product development are essential to long term business success (Brown & Eisenhardt, 1995). In addition, products and services are getting ever more complex. To deal with this increasing complexity some companies try to collaborate with other companies in new product development initiatives. Collaboration can assist in strengthening the competitive position by, for example, accessing new or critical resources or capabilities, and reduce cost and cycle time (Kale & Singh, 2009; Fliess & Becker, 2006; Handfield, Ragatz, Petersen, & Monczka, 1999). Therefore, inter-organization relationships have gained considerable popularity in the past decades. Nevertheless, literature reviews continue to find that the majority of inter-organizational relationships fail to achieve the envisioned results (e.g. Kale & Singh, 2009).

Collaboration with external parties can be especially important for SMEs. The quintessential SME has limited internal resources (Nootenboom, 1994). Due to limited internal resources, a SME can benefit considerably from external resources and capabilities (e.g. Pressey, Winkelhofer, & Tzokas, 2009; Freel, 2000). External resources might even be necessary to successfully complete the innovation project when the resources are not present within the company. Resources can be any asset or capability that a company possesses both tangible (e.g. equipment or buildings) and intangible (e.g. knowledge or management skills). Arguably the most import resource that is to be gained in today’s economy is knowledge. External knowledge is of critical importance to the innovation process (Cohen & Levinthal, 1990).

Suppliers have been widely acknowledged to be able to contribute valuable knowledge into the new product development process. Knowledge sharing with suppliers has been found to be a strong predictor of development outcome (Lawson, Petersen, Cousins, & Handfield, 2009). Research has shown that
collaborations with local and international suppliers have a strong positive effect on growth, profitability, turnover, and employment of SMEs (Robson & Bennett, 2000). Hence, companies try to leverage this potential by involving the suppliers in the new product development process (Johnson, 2009).

Nevertheless, the current supplier involvement literature has largely neglected SMEs, by focusing on large powerful manufacturers (Johnson, 2009). The way SMEs do business is significantly different from large powerful manufacturers. For instance, SMEs tend to rely more on interpersonal relationships in dealing with suppliers (Ellegaard, 2006). In recent years research on SMEs has gained recognition by academics. Despite the interest in SMEs in general, the literature on purchasing by SMEs is still limited in both purchasing and SME oriented journals (Ellegaard, 2006). The current purchasing literature “seems to be from and for larger companies” (Mumdambi & Schröder, 1996, p. 122). Johnson (2009) came to a similar conclusion after reviewing the supplier involvement literature; “most research to date has adopted the perspective of large powerful manufacturers” (Johnson, 2009, p. 195). Moreover, Mumdambi & Schüder (1996) concluded that the results of partnership-related studies conducted at larger firms are almost impossible to transfer to a SME setting. Therefore, the relevance of the supplier involvement literature for SMEs is highly questionable. Nevertheless, “SMEs stand to gain considerably from drawing on external resources such as suppliers” (Pressey, Winklhofer, & Tzokas, 2009 p. 215), a view which is shared by Ellegaard (2006).

Moreover, SMEs have been labeled as “the engine of our economy and driving force for innovation” (Rijksoverheid, 2014). Although some research has cast a doubt on this statement (CBS, 2015), SMEs are unquestionable of major importance for the health of the economy. Moreover, the positive relationship between collaborating with suppliers and, for example, SME growth combined with the lack of academic research targeted at collaborations between SMEs and their suppliers leads to an interesting research direction. Therefore, this thesis will focus on supplier involvement in the context of SMEs. Thereby, trying to bridge the gap between the perspective of a SME and the supplier involvement literature.

### 1.2 Thesis Outline

This paragraph will describe the further outline of the thesis. The next chapter will provide an overview of the theoretical background by means of a literature review. Based on the literature review four research questions will be formulated. The theoretical concepts will be incorporated into a research model, which can be found in chapter 3. From the research model four main hypotheses will be extracted. To investigate the research model a research methodology has been designed. The research design will be
presented in chapter 4. Next, chapter 5 will continue with the analysis of the data, giving a description of the used techniques and subsequent outcomes. Lastly, chapter 6 will provide a discussion of the results and present the practical implications, after which the limitations of the study will be described and directions for future research will be presented.

1.3 Conclusion

In this chapter the topic of this thesis was introduced, namely; the involvement of suppliers in the innovation projects of SMEs. It was concluded that the current supplier involvement literature holds little value for SMEs. Moreover, the argument was made that collaboration with suppliers might be especially important for SMEs because of their limited internal resources. The next chapter will delve deeper into the literature available on the topic.
2 THEORETICAL BACKGROUND

This chapter will investigate the theoretical concepts that form the foundation of this research. The investigation of the theoretical concepts is based on a literature review. The information is structured in the following manner; firstly, chapter 2.1 will describe the basic theoretical differences between SMEs and larger firms. Secondly, chapter 2.3 delves deeper into innovation by SMEs, followed by an examination of the supplier involvement literature. Thirdly, chapter 2.4 will investigate knowledge sharing. Lastly, in chapter 2.5 the research questions will be presented based on the gaps in the literature.

2.1 Difference Between SMEs and Larger Firm

First of all, SME has to be defined. The used definition in the literature for SME are ambiguous, for example, Fliess & Becker (2006) studied a ‘medium-sized’ enterprise with 1,3 billion annual turnover and approximately 4500 employees. Others, like Nieto & Santamaria (2010), define medium-sized companies as a company with between 50-200 employees. To prevent misconception the definition of the European Commission will be used, which states that a SME has less than 250 employees and annual revenue not exceeding €50 million (European Commission, 2003).

Due to the great variety of definitions used in the literature small deviations for the definition when reviewing the literature are unavoidable. Therefore, rigid appliance of this definition creates unnecessary complications, the definition will be used as a guideline and deviations from the guideline will be explicitly mentioned.

Now that SMEs are defined, the difference between SMEs and larger enterprises will be investigated. The major differences between SMEs and larger enterprises that influence innovation projects, and the role of suppliers in an innovation project, include:

- Limited internal resources (e.g. Nooteboom, 1994);
- Low formalization of the purchasing process (e.g. Pearson & Ellram, 1995);
- Close personal relationships with suppliers (e.g. Ellegaard, 2006).

Close personal relationship and low formalization of the purchasing process are relevant because these characteristics form the basis of the relationship between SMEs and their suppliers. Moreover, limited internal resources are relevant because this might influence the tendency of SMEs to involve suppliers in an innovation project. The next two sub-paragraphs will delve deeper into the above listed differences between SMEs and larger enterprises.
2.1.1 Limited Internal Resources

Numerous studies highlight that SMEs have limited internal resources (e.g. Rogers, 2004). Resources can be any asset or capability that a company possesses both tangible (e.g. equipment or buildings) and intangible (e.g. knowledge or management skills). As stated in the introduction, products and services are getting ever more complex. The limited internal resources and more complex products and services create friction. A solution for this problem could be external resources as found in some studies. “In particular, SMEs may rely more heavily on external knowledge networks as an input to innovation than do large firms” (Rogers, 2004, p. 143).

From the perspective of the resource-based view of the firm (Wernerfelt, 1984) the advantages of external resources may be resource complementation (i.e. accessing resources that are not currently accessible within the firm and can be effectively combined with resources available within the firm) or resource supplementation (i.e. getting access to more resources that are already available within the firm) (Rothwell, 1991). These possible advantages have also been identified by Freel (2000).

2.1.2 Formalization & Personal Relationships

Several researchers found that the formalization of the purchasing process in SMEs is generally low (Ellegaard, 2006; 2009; Pearson & Ellram, 1995; Pressey et al., 2009). However, this does not mean that SMEs are ‘bad’ purchasers. On the contrary, “empirical evidence suggests that small company owners perform well as purchasers” (Ellegaard, 2006, p. 280). In addition, Pearson & Ellram (1995) argue that the minimal formalization of purchasing does not imply shortage of management sophistication, Pressey et al. (2009) reported similar results. They argue that SMEs tend to invest in developing personalized informal relationships with suppliers. These personalized informal relationships might be based upon friendship among the firms’ owners or family ties (Pearson & Ellram, 1995). Ellegaard (2009) also found close trusting relationships between buyers and key suppliers. Although, these were not build upon friendship or close social interactions, instead these close trusting relationships were based upon a history of loyal and reliable exchange (Ellegaard, 2009).

The trust based interpersonal relationship between SMEs and their suppliers might also form the basis of purchasing performance. Handfield & Bechtel (2002) found that trust has a significant effect on supplier responsiveness. Supplier responsiveness was defined “as the supplier’s ability to quickly respond to the buying party’s needs” (Handfield & Bechtel, 2002, p. 367). Apart from trust, buyer dependence was also found to have a significant impact on supplier responsiveness. Although buyer dependence will probably
be low for larger suppliers of SMEs, a higher level of trust can lead to equal level of supplier responsiveness. In line with this thought Morrissey & Pittaway (2006, p.277) stated: “In the absence of power, trust offers the SME an alternative for managing interfirm relationships, especially in their relationships with suppliers”.

The antecedents explaining the close trusting relationships between buyers and their suppliers reported in the reviewed study are ambiguous. However, all articles agree that SME have close trusting relationships with suppliers. Additionally, controlling supplier performance by means of these informal relationships can be effective, even as effective as formal control measures of supplier evaluation employed by larger firms (Pearson & Ellram, 1995).

Personal relationships have also been identified as an influential factor in the alliances among SMEs. The personal network of the managing-director of the firm accounts for up to 22% of the alliances (BarNir & Smith, 2002). Additionally, Larson (1992) found personal relationships to be an important antecedent of alliances among SMEs. He argued that this is because personal relationships help to reduce uncertainty.

2.2 Innovation by SMEs

The classical Schumpeterian debate about the relation between firm size and innovative capabilities has been extensively researched on a conceptual and empirical level. Nevertheless, consensus does not appear to have been reached. A detailed review of the debate exceeds the scope of this chapter. However, some contributions have delivered results that are relevant.

Traditionally SMEs have been viewed as having better internal conditions to stimulate innovation, like rapid response to changing market conditions and flexibility (e.g. Nooteboom, 1994). The advantage of larger firms resides in their relatively strong resource position. Furthermore, large firm have economies of scale and scope allowing them to spread the fixed cost of innovation over a larger customer base, lowering the relative cost of innovation (Rogers, 2004).

The strengths of larger firms make them better equipped for innovation projects that require capital expensive equipment of large specialized project teams (Nieto & Santamaria, 2010). On the other hand, SMEs are ought to be better at small scale applications for niche markets due to the flexibility and ability to rapidly respond to market signals (Nooteboom, 1994). Additionally, SMEs have been found to be more focused on product innovation than process innovation (Verhees & Meulenberg, 2004; Nieto &
Santamaria, 2010). Verhees & Meulenberg (2004) argue that process innovations are less saleable than product innovations and therefore less attractive for SMEs.

Other research suggests that SMEs seem to be less innovative than larger firms (Nieto & Santamaria, 2010), which may result from any of the above described innovation characteristics of SMEs and larger firms. However, SMEs that engage in vertical collaborations (i.e. collaborations with customers or suppliers) gain considerably in terms of innovativeness (Nieto & Santamaria, 2010). The effects of collaborative arrangements are graphically shown for product innovation in Figure 1 and for process innovation in Figure 2. In both figures the vertical axes represents the percentage of firms that reported to have brought an innovation to the market, with innovation being a dichotomous variable (i.e. either there has or there has not been a new product or process introduction). The horizontal axis represents the time.

Figure 1, percentage of firms introducing product innovation (Nieto & Santamaria, 2010)

Figure 2, percentage of firms introducing process innovation (Nieto & Santamaria, 2010)

The definitions for small, medium and large firms used in Figure 1 and Figure 2 are slightly different from the definition presented in chapter 2.1. In Figure 1 and Figure 2 large firms are firms with more than 200 employees, compared to 250 as defined in chapter 2.1. It is unlikely that this difference in definition will significantly change the conclusion made based on the results.
The results of the study by Nieto & Santamaría (2010) clearly show that large firms perform more product and process innovations than SMEs when considering the whole sample. However, when only considering vertically collaborating firms, SMEs have almost the same level of product innovation as large companies. Process innovations are still dominated by large firms, nevertheless vertically collaborating SMEs perform significantly more process innovations than SMEs that do not engage in vertical collaborations.

Nieto & Santamaría (2010) did not differentiate between collaboration with suppliers or customers, i.e. the level of detail was vertical collaborations. Freel (2000) separated vertical collaboration into collaborative agreements with customers and suppliers. He also concluded that vertical collaborations were undertaken significantly more by innovators than non-innovators. More specifically, “new product development/improvement” with suppliers was undertaken significantly more by innovators than by non-innovators. In line with this reasoning both Arend (2006) and Minguela-Rata, Fernández-Menéndez, & Fossas-Ollalla (2014) also found that collaboration with suppliers are beneficial for SMEs.

The section above paints a promising picture for the collaboration between SMEs and their suppliers. However, two important side notes have to be made. Firstly, the studies only investigated the relationship between introducing a new product or process and not introducing a new product or process in relation to vertical collaborations. The effect of the innovation performance was not examined.

Secondly, in the study of Nieto & Santamaría (2010) only one in eight small and one out of three medium sized firms seem to engage in vertical collaborations. Other studies, like Freel (2000), show similar results. This finding seems counterintuitive, on the one hand vertical collaboration greatly improves innovativeness and on the other hand only a small portion of SMEs engage in vertical collaborations. Possible explanation for this irregularity might be difficulty of reaching a technological agreement (Nieto & Santamaría, 2010). Furthermore, collaboration may imply exposure to considerable risk. Capturing the advantages of supplier involvement may require sharing sensitive information about internal processes or cost buildup. This may reduce future bargaining power over the supplier and create an exposure to opportunistic behavior of the supplier (Jap, 1999). In addition, suppliers might use this information in their relationship with a competitor.

### 2.3 Supplier Involvement

The definition of supplier involvement varies among studies. In this examination of literature the definition of supplier involvement by Van Echtelt, Wynstra, Van Weele, & Duysters (2008, p. 182) will be used: “Supplier involvement refers to the resources (capabilities, investments, information, knowledge,
ideas) that suppliers provide, the tasks they carry out and the responsibilities they assume regarding the development of a part, process or service for the benefit of a buyer's current or future product development projects”.

Supplier involvement literature has been written from the perspective of a large powerful manufacturer (Johnson, 2009). In paragraph 2.1 the conclusion was drawn that SMEs are distinctively different from their larger counterparts. Therefore a comprehensive overview of the supplier involvement literature does not align with the scope of this thesis. Nevertheless some aspects of the literature are relevant to SMEs. This chapter will present a method of describing different gradations of supplier involvement, irrespective of firm size. This can be done by describing two factors of supplier involvement: the responsibility given to the supplier and the timing of the involvement of the supplier (Wynstra, 1998). Subsequently, the governance mechanisms for inter-organizational relationships will be described.

The subjects in this subchapter will first be viewed from the perspective of the supplier involvement literature, after which the position of the SME is taken.

2.3.1 Describing Supplier Involvement

The first factor in describing supplier involvement, degree of development responsibility, may vary between none until the complete development of a part or module. The extent to which a supplier is involved may largely be based on the knowledge and capabilities of the supplier relative to the knowledge and capabilities of the buyer. The bigger the ‘gap’ between the knowledge and capabilities of the supplier and buyer the greater the contribution of the supplier can be, and therefore the higher the possible development responsibility (Wynstra, 1998).

Fliess & Becker (2006) use a term similar to development responsibility, namely cooperation intensity. Although, cooperation intensity can increase without the supplier getting more development responsibility. This could happen through, for instance, a new product which cannot be separated into modules, increasing the interfaces between the two (or more) developing parties, i.e. the different parts and/or modules are inextricably intertwined. The term cooperation intensity captures the need to cooperate because of development tasks as well as coordination tasks.

The model by Petersen, Handfield, & Ragatz (2005), as shown in Figure 3, does not explicitly take coordination tasks into account, making the model less comprehensive than the model of Fliess & Becker (2006). However, the model by Petersen et al. (2005) does provide a more clear distinction between
different types of supplier involvement compared to the model of Fliess & Becker (2006) because of the more simplistic representation. Moreover, there are existing measurement tools available for the model by Petersen et al. (2005) (e.g., Koufteros, Cheng, & Lai, 2007). Therefore, the model by Petersen et al. (2005) is adopted in this research.

<table>
<thead>
<tr>
<th>None</th>
<th>“White Box”</th>
<th>“Grey Box”</th>
<th>“Black Box”</th>
</tr>
</thead>
<tbody>
<tr>
<td>No supplier involvement</td>
<td>Informal supplier integration.</td>
<td>Formalized supplier integration.</td>
<td>Design is primarily supplier</td>
</tr>
<tr>
<td></td>
<td>Buyer “consults” with supplier</td>
<td>Joint development activity</td>
<td>driven, based on buyer’s</td>
</tr>
<tr>
<td></td>
<td>on buyers design.</td>
<td>between buyer and supplier.</td>
<td>performance specification.</td>
</tr>
</tbody>
</table>

Increasing Supplier Responsibility

Figure 3, types of supplier involvement by Petersen, Handfield, & Ragatz (2005)

The second factor to describe supplier involvement, timing of the supplier involvement, refers to the point at which the supplier is involved in the new product development process. Handfield, Ragatz, Petersen, & Monczka (1999) stated that supplier integration is possible at any point during a ‘generic’ five step new product development process, resulting in Figure 4. The five steps are interdependent and may overlap with each other. Furthermore, some phases might have to be iterated because of changes to the plan or design. Other authors used slightly different models, for instance, Fliess & Becker (2006) used a four step model. However, the basic idea remains the same throughout the supplier involvement literature: new product development is conceptualized as a linear process with a number of steps which result in a final product/process/service when completed.

Figure 4, five step new product development process, by Handfield et al. (1999)
As argued above, supplier integration into the new product development process is possible during any stage of the new product development process. This does not answer the question on when a company should involve the supplier into an innovation project. The relevance of this question is illustrated by Figure 5, showing that the degrees of freedom for specification and purchasing are higher early in the new product development process. As the process progresses the degrees of freedom for purchasing diminishes while the cost of engineering changes rises (Van Weele, 2009). Additionally, Petersen et al. (2005) pointed out that the future supply chain is, implicitly or explicitly, designed early in the new product development process. Consequentially, the early stages of the development process have a relatively big impact on the future cost build-up.

![Figure 5, the effect of time on the freedom of specification by Van Weele (2009)](image)

Nevertheless, the empirical results on when to involve suppliers in an innovation project are ambiguous, for instance McGinnis & Vallopra (1999) argued that not the earliest involvement of suppliers is important but rather the involvement of supplier “in the process when they are needed” (McGinnis & Vallopra, 1999, p. 14). Moreover, Primo & Amundson (2002) found mixed support for the early involvement of suppliers in innovation project.

When investigating small companies, Ellegaard (2009) found that suppliers were consulted when major design decision had already been made. Therefore, the validity of the results, for example McGinnis & Vallopra (1999), for SMEs is questionable. Furthermore, the sample investigated by Ellegaard (2009) contained only 11 small firms. Hence, the literature does not provide guidance to SMEs on when to involve supplier in the innovation process. Nevertheless, it can be concluded that effective timing of supplier involvement impacts the innovation process.
2.3.2 Governance of Supplier Involvement

Chapter 2.2 mentioned that supplier involvement implies risk. Companies try to mitigate this risk by the use of governance mechanisms. Most authors distinguish between two types of governance mechanisms, namely: formal and informal control mechanisms (Dekker, 2004). The goal of these governance mechanisms is to create conditions to motivate buyer and seller to achieve mutually desirable goals (Dekker, 2004).

“Formal control consists of contractual obligations and formal organizational mechanisms for cooperation” (Dekker, 2004, p. 31). Informal control, also known as social control or relational governance (Dekker, 2004), refers to the development of shared values, beliefs, and goals between buyer and supplier (Das & Teng, 2001). Informal control is a self-enforcing, trust based, mechanism (Poppo & Zenger, 2002).

Trust is a complex concept which has been interpreted differently by scholars, and consensus on a definition has not yet been reached (Das & Teng, 1998; 2001). Some studies interpret trust as a construct with a single dimension (e.g. Weaver & Dickson, 1998). Others, for instance, Das & Teng (2001), view trust as a multidimensional construct. The multidimensional interpretation also has different schools of thought. This thesis has used the definition of trust that has been applied in the study of inter-organizational relationships by for instance Dekker (2004) and Das & Teng (2001). These scholars make a distinction between goodwill trust and capability trust, the latter is also known as competence trust. “Goodwill trust is the expectation that another will perform in the interests of the relationship, even if it is not in the other’s interest to do so, and essentially relates to not behaving opportunistically” (Dekker, 2004, p. 32). Competence trust is the expectation of a satisfactory technical performance by the other party (Das & Teng, 2001; Dekker, 2004).

Larson (1992) found that SMEs rarely use contracts (i.e. formal control) in a dyadic relation, the companies that maintained a contract uniformly did not perceive the contract as relevant. Chapter 2.1.2 found that SMEs maintain close personal relationships with suppliers (i.e. informal control). Weaver & Dickson (1998) argue that SMEs tendency to stay away from formal contracts originates from the origin of the relationship, companies do not want do convey distrust in the other party. Nevertheless, contracts are used in the relationship between SMEs, notwithstanding that the value of these contracts remains dubious.
2.4 Knowledge Sharing

To reap the benefits of supplier involvement in an innovation project, sharing knowledge is inevitable (Lawson, Petersen, Cousins, & Handfield, 2009), because knowledge is an essential ingredient for innovation (Cohen & Levinthal, 1990). Moreover, the knowledge that can be gained in a collaborative effort with suppliers might be unavailable through traditional market–transaction mechanisms (Lawson et al., 2009). Authors often distinguish between intra- and inter-organizational knowledge sharing. Since knowledge sharing with suppliers is by definition inter-organizational any mention of, or reference to, knowledge sharing should be interpreted as inter-organizational knowledge sharing.

Different types of knowledge sharing have been investigated in previous research. Some authors, for example Im & Rai (2008), distinguish between explorative and exploitative knowledge sharing. In which exploitative knowledge is aimed at refining existing knowledge, through which short-term goals can be attained. The explorative knowledge sharing is directed towards new knowledge and opportunities.

Van Wijk et al. (2008) performed a meta-analytic review of the antecedents and consequences of knowledge sharing. They concluded that knowledge sharing is positively correlated with both innovativeness and performance (Van Wijk et al., 2008). Furthermore, trust and tie-strength were found to be significant antecedents of knowledge sharing.

Trust was in chapter 2.1.2 found to be the foundation of the buyer-supplier relationship in SMEs. Moreover, tie-strength is expected to be high since the relationship between buyer and key supplier was described as ‘close interpersonal relationships’. These antecedents give a positive expectation for knowledge sharing between SMEs and their suppliers.

2.5 Research Objective

In the prior paragraphs the literature concerning supplier involvement in the context of SMEs has been reviewed. The previous paragraphs concluded that the current supplier involvement literature does not provide valuable guidance to SMEs. It was concluded that the current supplier involvement literature has been focused on the perspective of the large powerful manufacturer, effectively ignoring the perspective of SMEs. Nevertheless, SMEs might benefit considerably from knowledge sharing with suppliers. This is highlighted by for instance the study of Nieto & Santamaria (2010), which shows that vertically collaborting SMEs are more likely to introduce new product and process innovations.
To investigate the relationship between knowledge sharing with suppliers and innovation performance of SMEs the following research question has been formulated:

*How can SMEs maximally benefit from the knowledge of suppliers during an innovation project?*

Investigating this research question might be the onset of the closing of the gap between the current supplier involvement literature and the perspective of SMEs. To provide an informed answer to the research question and contribute to the literature five sub-research questions have been formulated.

The first sub-research question is elemental in nature but the literature does not provide a satisfying answer to what extent and what the timing of the involvement is, raising the following sub-question:

*How and when do SMEs involve suppliers in their innovation projects?*

Nieto & Santamaria (2010) showed that vertically collaborating SMEs are more likely to introduce project and process innovations, as shown in chapter 2.2. The innovation performance (i.e. quality, date of completion, budget, and profit margin of the final product) of the innovation projects have not been examined. Therefore, the effect of supplier involvement on the innovation performance of SMEs is unclear, leading to the second sub-research question:

*Does involving suppliers in the innovation project of an SME result in better innovation performance?*

Previous research has highlighted that trust and personal relationships form the foundation of the relationship between SMEs and their suppliers, as described in chapter 2.1.2. Formal contracts were found to only play a marginal role. Nevertheless, it remains unclear to what extent these findings can be extrapolated to the context of supplier involvement, giving rise the third sub-research question:

*What is the effect of the existing relationship characteristics trust, age of relationship and contractual specificity on supplier involvement by SMEs?*

The different kinds of supplier involvement, uncovered in chapter 2.3.1, result in different modes of collaboration between buyer and supplier. While practicing white box supplier involvement suppliers are informally asked for advice, during black box supplier involvement suppliers independently design and/or construct a component or product. The relation between the different types of supplier involvement and knowledge sharing has not been investigated in the current literature, resulting in the following sub-research question:
What is the effect of involving suppliers during an innovation project on knowledge sharing between buyer and supplier?

The fifth and final sub-research question concerns the relationship between knowledge sharing and innovation performance. Earlier research by Lawson et al. (2009) found a positive correlation between knowledge sharing and project outcome in inter-organizational product development teams. It is unclear to what extent these results can be applied to SMEs involving supplier in their project. Resulting in the following sub-research question:

What is the effect of knowledge sharing with suppliers on the innovation performance of SMEs?

2.6 Conclusion

This chapter started out by a literature investigation about the differences between SMEs and larger firms when considering supplier involvement. Thereby it was uncovered that SMEs seem to have limited internal resources, low formalization of the purchasing process, and close personal relationships with suppliers. Moreover, the differences in innovativeness between firms that are involved in vertical collaboration and firms that do not was examined. Followed by a short overview of the supplier involvement literature that could be applied to SMEs. Describing among other things a method to describe supplier innovation. Lastly, the research objective was stated, which is based upon the shortcomings of the current literature.

The upcoming chapter will be devoted to the description of the research framework based upon the concepts that have been described in this chapter.
3 RESEARCH MODEL AND HYPOTHESIS

This chapter is dedicated to the description of the research model and the development of the accompanying hypothesis. This chapter will be structured in the following manner; first, the unit of analysis will be determined. Subsequently, a basic model of the research framework will be presented. This basic research framework will then be extended by several hypothesis leading to the research framework.

3.1 Unit of Analysis

The phenomenon of supplier involvement can be studied from different perspectives. For instance Koufteros et al. (2007) investigated the performance of the entire company in relation to supplier involvement. Others, like for example Van Echtelt et al. (2008), have investigated the success factors of supplier involvement from a project level perspective.

In this research the unit of analysis will be the innovation project. In this study an innovation project has been defined as; a project in which a new product, solution or process was developed or applied. This definition was chosen in consultation with the leaders of the selected network organizations that were surveyed (also see chapter 4). The reasoning behind the choice to use an innovation project as unit of analysis is that this will not only result in a contribution to the literature but also deliver some guidance to SMEs, this might help to increase the willingness of entrepreneurs to participate in the study.

3.2 Basic Research Framework

The research framework is grounded in the resource-based view of the firm (hereinafter RBV) (e.g. Barney, 1991). RBV perceives a firm as a bundle of resources which is comprised of all assets and capabilities that a company possesses, both tangible (e.g. equipment or buildings) and intangible (e.g. knowledge or management skills). These resources can lead to a sustainable competitive advantage when the resources are; rare, imperfectly imitable, and non substitutable (Barney, 1991).
The research framework aims at predicting the innovation performance of an innovation project by the knowledge that is shared with suppliers. Through knowledge sharing with suppliers new combinations of knowledge emerge which are valuable and imperfectly imitable by competitors. Hence, this is a competitive advantage that will result in superior innovation performance. Knowledge sharing with suppliers is conceptualized to originate from supplier involvement. In other words, supplier involvement is hypothesized to create the medium through which the knowledge is shared. Eisenhardt & Schoonhoven (1996) extended the RBV to the realm of alliance formation, arguing among other things that alliances can be formed from a social opportunity. Supplier involvement can be seen as a specific type of alliance, and therefore these findings can also be applied to supplier involvement. From this reasoning it can be stated that the relationship with suppliers is the antecedent of supplier involvement.

Lastly, the impact a resource (i.e. knowledge) is hypothesized to be bigger in the beginning of the innovation project than in the end of the innovation project for two reasons. The first reason being that the potential impact of a resource is bigger in the beginning of an innovation project since the resource does not have to be aligned with many other resources. The second reason is that there is more time to fully utilize the resource when the resource is available in the beginning of the innovation project.

### 3.3 Hypothesis development

In the previous paragraph the rough outlining of the basic research model was created. This paragraph will build upon and refine this basic framework, starting with the relation between buyer and supplier. Chapter 2.1.2 found that SMEs maintain strong personal relationships with suppliers. These relationships rarely relied on formal contracts, if there was a contract in place at all. Trust was found to be the foundation of the relationship between SMEs and their suppliers. Moreover, trust was found to increase supplier responsiveness (Handfield & Bechtel, 2002), an effective governance mechanism (Morrissey & Pittaway, 2006), and might help to mitigate risk (Larson, 1992). However, trust was also found to be a complicated construct that has different interpretations among different scholars. In line with chapter
2.3.2 trust will be conceptualized as a multidimensional construct consisting of goodwill trust and competence trust.

Supplier involvement was defined in chapter 2.3.1. Additionally, it was argued that supplier involvement can be described by two factors, namely; timing and type of supplier involvement (Wynstra, 1998). Four different types of supplier involvement were identified (in order of the suppliers responsibility); none, white box, grey box, and black box supplier involvement, as was graphically shown in Figure 3.

Extending the line of thought, that trust forms the foundation of the relationship between SMEs and their suppliers and strategic alliances emerge from social opportunities; one would expect that more supplier responsibility would require a higher level of trust between the involved parties. In other words, the first hypothesis is:

H1a. More goodwill trust and capability trust, from the buyer in the supplier, will lead to more development responsibility for the supplier.

Apart from trust, a history of exchange was found to be an important aspect in the relationship between SMEs and their suppliers. Leading to the sub-hypothesis two:

H1b. The duration of the relationship with suppliers leads to more development responsibility for the supplier.

Next to the ‘softer’ factors in a relationship between SMEs and suppliers, contracts may be in place. However, in chapter 2.1.2 it was concluded that SMEs do not often use formal contracts in their relationship with suppliers. Contracts might function as a measure to avert some part of the risks when suppliers get more development responsibility. This leads to the following hypothesis:

H1c: Contractual specificity increases as the development responsibilities of suppliers increase.

The seminal article on learning by Cohen & Levinthal (1990, p. 128) opens with: “Outside sources of knowledge are often critical to the innovation process”. In line with this statement, Lawson et al. (2009) found that knowledge sharing with suppliers has a significant positive impact on the development performance in new product development. However, knowledge sharing does not happen automatically. In this thesis it is hypothesized that knowledge sharing originates from involving suppliers in the innovation project.
Chapter 2.4 defined two distinctively different types of knowledge sharing. Exploitative knowledge sharing aimed at short term gain and explorative knowledge sharing aimed at longer-term business development (Im & Rai, 2008). This thesis will apply this multidimensional view on knowledge sharing to be able to differentiate between knowledge sharing aimed at short- and longer term gains.

All three forms of supplier involvement are hypothesized to positively influence knowledge sharing. However, white box supplier involvement (i.e. consultation of buyer with the supplier) is conceptualized not to have an effect on explorative knowledge sharing since this is expected not to be the goal of the consultations. Hence, the following hypotheses were posited:

H2a. White box supplier involvement has a positive impact on exploitative knowledge sharing and no impact on explorative knowledge sharing.
H2b. Grey box supplier involvement has a positive impact on exploitative and explorative knowledge sharing.
H2c. Black box supplier involvement has a positive impact on both exploitative and explorative knowledge sharing.

The meta-analytic study by Van Wijk et al. (2008) found strong evidence that knowledge sharing has a positive impact on both performance and innovativeness in various situations. Moreover, as mentioned on the previous page, Lawson et al. (2009) found a significant positive impact of knowledge sharing with suppliers on the development performance. Therefore, it is expected that knowledge sharing has a positive impact on the innovation performance. Innovation performance refers to the profit margin, development budget, completion date and resulting quality of the innovation project.

Since exploitative knowledge sharing is aimed at short term gain it can be expected to have a positive impact on the innovation performance. Explorative knowledge sharing, on the other hand, might lead to higher levels of innovativeness overall but the benefits on the innovation performance of the innovation project in which the supplier is involved is not self-explanatory. Explorative knowledge sharing is aimed at long term business performance. Hence, it can be expected that explorative knowledge sharing has no significant effect on the innovation performance on shorter term (the scope of a specific innovation project). Thus, the following hypotheses were posited:

H3a. Exploitative knowledge sharing has a positive impact on the innovation performance.

H3b. Explorative knowledge sharing has no effect on the innovation performance.
3.4 Moderating effect

The second factor describing supplier involvement, timing of the supplier involvement has been discussed in chapter 2.3.1. The degrees of freedom for specification and purchasing were found to be higher early in the new product development process (graphically shown in Figure 5). Moreover, the cost associated to engineering changes are relatively small in the beginning of an innovation project. Therefore, it is expected that the relationship between exploitative knowledge sharing and innovation performance is bigger if it happens earlier in the innovation project. Leading to the following hypothesis.

H4. The phase of supplier involvement positively mediates the effect between exploitative knowledge sharing and innovation performance.

3.5 Research Framework

Combining the hypotheses with the earlier presented basic research framework results in the research framework as shown below in Figure 7.

Figure 7, research framework

3.6 Conclusion

In this chapter the examined literature of chapter 2 and the perspective of the resource based view of the firm have been combined to create the research framework. The next chapter will describe the method by which the research model will be analyzed.
4 RESEARCH DESIGN

This chapter will elaborate on the used research method. In this research qualitative and quantitative research methods have been combined in an effort to achieve academic rigor while maintaining practical relevance. The qualitative part of the research consisted of two interviews. The quantitative part of the research was a survey. The research methodology can be schematically depicted as shown in Figure 8 below.

![Figure 8, schematic diagram of the research design](image)

In the next paragraph the interviews will be described. Thereafter the survey design and data collection will be presented.

4.1 Interviews

The goal of the interviews was to refine the knowledge of the researcher and informally evaluate if the concepts that were reviewed in the literature, and form the foundation of the research model, can be observed in practice. Moreover, this practical experience should lead to a more SME specific questionnaire.

Interviews were conducted with the managing directors of two SMEs. The managing directors of the companies were asked for the interview because they are probably the most well informed person within the company. Moreover, the managing director of a SME play a central role in alliances with other companies (BarNir & Smith, 2002).

Both interviews were in-depth semi-structured interviews that took approximately one hour each. The interviews were held at the site of the respective companies and started with some general questions to provide some company background. Thereafter, the chorological walkthrough of one innovation project was asked. The structure that was used during the interview has been added as appendix A.

4.2 Survey design

The questionnaire was developed to measure the constructs of the research framework. For the measurement of these constructs mostly multi-item scales were used. Whenever possible the measurement scales were based upon existing empirical studies, thereby increasing construct validity.
Hair, Black, Babin, & Anderson, 2010). Appendix B provides a comprehensive overview of the used measurement scales and the origin of the measurement scales.

The measurement scales that were identified in the literature used both 5-point and 7-point Likert scales. There was no coherent explanation given for the use of either type of scale. For ease of completion and uniform appearance the use of a single scale in the questionnaire is desirable. Research has found that the use of 5- or 7-point Likert scale does not result in different data characteristics (Dawes, 2008). The representatives of the surveyed organizations perceived a 5-point Likert scale as faster to complete. Therefore, this research adopted a 5-point Likert scale, ranging from 1 strongly disagree to 5 strongly agree.

Furthermore, three actions were taken to increase comprehensibility of the questions and reduce the time it takes to complete the survey. First, the questions have all been translated to Dutch to ensure that the respondents fully comprehend the questions and can complete the survey in their native language. Secondly, the questionnaire has been reviewed by the leaders of the respective network-organizations to ensure that the questions are relatable to the respondents. Based on these reviews changes were made to the questions, none of which changed the nature of the questions. Moreover, the number of questions for some measurements was reduced because the questions were perceived as ‘too similar’ by the reviewer. Thirdly, the final questions were reviewed by an experienced researcher. The final questionnaire has been added to this thesis as Appendix E.

4.2.1 Data collection

The research framework that emerged from the literature consists of fourteen constructs. To accurately analyze the framework a dataset of at least 100 respondents is desirable. A great deal of sustained effort has been devoted to finding and convincing network organizations to participate in the research. In total the survey has been send out to 319 potential respondents. The approach of the respondents was carried out with the aid of three network organizations, Inka Inkoopcombinatie, Vereniging Metalen Ramen en Gevelcontracties, and the Biotech Systems Platform. Inka Inkoopcombinatie is a collection nineteen fitting contractors of which 14 completed the survey resulting in a response rate of 73%. Furthermore, the Vereniging Metalen Ramen en Gevelconstructies (VMRG) members were requested to complete the survey. The VMRG is a collective of 220 Dutch façade contractors, 29 completed surveys were received resulting in a response rate of 13%. Lastly, the members of the Biotech Systems Platform were invited to complete the survey. The Biotech Systems Platform is devoted to bridging the gap between the biotech
and the high tech sector in The Netherlands and encompasses 80 companies of which 10 completed the survey resulting in a response rate of approximately 13%.

The survey was distributed by e-mail using Google Forms and participation was on a voluntary basis. 10 days after the survey was distributed all potential respondents received a reminder with a link to the questionnaire. In total 53 completed questionnaires have been received resulting in an overall response rate of 16.6%.

4.3 Outliers and missing data

This paragraph will first describe the methods used to identify possible outliers. Secondly, the analysis of the missing data will be described. Additionally, all transformations of the data based on the analysis of the possible outliers and missing data are reported.

To identify potential univariate outliers two methods were utilized. Initially, the descriptive statistics of the variables were inspected, followed by a visual inspection of the boxplots of the individual variables that were created. The descriptive statistics and the boxplots of the turnover showed five potential outliers. Three of which were, most likely, data entry errors in which the annual turnover was entered in euro’s instead of millions of euro’s. These three data entries were deleted but the rest of the data from the case was retained. The remaining two potential outliers do not exceed the limit of the definition of a SME that was adopted in chapter 2.1 and are therefore not removed from the dataset. Furthermore, some other variables showed potential outliers in the boxplots. However, these are all valid data entries and after close inspection there is no reason to delete these cases, there for all other data is retained.

To investigate possible bivariate outliers scatterplots were created and visually analyzed, identifying one outlier. The outlier had more fulltime employees working on innovation than it reported to have fulltime employees. Based on this finding both the number of employees and the number of employees working on innovation were removed. Visual inspection of the other scatterplots did not provide suspicions of further bivariate outliers.

The missing data was first investigated per variable followed by an investigation per case. When investigating the missing data per variable the turnover of the company showed 14 missing values. A likely explanation for this high number of missing values is that turnover is considered confidential information. The variable turnover is therefore rejected from further analysis. The number of employees
will function as a measure of company size. No further variables showed an amount of missing data that exceeded 5% (i.e. more than two missing cases).

When analyzing the cases for missing values one case showed 24 missing values. Conforming to the rules of thumb by Hair et al. (2009) regarding missing data, the case was deleted. The deletion of the case is justified because deleting this case reduces the number of missing values to a large extent. Moreover, when data is missing from the dependent variables the case is typically deleted to avoid any artificial increase in the relationship with independent variables (Hair et al., 2009).

To investigate the randomness of the remaining missing data a Little’s MCAR test was performed, which was found to be non-significant (p > 0.05). Thus, the cases with missing values cannot be distinguished from the cases that have no missing data and thus are truly randomly missing values. Because the sample size is already limited the choice was made to impute values for the missing data. The imputation was performed using the expectation-maximization function in the SPSS module Missing Values. This method was chosen because it delivers nearly unbiased estimates of means, even if the assumption of multivariate normality is broken (Howell, 2007).

### 4.4 Normality assumption

The small sample size raises concerns if the normality assumption can be upheld. Hence, all variables were subjected to the Shapiro-Wilk test. The Shapiro-Wilk test was significant for almost all variables, concluding that almost all variables significantly differ from the normal distribution. Hence, the normality assumption is broken and further statistical tests should be suitable for non-normal data.

### 4.5 Sample characteristics

Firstly, a Kruskal-Wallis test was performed to inspect if the data of the different overarching organizations are statistically different from each other. The Kruskal-Wallis test is the nonparametric equivalent of the one-way independent ANOVA (Field, 2009). None of the variables tested statistically significant at the 0.05 level. Thus, the data from the different network organizations are not statistically different from one another and will therefore be analyzed as one dataset.

The respondents of the questionnaire mostly indicated to be managing director of the firm, namely 45 of the respondents (84%). The remaining 8 respondents consisted of three innovation managers (6%), two project managers (4%), two project engineers (4%), and one technical manager (2%). The sizes of the respective companies are shown in the table below
Of the 52 valid surveys that were received, 37 of the respondents indicated to have completed an innovation project (approximately 71.7%). Since this thesis is focused on innovation the analysis from this point onward will be based on the respondents that have reported to have completed an innovation project. Suppliers were involved in 27 of the 37 innovation projects. Table 2 & Table 3 below give an impression of the phase of involvement and type of supplier involvement, the categories in both timing and type of supplier involvement are not mutually exclusive.

### Table 2, type of supplier involvement reported by the respondents

<table>
<thead>
<tr>
<th>Type of involvement</th>
<th>Num.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White box supplier involvement</td>
<td>20</td>
</tr>
<tr>
<td>Grey box supplier involvement</td>
<td>18</td>
</tr>
<tr>
<td>Black box supplier involvement</td>
<td>9</td>
</tr>
</tbody>
</table>

### Table 3, timing of supplier involvement reported by the respondents

<table>
<thead>
<tr>
<th>Timing of supplier involvement</th>
<th>Num.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea generation</td>
<td>5</td>
</tr>
<tr>
<td>Business and technical evaluation</td>
<td>7</td>
</tr>
<tr>
<td>Engineering &amp; design</td>
<td>22</td>
</tr>
<tr>
<td>Prototype built, test and pilot</td>
<td>7</td>
</tr>
<tr>
<td>Project execution (production)</td>
<td>6</td>
</tr>
</tbody>
</table>

### 4.6 Method of evaluation research framework

To test the hypotheses the data was analyzed with the Partial Least Squares Structural Equation Modeling method (hereinafter PLS-SEM) using the SmartPLS 3.2.0 statistical software package (latest release at the time of writing). The reasoning behind for PLS-SEM choice is that “PLS-SEM is suitable for applications where strong assumptions cannot be fully met” (Hair, Sarstedt, Ringle, & Mena, 2012, p. 416). Furthermore, PLS-SEM is good method for theory development and explanation of variance (Hair, Hult, Ringle, & Sarstedt, 2014). Moreover, PLS-SEM requires a relatively small sample size, as is the case in the presented study.

To run the model the software settings suggested by Hair et al. (2012) will be used, resulting in the following settings:
- Uniform value of 1 was given for each of the outer weights
- Path weighting scheme
- Stop criterion was set to $10^{-5}$, with a maximum of 300 iterations

Significance was determined by a bootstrapping procedure. The suggestions of Hair et al. (2012) were also applied to this procedure, resulting in a bootstrapping procedure with 5,000 bootstrap samples in which individual sign changes were allowed.

The analysis of the research framework with SmartPLS was conducted using the 27 innovation projects in which suppliers were involved since the required data is only available for these cases.

4.7 Conclusion

This chapter has provided insight into the design of the research. Moreover, the used survey and sample were described. Despite a sustained effort the sample size was found to be smaller than desired. The next chapter will be devoted to the actual analysis of the research framework.
5 ANALYSIS

This chapter will describe the analysis of the data, starting with a description of the modeling of the research framework in SmartPLS. Followed by a description of the validity and reliability, specifically investigating the measurement model and providing a correlation matrix. Next, a comparison of the innovation performance between innovation projects in which supplier were involved and innovation projects in which suppliers were not involved will be presented. Finally, the analysis of the research model will be described, evaluating the hypotheses that have been described in chapter 3. Lastly, a polynomial regression with surface response analysis will be presented, this advance statistical procedure was used to gain a deeper understanding of the effects of knowledge sharing on the innovation performance.

5.1 Modeling

The research model, as presented in chapter 3, was inserted into SmartPLS. Apart from exploitative and exploratory knowledge sharing, all indicators were modeled reflectively. The two types of knowledge sharing were modeled formatively for two reasons. Reason number one; a confirmatory tetrad analysis (Gudergan, Ringle, Wende, & Will, 2008) was performed in which the null hypothesis was rejected for exploratory and exploitative knowledge sharing as well as for trust. This data driven method of determining the measurement model has to be supplemented with theoretical considerations (Hair et al., 2014). Reason number two; the measurement items of knowledge sharing were consequential in nature and should therefore be modeled as formative indicators (Rossiter, 2002). The results of the confirmatory tetrad analysis in combination with the theoretical consideration led to the decision to model the indicators for both explorative as exploitative knowledge sharing as formative. No theoretical foundation was found that supported the confirmatory tetrad analysis to model the indicators of trust formatively. Therefore the indicators of trust were modeled reflectively.

5.2 Validity and reliability

A robust confirmatory factor analysis requires normally distributed data and a larger sample size than obtained in this research. Therefore, the measurement model is evaluated with PLS-SEM. A summary of the evaluation is provided below, the outer loadings of the final measurement model can be found in Appendix C on page 58.
5.2.1 Measurement model

The measurement model was tested against the criteria summarized by Hair et al. (2012). To ensure convergent validity a factor loading cut-off of 0.7 for reflective indicators, 0.5 for formative indicators, and an AVE cut-off of 0.5 were upheld. Based on the factor loading criteria one goodwill trust indicator was deleted (loading: 0.490). A possible explanation for the poor factor loading of the indicator is that it was a reverse measurement and might therefore have been misinterpreted by some of the respondents. Moreover, one explorative knowledge sharing indicator had a loading of 0.488, which was found to be insignificant. Combining these facts leads to the deletion of the indicator (Hair et al., 2014).

After deletion of the goodwill trust indicator, one goodwill trust indicator still showed an insufficient factor loading. At the same time a high cross-loading with competence trust was observed. Providing substantial doubt about the discriminant validity between goodwill trust and capability trust. Therefore, trust was modeled as a second order structure. Capability trust and goodwill trust combined explain the higher order construct trust. Because trust is a more general factor a reflective-reflective modeling with repeated indicators approach is adopted, as recommended by Hair et al. (2014). This second order structure helps to overcome the concerns of discriminant validity (Hair et al., 2014). Moreover, the new structure met all cut-off values. In the remainder of this thesis the higher order modeling of trust will not be shown in order to keep the models and tables simple and uncluttered. Nevertheless, all analysis have been completed with the trust modeled as a reflective-reflective second order construct.

As suggested by Hair et al. (2012) Cronbach’s alpha was not used as a proxy for internal consistency. Instead the composite reliability was examined, with a cut-off value of 0.70. Further assessment of the discriminant validity was conducted via the Fornell & Larcker (1983) criteria. Implying that the AVE of each construct should be higher than the squared correlation estimate with any other construct. Additionally, the cross-loadings were examined. The results for ‘profit margin’ and ‘project budget’ showed a strong cross loading of 0.868, raising doubt about the discriminant reliability of the two variables. Therefore the two variables were merged into a new latent variable ‘financial performance’ which performs well for all validity and reliability criteria.

Lastly, collinearity was inspected using the VIF score, in which a tolerance of 0.20 was maintained (Hair et al., 2012) leading to a maximum VIF of 5 (Hair et al., 2014). One indicator of exploitative knowledge sharing showed a VIF of 6.272 and is therefore deleted because it exceeded the maximum. The latent variable is still measured by four other indicators which in the view of the researcher still captures the
entire construct, furthermore the loading of the deleted indicator was non-significant. Moreover, one indicator of contractual specificity was also deleted since it had a VIF of 21.715.

In the two tables below a comprehensive overview of the measurement model is given by presenting the overview of the means, standard deviation, AVE, and composite reliability in Table 4. Moreover, Table 5 in Table 5 the correlation matrix of the latent variables is given.

<table>
<thead>
<tr>
<th>Latent variable</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Average variance extracted (AVE)</th>
<th>Composite reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of relationship</td>
<td>3.81</td>
<td>1.17</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Trust</td>
<td>4.26</td>
<td>0.52</td>
<td>0.679</td>
<td>0.894</td>
</tr>
<tr>
<td>Contractual specificity</td>
<td>2.35</td>
<td>1.18</td>
<td>0.894</td>
<td>0.944</td>
</tr>
<tr>
<td>White box</td>
<td>3.88</td>
<td>0.69</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Grey box</td>
<td>3.57</td>
<td>0.85</td>
<td>0.918</td>
<td>0.957</td>
</tr>
<tr>
<td>Black box</td>
<td>2.61</td>
<td>1.23</td>
<td>0.849</td>
<td>0.981</td>
</tr>
<tr>
<td>Exploitative knowledge sharing</td>
<td>3.27</td>
<td>1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploitative knowledge sharing</td>
<td>3.53</td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial results</td>
<td>2.70</td>
<td>0.90</td>
<td>0.934</td>
<td>0.966</td>
</tr>
<tr>
<td>Quality</td>
<td>3.59</td>
<td>1.00</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Planning</td>
<td>2.70</td>
<td>0.95</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4, data on the latent variables

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age of rel.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Black box</td>
<td>0.385</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Contractual s.</td>
<td>0.176</td>
<td>0.066</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Exploitative k.s.</td>
<td>0.441</td>
<td>0.729</td>
<td>0.182</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Explorative k.s.</td>
<td>0.226</td>
<td>0.642</td>
<td>0.326</td>
<td>0.748</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Financial results</td>
<td>0.232</td>
<td>0.550</td>
<td>-0.243</td>
<td>0.710</td>
<td>0.557</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Grey box</td>
<td>0.352</td>
<td>0.621</td>
<td>0.318</td>
<td>0.541</td>
<td>0.715</td>
<td>0.398</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Phase of inv.</td>
<td>-0.091</td>
<td>-0.076</td>
<td>0.031</td>
<td>-0.278</td>
<td>-0.196</td>
<td>-0.263</td>
<td>0.136</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Planning</td>
<td>0.018</td>
<td>0.367</td>
<td>-0.086</td>
<td>0.499</td>
<td>0.150</td>
<td>0.366</td>
<td>0.266</td>
<td>-0.136</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Quality</td>
<td>0.354</td>
<td>0.533</td>
<td>0.146</td>
<td>0.687</td>
<td>0.652</td>
<td>0.500</td>
<td>0.625</td>
<td>0.012</td>
<td>0.229</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Trust</td>
<td>0.150</td>
<td>0.421</td>
<td>0.074</td>
<td>0.429</td>
<td>0.470</td>
<td>0.396</td>
<td>0.395</td>
<td>-0.244</td>
<td>0.192</td>
<td>0.416</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12. White box</td>
<td>-0.026</td>
<td>0.329</td>
<td>-0.262</td>
<td>0.390</td>
<td>0.197</td>
<td>0.374</td>
<td>0.047</td>
<td>-0.268</td>
<td>0.527</td>
<td>0.261</td>
<td>0.163</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5, correlation matrix of the latent variables

* Exploitative and explorative knowledge sharing were modeled formatively, therefore calculation of AVE and composite reliability is not possible.
5.2.1  Common method bias and nonresponse bias

Herman’s single factor test was performed to check for common method bias. IBM SPSS Statistics 22 was used to perform an unrotated principal component factor analysis in which the extracted number of variables was forced to one. All indicators used in the model were loaded for the cases that involved suppliers during the innovation project. The extracted factor explained 41.08% of the variance. Since less than half of the variance is explained common method bias is no significant concern (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Nonresponse bias was investigated using time trends, making the assumptions that respondents that answer later are more similar to nonrespondents than early respondents (Armstrong & Overton, 1977). The analysis was divided into two parts. First, the entire dataset of 53 was examined, taking the first 13 respondents and the last 13 respondents (equal to the first and last 25 percent of the respondents). These two groups were compared with a Kruskal-Wallis test on two variables, the first being the completion of an innovation project and the second being the involvement of suppliers. Both variables tested not significant. Therefore, it can be stated that the early and late respondents are not significantly more or less likely to have completed an innovation project or have involved suppliers in an innovation project.

Secondly, the projects that have involved suppliers in their projects were selected were filtered from the dataset (27 cases). Of this dataset the first seven and last seven respondents were selected (i.e. first and last 25% of the respondents). On this data a Kruskal-Wallis test was performed, comparing all indicator data that is used in the research model. None of the Kruskal-Wallis test showed a significant result. Because the Kruskal-Wallis tests were not significant the conclusion was drawn that nonresponse bias is not a significant concern.

5.3  Supplier involvement vs. no supplier involvement

Of the 37 innovation projects nine respondents reported that suppliers did not play a role in the innovation project. A Kruskal-Wallis test was performed, using IBM SPSS Statistics 22, to test if the innovation performance of the projects that involved suppliers in the innovation project were significantly different from the respondents that did not involve suppliers during the innovation project. The Kruskal-Wallis test was non-significant for all four innovation performance indicators. Thus, the innovation performance of the projects in which suppliers were involved was not significantly different from projects in which no suppliers were involved.
These results suggest two possible scenarios; (1) suppliers did not add value to the innovation performance of the innovation project, (2) involving suppliers was necessary to complete the innovation project at all. The perception of the importance of supplier involvement to be able to complete the project was measured by a single item question, namely: ‘without involving suppliers the innovation project could not have been completed’. This item was measured on a 5-point Likert scale ranging from ‘totally not agree’ (1) to ‘totally agree’ (5), Table 6 below shows the responses.

<table>
<thead>
<tr>
<th>Response</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>13</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 6, response to; ‘without involving suppliers the innovation project could not have been completed’

Table 6 indicates that suppliers were perceived as important for the completion of 15 of the 27 innovation projects. Thus, more than half of the respondents perceived suppliers had an important role in completing the innovation project.

Performing a Kruskal-Wallis test comparing the cases that responded with a 2 or lower (7 cases), to the cases that responded with a 3 or higher (20 cases) the result for quality is significant (sign. = 0.024) and the results for profit margin are significant at the p < 0.10 (sign. = 0.053). Thus, companies that would not have needed the assistance of their suppliers have significantly different results from the companies that needed the assistance of their suppliers. A simple PLS model was ran (using SmartPLS), showing a negative path coefficient. Hence, cases in which the perception of the necessity of involving suppliers is lower, perform significantly better in terms of quality.

Nevertheless, the Kruskal-Wallis test comparing the cases in which (1) suppliers were not deemed to be necessary to complete the project, to (2) no supplier involvement, remains insignificant, meaning that the innovation performance for the two groups cannot be statistically differentiated from each other. Side note to this analysis is that the two groups are both very small, 7 and 10 respectively. Therefore the statistical power of this test is questionable.

### 5.4 Analysis of the research model

The path model was analyzed using the setting described in chapter 5.1. For this analysis the data of the 27 cases in which an innovation project had been performed in which supplier were involved were used. Table 7 and Table 8 show the results of the path model and consequentially the rejection or support of the
corresponding hypotheses\textsuperscript{†}. The model was run using all cases that involved suppliers in the innovation project. In this chapter only effect with a p-value smaller than, or equal to, 0.05 will be considered significant.

<table>
<thead>
<tr>
<th>Relation</th>
<th>Hypoth.</th>
<th>Path coefficient</th>
<th>p-value</th>
<th>$f^2$</th>
<th>Supp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of rel. &lt;-&gt; White box</td>
<td>H1b</td>
<td>-0.005</td>
<td>0.965</td>
<td>0.000</td>
<td>Yes</td>
</tr>
<tr>
<td>Age of rel. &lt;-&gt; Grey box</td>
<td>H1b</td>
<td>0.258</td>
<td>0.092</td>
<td>0.091</td>
<td>Yes</td>
</tr>
<tr>
<td>Age of rel. &lt;-&gt; Black box</td>
<td>H1b</td>
<td>0.333</td>
<td>0.036</td>
<td>0.147</td>
<td>Yes</td>
</tr>
<tr>
<td>Trust &lt;-&gt; White box</td>
<td>H1a</td>
<td>0.184</td>
<td>0.176</td>
<td>0.037</td>
<td>Yes</td>
</tr>
<tr>
<td>Trust &lt;-&gt; Grey box</td>
<td>H1a</td>
<td>0.338</td>
<td>0.033</td>
<td>0.159</td>
<td>Yes</td>
</tr>
<tr>
<td>Trust &lt;-&gt; Black box</td>
<td>H1a</td>
<td>0.372</td>
<td>0.032</td>
<td>0.189</td>
<td>Yes</td>
</tr>
<tr>
<td>Contractual specificity &lt;-&gt; White box</td>
<td>H1c</td>
<td>-0.275</td>
<td>0.112</td>
<td>0.081</td>
<td>No</td>
</tr>
<tr>
<td>Contractual specificity &lt;-&gt; Grey box</td>
<td>H1c</td>
<td>0.247</td>
<td>0.116</td>
<td>0.085</td>
<td>No</td>
</tr>
<tr>
<td>Contractual specificity &lt;-&gt; Black box</td>
<td>H1c</td>
<td>-0.020</td>
<td>0.873</td>
<td>0.001</td>
<td>No</td>
</tr>
<tr>
<td>White box &lt;-&gt; Exploitative knowledge sharing</td>
<td>H2a</td>
<td>0.204</td>
<td>0.137</td>
<td>0.084</td>
<td>No</td>
</tr>
<tr>
<td>White box &lt;-&gt; Explorative knowledge sharing</td>
<td>H2a</td>
<td>0.079</td>
<td>0.492</td>
<td>0.013</td>
<td>No</td>
</tr>
<tr>
<td>Grey box &lt;-&gt; Exploitative knowledge sharing</td>
<td>H2b</td>
<td>0.196</td>
<td>0.347</td>
<td>0.053</td>
<td>Partial</td>
</tr>
<tr>
<td>Grey box &lt;-&gt; Explorative knowledge sharing</td>
<td>H2b</td>
<td>0.536</td>
<td>0.032</td>
<td>0.401</td>
<td>Partial</td>
</tr>
<tr>
<td>Black box &lt;-&gt; Exploitative knowledge sharing</td>
<td>H2c</td>
<td>0.540</td>
<td>0.016</td>
<td>0.364</td>
<td>Partial</td>
</tr>
<tr>
<td>Black box &lt;-&gt; Explorative knowledge sharing</td>
<td>H2c</td>
<td>0.283</td>
<td>0.145</td>
<td>0.100</td>
<td>Partial</td>
</tr>
<tr>
<td>Exploitative knowledge sharing &lt;-&gt; Financial results</td>
<td>H3a</td>
<td>0.604</td>
<td>0.047</td>
<td>0.364</td>
<td>Yes</td>
</tr>
<tr>
<td>Explorative knowledge sharing &lt;-&gt; Financial results</td>
<td>H3b</td>
<td>0.108</td>
<td>0.607</td>
<td>0.009</td>
<td>No</td>
</tr>
<tr>
<td>Exploitative knowledge sharing &lt;-&gt; Planning</td>
<td>H3a</td>
<td>0.877</td>
<td>0.001</td>
<td>0.531</td>
<td>Yes</td>
</tr>
<tr>
<td>Explorative knowledge sharing &lt;-&gt; Planning</td>
<td>H3b</td>
<td>-0.507</td>
<td>0.044</td>
<td>0.177</td>
<td>No</td>
</tr>
<tr>
<td>Exploitative knowledge sharing &lt;-&gt; Quality</td>
<td>H3a</td>
<td>0.451</td>
<td>0.028</td>
<td>0.185</td>
<td>Yes</td>
</tr>
<tr>
<td>Exploitative knowledge sharing &lt;-&gt; Quality</td>
<td>H3b</td>
<td>0.315</td>
<td>0.098</td>
<td>0.090</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 7, results of the analysis of the research model

Table 8 below shows the adjusted $R^2$ of the research model. The adjusted $R^2$ is reported because the $R^2$ is biased towards complex models (Hair et al., 2014). Moreover, shows the cross-validated redundancy (obtained using a blindfolding procedure, with an omitted distance of 8 conforming to the guidelines of Hair et al. (2014)).

\textsuperscript{†} The small sample size raises doubt about the statistical power of the analysis, therefore Kruskal-Wallis tests were, informally, performed for all relationships using SPSS. These tests showed no major deviations from the results reported above (i.e. changes from significant to insignificant or vice versa).
Table 8. \( R^2 \) Adjusted and \( Q^2 \) of the latent variables

<table>
<thead>
<tr>
<th>Construct</th>
<th>( R^2 ) Adjusted</th>
<th>( Q^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>White box</td>
<td>-0.015</td>
<td>-0.056</td>
</tr>
<tr>
<td>Grey Box</td>
<td>0.212</td>
<td>0.156</td>
</tr>
<tr>
<td>Black Box</td>
<td>0.190</td>
<td>0.108</td>
</tr>
<tr>
<td>Exploitive knowledge sharing</td>
<td>0.524</td>
<td>0.370</td>
</tr>
<tr>
<td>Explorative knowledge sharing</td>
<td>0.526</td>
<td>0.332</td>
</tr>
<tr>
<td>Financial results</td>
<td>0.425</td>
<td>0.433</td>
</tr>
<tr>
<td>Planning</td>
<td>0.308</td>
<td>0.248</td>
</tr>
<tr>
<td>Quality</td>
<td>0.475</td>
<td>0.400</td>
</tr>
</tbody>
</table>

Figure 9 below graphically shows the results of the analysis. Effects with \( p > 0.15 \) have been omitted for clarity. Important to keep in mind is that the arrows between the constructs do not represent a causal link.

Figure 9, graphical representation of the results of the analysis

5.4.1 Relation and supplier involvement

Age of the relationship and trust were found to have a positive impact on grey and black box supplier involvement as hypothesized in H1. However, the effect of trust can be categorized as more important since the \( f^2 \) score is more than double that of age of relationship.

The relation between contract specificity and supplier involvement can be labeled as weak for all types of supplier involvement considering the \( f^2 \) values. Moreover, contract specificity has no significant influence on supplier involvement, leading to the rejection of H1c.

Furthermore, none of the in hypothesis one specified relationships had a significant impact on white box supplier involvement. Furthermore, the \( Q^2 \) value of white box supplier involvement is negative, indicating
that the model holds no significant predictive relevance for white box supplier involvement (Hair et al., 2014). Based on the $Q^2$ values the model has moderate predictive relevance for grey and black box supplier involvement. Moreover, by considering trust, age of relationship, and contract specificity almost 23% and 25% percent of the variance found in black and grey box supplier involvement can be explained (contract specificity does not significantly contribute to these statistics).

These results suggest the importance of personal relationships and unimportance of formal contracts, found in chapter 2.1.2 to be dominant in the purchasing process of SMEs, can be extended to supplier involvement efforts by SMEs.

### 5.4.2 Supplier involvement and knowledge sharing

The analysis of the relationship between supplier involvement and knowledge sharing shows unexpected results. First of all, white box supplier involvement does not significantly influence knowledge sharing. However, the correlation matrix (Table 5, pp. 31) shows a correlation of 0.527 with planning. This is an indication that there might be a relationship between white box supplier involvement and planning that is not captured in the present research model.

Secondly, the relationships between grey & black box supplier involvement and knowledge sharing are surprising. It was hypothesized that both grey and black box supplier involvement would have a positive relationship with explorative and exploitative knowledge sharing. However, grey box supplier involvement only has a significant effect on explorative knowledge sharing. Moreover, black box supplier involvement only has a significant effect on exploitative knowledge sharing. Thus, hypothesis 2 is only partially supported.

### 5.4.3 Knowledge sharing and innovation performance

The results of exploitative knowledge sharing on financial results and planning, with an $f^2$ of 0.364 and 0.531 respectively, can be classified as strong. The relationship between explorative knowledge sharing and quality is classified as moderate ($f^2 = 0.185$). Thereby, supporting the hypothesis H3a; Exploitative knowledge sharing has a positive impact on the innovation performance.

However, H3b; ‘explorative knowledge sharing has no effect on the innovation performance’, is not supported. Explorative knowledge sharing was not found to have a significant positive impact on any of the innovation performance measures. Nevertheless, explorative knowledge sharing has a significant negative effect on planning. Indicating that explorative knowledge sharing is correlated with a longer than
anticipated innovation project duration. All other relations between explorative knowledge sharing and the innovation performance are not significant.

Based on the $Q^2$ values the research model has strong predictive relevance for the innovation performance indicators financial results and quality and moderate predictive relevance for planning.

### 5.4.4 Analysis of moderation

The moderating effect of phase of supplier involvement on the relationship between exploitative knowledge sharing and the innovation performance (hypothesis 4) was found to be insignificant. Thus, hypothesis four is not supported.

<table>
<thead>
<tr>
<th>Relation</th>
<th>Path coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploitative k.s. x phase of supplier involvement &lt;-&gt; financial performance</td>
<td>-0.069</td>
<td>0.861</td>
</tr>
<tr>
<td>Exploitative k.s. x phase of supplier involvement &lt;-&gt; quality</td>
<td>-0.057</td>
<td>0.736</td>
</tr>
<tr>
<td>Exploitative k.s. x phase of supplier involvement &lt;-&gt; planning</td>
<td>0.103</td>
<td>0.789</td>
</tr>
</tbody>
</table>

Table 9, results of the analysis of moderation from SmartPLS

The moderating effect of phase of supplier involvement was assumed to be linear (i.e. the earlier the supplier is involved the more positive the effect of knowledge sharing on the innovation performance), since this effect was found to be insignificant an alternative was also tested. The standardized values of phase of involvement were squared to test if an inversed u-shaped distribution would fit better in the model. This effect means that the effect of exploitative knowledge sharing and innovation performance is the strongest in the middle of an innovation project and gets evenly weaker in the beginning and end of the project. Unfortunately this effect has to be rejected because the moderating effect was not significant.

### 5.5 Polynomial Regression with Response Surface Analysis

To gain additional insight into the how explorative, exploitative knowledge sharing, and the combination of the two influence the innovation performance, a polynomial regression equation (Edwards & Parry, 1993) was created upon which a response surface analysis was performed. This analysis was performed according to the guidelines of Shanock, Baran, Gentry, Pattison, & Heggestad (2010). The standardized latent variable scores from SmartPLS of exploitative knowledge sharing, explorative knowledge sharing, planning, quality, and financial performance were used as input data.
Based on the data three polynomial regression models were estimated using SPSS. These estimated models were then translated into threedimensional graphs in Excel which are presented in Appendix D (page 59) together with the parameter estimates for these graphs. Subsequently, the significance of the slopes and curvatures were calculated by the Excel sheet of Shanock et al. (2010) for each of the innovation performance measures. The results of these analysis are shown in the three tables below, in all of the analyses exploitative knowledge sharing was coded as x and explorative knowledge sharing was coded as y.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Coefficient</th>
<th>Error</th>
<th>Stat (t)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$: Slope along $x = y$ (as related to $Z$)</td>
<td>0.37</td>
<td>0.24</td>
<td>1.507</td>
<td>0.143</td>
</tr>
<tr>
<td>$a_2$: Curvature on $x = y$ (as related to $Z$)</td>
<td>-0.10</td>
<td>0.18</td>
<td>-0.566</td>
<td>0.576</td>
</tr>
<tr>
<td>$a_3$: Slope along $x = -y$ (as related to $Z$)</td>
<td>0.90</td>
<td>0.51</td>
<td>1.777</td>
<td>0.087</td>
</tr>
<tr>
<td>$a_4$: Curvature on $x = -y$ (as related to $Z$)</td>
<td>-0.95</td>
<td>1.03</td>
<td>-0.929</td>
<td>0.361</td>
</tr>
</tbody>
</table>

Table 10, results of the surface response analysis $Z = $ planning

<table>
<thead>
<tr>
<th>Effect</th>
<th>Coefficient</th>
<th>Error</th>
<th>Stat (t)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$: Slope along $x = y$ (as related to $Z$)</td>
<td>0.74</td>
<td>0.17</td>
<td>4.265</td>
<td>0.000</td>
</tr>
<tr>
<td>$a_2$: Curvature on $x = y$ (as related to $Z$)</td>
<td>0.17</td>
<td>0.13</td>
<td>1.310</td>
<td>0.201</td>
</tr>
<tr>
<td>$a_3$: Slope along $x = -y$ (as related to $Z$)</td>
<td>0.07</td>
<td>0.36</td>
<td>0.186</td>
<td>0.854</td>
</tr>
<tr>
<td>$a_4$: Curvature on $x = -y$ (as related to $Z$)</td>
<td>-1.07</td>
<td>0.73</td>
<td>-1.469</td>
<td>0.153</td>
</tr>
</tbody>
</table>

Table 11, results of the surface response analysis $Z = $ financial performance

<table>
<thead>
<tr>
<th>Effect</th>
<th>Coefficient</th>
<th>Error</th>
<th>Stat (t)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$: Slope along $x = y$ (as related to $Z$)</td>
<td>0.71</td>
<td>0.19</td>
<td>3.782</td>
<td>0.001</td>
</tr>
<tr>
<td>$a_2$: Curvature on $x = y$ (as related to $Z$)</td>
<td>-0.04</td>
<td>0.35</td>
<td>-0.102</td>
<td>0.919</td>
</tr>
<tr>
<td>$a_3$: Slope along $x = -y$ (as related to $Z$)</td>
<td>0.06</td>
<td>0.38</td>
<td>0.149</td>
<td>0.883</td>
</tr>
<tr>
<td>$a_4$: Curvature on $x = -y$ (as related to $Z$)</td>
<td>-0.50</td>
<td>0.84</td>
<td>0.597</td>
<td>0.556</td>
</tr>
</tbody>
</table>

Table 12, results of the surface response analysis $Z = $ quality

Effect $a_1$, slope along $x=y$, is significant for both quality and financial performance. Meaning that increased financial performance and quality can only be attained when both explorative and exploitative knowledge sharing with suppliers are practiced.

Effect $a_3$, slope along $x=-y$, is significant for planning at $p < 0.10$. Meaning that an increase in exploitative knowledge sharing without an increase in explorative knowledge sharing is correlated with higher planning scores.

‡ The Excel sheet is available at http://www.springer.com/psychology/personality+%26+social+psychology/journal/10869 on the right hand side of the screen under ‘Response Surface Analysis Excel’
The three effects that have been uncovered in this paragraph form a trade-off. On the one hand high exploitative and explorative knowledge sharing is correlated with better financial performance and better quality, on the other hand, explorative knowledge sharing is negatively correlated with planning.

### 5.6 Conclusion

In this chapter the research framework was analyzed by means of PLS-SEM. Based upon this analysis the earlier formulated hypotheses were evaluated. Three hypothesis were supported, three hypothesis were rejected, and two hypothesis were partially supported. Lastly, a polynomial regression with surface response analysis was performed. This analysis provided a more in depth view on the effects of explorative and exploitative knowledge sharing and the innovation performance. Showing that there is a trade-off between financial performance and quality, and planning of the innovation project.

The upcoming chapter will discuss the results in relation the literature and describe the practical implications of the findings.
6 DISCUSSION & LIMITATIONS

This chapter will discuss the results of this study. First, the research questions that were presented in chapter 2.5 will be answered. Subsequently, the managerial implications will be presented. Followed by a separate discussion on the concerns about the obtained sample size. Lastly, the limitations and directions for further research will be presented.

6.1 Discussion

This thesis set out to find an answer to the question: ‘How can SMEs maximally benefit from the knowledge of suppliers during an innovation project?’ In the search for an answer to the main research question five sub-questions were drafted. The next paragraphs will discuss the sub-research questions one-by-one, after which the answer to the main research question will be presented.

The first sub-research question was rather elemental in nature but was not answered in a satisfactory manner by the reviewed literature: ‘How and when do SMEs involve suppliers in their innovation process?’ In this research a dataset of 52 SMEs was gathered of which 37 had completed an innovation project. Of these 37 respondents, 27 respondents involved suppliers in their innovation project. This means that more than half of the surveyed companies completed an innovation project in which suppliers were involved.

In over 81% of the innovation projects that involved suppliers in one or more ways§, white box supplier involvement was practiced (22 of the 27 cases). Grey and black box supplier involvement was reported in 18 and 9 cases respectively. The majority of SMEs involved suppliers in at least the ‘engineering & design’ phase, as reported in Table 3. Compared to earlier studies among larger firms, for example Handfield et al. (1999), supplier involvement in the earliest stages of the development process is observed less frequently. SMEs seem to involve suppliers later in the process than their larger counterparts. This is in line with the results of the study of Ellegaard (2009) among twelve small companies.

Interestingly, the hypothesized moderation effect of timing of supplier involvement on the relationship between knowledge sharing and innovation performance was found to be insignificant. In fact, the correlation matrix shows that timing of supplier involvement does not strongly or moderately correlates

§ A critical side-note to this finding is justified, the invitation to participate specifically mentioned the role of suppliers in the innovation process of SMEs. Thereby, respondents that have experience with the practice of supplier involvement might be more inclined to participate in the study.
with any of the other constructs. A possible explanation could be the argument of McGinnis & Vallopra (1999), they argued that suppliers should be involved in an innovation project when they are needed. This might lead to insignificant results in the applied research method, because this would not lead to one ideal time to involve suppliers but rather to a case specific ideal time to involve suppliers. Extending this line of thought leads to the suggestion that input from supplier is mostly needed in the ‘engineering and design phase’ of the innovation project of SMEs.

Moreover, the lack of significance of timing of supplier involvement suggests that Figure 5, the effect of time on the freedom of specification by Van Weele (2009), might be conceptually valid but does not provide a valid argument on when to involve suppliers in an innovation project in the setting of this study. In conclusion, this research has shown that the timing of involvement of suppliers in an innovation project cannot be viewed as ‘the earlier the better’. Unfortunately this research cannot provide guidance in when suppliers should be involved.

The second sub-question was formulated as: ‘Does involving supplier in the innovation project of an SME result in better innovation performance?’ The wide-spread application of supplier involvement among the respondents suggests that SMEs are aware of the innovative potential present at their suppliers. However, the widespread use of suppliers in innovation projects is not correlated with improved innovation performance in itself (nor deteriorating innovation performance). As reported in chapter 5.3, innovation projects in which supplier were involved do not perform significantly different from innovation projects in which suppliers were not involved. Nevertheless, suppliers do seem to play an import role in 15 of the 27 investigated innovation projects. In these 15 innovation projects suppliers were perceived as necessary to complete the innovation project. Innovation projects in which suppliers were not perceived as necessary to complete the project, the quality ($p < 0,05$) and profit margin ($p < 0,10$) are significantly better than innovation projects that perceived supplier involvement to be necessary to complete the project. This suggests that suppliers have expert knowledge which can be used to increase the innovation performance of SMEs even if the knowledge of suppliers is not required for the completion of the innovation project.

The high number of projects in which suppliers were seen as important for the completion of the project might also partially explain the relatively high number of the cases of supplier involvement. Some of the SMEs might have no real choice but to involve suppliers in their innovation project if they want to complete the innovation project at all. This finding might also provide a more in depth insight into the results of Nieto & Santamaria (2010), they concluded that vertically collaborating SMEs (i.e. SMEs that
collaborate with suppliers or customers) are significantly more likely to introduce product and process innovations. The results of this study suggest that suppliers introduce part of the necessary resources to complete the innovation project, thereby increasing the likelihood that a SME has introduced an innovation in the market.

The third sub-research question was: What is the effect of the existing relationship characteristics trust, age of relationship and contractual specificity on supplier involvement by SMEs? The results of this research have shown that trusting and longer relationships are correlated with types of supplier involvement that give more responsibility to the involved supplier in the innovation project. This confirms the importance of relationships that SMEs have with suppliers, as found in chapter 2.1.2, and extending these findings to the realm of supplier involvement by SMEs.

The findings concerning contracts specificity were more surprising. In contradiction to chapter 2.3.2 contracts were in place in most of the relationships with suppliers. Nevertheless, contractual specificity was not found to correlate with any of the types of supplier involvement with p < 0,05. Nevertheless, the relationship between contractual specificity and white and grey box supplier involvement were found to be significant at the p < 0,15 level. A negative correlation was found with white box supplier involvement and a positive relationship was found with grey box supplier involvement. Moreover, was no relationship found between contractual specificity and black box supplier involvement, which is also out of line with the reasoning that contracts are used to mitigate risk. This is unexpected because it was expected that contracts would be used to mitigate risk, which is more profoundly present in black box supplier involvement compared to grey box supplier involvement. Upon inspecting the correlation matrix (Table 5) one can observe that contractual specificity does not strongly correlate with any of the other constructs. Overall, this seems to suggest creating highly specific contracts (or very general contracts) does not seem to have a substantial impact on supplier involvement in the innovation projects of SMEs.

The fourth sub-research question was: ‘What is the effect of involving suppliers during an innovation project on the knowledge sharing between buyer and supplier?’ This research has found that white box supplier involvement has a relationship with exploitative knowledge sharing (p < 0,15). This effect was hypothesized although significance level raises doubts about this effect. Moreover, the analysis found that the research model holds no predictive relevance (Q² < 0) for white box supplier involvement. There are three possible explanations for the lack of significance of the relationships surrounding white box supplier involvement. The first, and most obvious explanation, is that the research framework indeed holds no predictive relevance for white box supplier involvement and white box supplier involvement is
not correlated with explorative knowledge sharing and weakly correlated with exploitative knowledge sharing. Second explanation, could be that the research framework does not accurately capture the antecedents and/or consequences of white box supplier involvement. The third possible explanation is related to the used measurement scale, the literature did not provide an adequate measurement scale for white box supplier involvement. Therefore, the questions for grey and black box supplier involvement were ‘extrapolated’ to white box supplier involvement. Despite the efforts to create an accurate measurement tool, it might be flawed.

Grey and black box supplier involvement correlate to different types of knowledge sharing. Grey box supplier involvement was found to correlate strongest with explorative knowledge sharing. Black box supplier involvement was found to correlate strongest with exploitative knowledge sharing. The research model also hypothesized relationships between black box supplier involvement and explorative knowledge sharing and grey box supplier involvement and exploitative knowledge sharing. However, the results only show a moderately significant relationship between black box supplier involvement and explorative knowledge sharing, due to the significance level of this relationship this effect should be interpreted with caution. A possible explanation for these unexpected findings could be that grey box supplier involvement was practiced more often in projects that were more explorative in nature and black box supplier involvement was practiced more in projects that had a more exploitative nature. However, this was not controlled for in the research model and can therefore not be tested. Another explanation for the findings could be that grey box supplier involvement is the only type of supplier involvement in which buyer and supplier collaboratively work on a project, product, or component. This collaboration might be the required medium for explorative knowledge sharing to occur. A medium which is not present in white box supplier involvement (no significant relationship with explorative knowledge sharing) and to a lesser extent in black box supplier involvement (moderately significant relationship with explorative knowledge sharing).

The fifth and final, sub-question was: ‘What is the effect of knowledge sharing with suppliers on the innovation performance of SMEs?’ In line with previous research the SEM-PLS model uncovered that exploitative knowledge sharing with suppliers has a significant positive impact on all innovation performance indicators. Moreover, the relation with planning and financial results was found to be strong and the relation with quality was found to be moderate. In the PLS-SEM model explorative knowledge sharing painted a less conclusive picture. Explorative knowledge sharing was found to have a negative relationship with planning (i.e. the completion date of the innovation project) and a positive relationship
with quality \((p = 0.098)\). To gain a deeper insight in the effect of knowledge sharing on the innovation performance a polynomial regression with surface response analysis was performed.

The surface response analysis confirmed the relationships of explorative and exploitative knowledge sharing and planning. The negative relationship between explorative knowledge sharing and planning might be due to the nature of the project. Explorative projects are by definition more uncertain in nature which might lead to unexpected setbacks in the innovation project. This would be in line with the suggestion made for the link between grey box supplier involvement and explorative knowledge sharing.

The uncovered picture of the relationship between knowledge sharing and quality nuanced the results found by the PLS-SEM model. The surface response analysis found that in order to increase the quality both explorative and exploitative knowledge sharing has to be practiced.

Although, the PLS-SEM model did not find a significant relationship between explorative knowledge sharing and financial performance of the innovation project, the surface response analysis found that explorative knowledge sharing does influence financial performance. More specifically, financial performance increases when both explorative and exploitative knowledge sharing are practiced. This finding mimics the finding concerning the relationship between knowledge sharing and quality. However, this creates friction with the relation between explorative knowledge sharing and planning. A trade-off emerges between financial performance and quality on the one hand and planning on the other hand.

An important side note to the findings concerning explorative knowledge sharing is that the main effect might not be observable within the boundaries of the innovation project. Explorative knowledge sharing is focused on new opportunities. It is questionable to what extent new opportunities can be capitalized within the innovation project. This research has not been designed to measure such effects and therefore this argument cannot be tested within this thesis. However, the surface response analysis has shown that both explorative and exploitative knowledge sharing with supplier are important to maximize the financial performance and quality of an innovation project.

Combining the answers to the sub-research questions should lead to an answer of the main research question: ‘How can SMEs maximally benefit from the knowledge of suppliers during an innovation project?’ The investigated research model explained over 50% of the variance of the reported knowledge sharing. Thereby, this research has shown that supplier involvement is a useful practice for SMEs to improve knowledge sharing with suppliers. Knowledge sharing, more specifically exploitative knowledge sharing, with suppliers was found to have a strong predictive relevance for innovation performance. The
research model explained almost half of the variance of the financial results (42.5%) and quality (47.5%). Moreover, more than 30% of the variance in completion date was explained by the research model.

Black box supplier involvement was found to have the strongest relationship with exploitative knowledge sharing, thereby delivering the strongest indirect contribution to innovation performance. Grey box supplier involvement was found to have a strong significant impact on explorative knowledge sharing. And thereby was found to have an indirect negative effect on the planning. However, a more in depth analysis of the relationship between knowledge sharing and innovation performance has shown the need for both explorative and exploitative knowledge sharing in order to maximize the financial performance and quality of an innovation project. Nevertheless, the negative effect of explorative knowledge sharing on planning was confirmed, creating a trade-off between planning on the one hand and quality and financial performance on the other hand.

Another important finding is that 15 out of the 37 (40%) respondents that completed an innovation project perceive the contribution of suppliers as necessary to complete the innovation project at all. Indicating that the resources suppliers add to an innovation project are often of vital importance to completion of the innovation project. Moreover, this suggests that role for suppliers might be far bigger than merely increasing the innovation performance of the innovation project. Suppliers might even be act as co-innovators.

6.2 Practical implications

First of all the reason for supplier involvement has to be defined. This research has shown that a significant number of SMEs involve suppliers in their innovation project because involvement of suppliers was necessary for the completion of the project. These suppliers might contribute specialized resources to the innovation project that complement or supplement the base of resources available within the firm. Other SMEs have reported to have involved suppliers in their innovation project for other reasons, of instance speeding up the innovation project. Both of these reasons can, and have, led to successful innovation projects. Showing that suppliers have valuable resources to contribute to the innovation projects of SMEs. The next paragraphs will discuss the factors that have been uncovered in this thesis. These factors might help in successfully involving suppliers in an innovation project.

When one has decided to involve suppliers in an innovation project a pressing question is how much responsibility to give these suppliers. This research has distinguished between three types of supplier involvement that give increasingly more responsibility to the suppliers; informally consulting suppliers
(i.e. white box), collaboratively working on a component or part (i.e. grey box), and the subcontracting of the development of a component, product, or part to a supplier (i.e. black box). These three types of supplier involvement are not mutually exclusive, nor are the borders between these types of supplier involvement always clear. Moreover, these different types of supplier involvement result in different kinds of knowledge sharing.

Informally consulting suppliers does not lead to a significant amount of knowledge sharing, nevertheless informally consulting with suppliers is correlated to the timely completion of the innovation project. Therefore, informally consulting suppliers is highly recommended for any innovation project. Moreover, informally consulting suppliers does not require a trusting relationship, hence both current and potential supplier can also be approached for informal advise.

Collaboratively working on an innovation project is correlated to explorative knowledge sharing, this is knowledge sharing that is most valuable in the longer term and maybe even outside the scope of the innovation project. Subcontracting parts of the innovation project to suppliers is strongly correlated with exploitative knowledge sharing and to lesser extend to explorative knowledge sharing. Exploitative knowledge sharing is aimed at gaining results within the scope of the innovation project. However, the recommendation of these types of supplier involvement is more nuanced. Because the different kinds of knowledge sharing have different relationships to the innovation performance, which were in this study defined as project planning, financial performance, and quality of the end product. Increasing the quality and financial performance requires equal amount of explorative and exploitative knowledge sharing, the more the better. However, sticking to the project planning requires as little explorative knowledge sharing is possible. This creates a trade-off for which entrepreneurs should keep in mind that when speedy completion is of the essence explorative knowledge sharing should be avoided. To achieve this entrepreneurs should avoid collaboratively working with suppliers and instead subcontract a part of the contract, or commit more of the company’s own resources. Nevertheless, subcontracting a part might lead to unbalanced exploitative knowledge sharing, in relation to explorative knowledge sharing, and thus might be harmful for the financial performance and quality of the innovation project.

An example of supplier involvement came up during one of the interviews (see chapter 4.1) which will be used to illustrate the trade-off described above. The concerning company needed a highly advanced electronics component to integrate into the system of which they sell a few each year. The component could be produced in-house, however this would consume a lot of their resources. A personal contact of the director of the company works at a company that could deliver a compatible product that would only
need minor tweaking. The product would not fit the full wish list, but the machine would function. By subcontracting the component to the supplier (i.e. black box supplier involvement) the innovation project would run ahead of schedule (i.e. positive effect on planning). However, the functionality of the eventual machine would be slightly lower and the component is more expensive a piece than a similar component that could be build in-house, but would cost an initial investment to develop (i.e. lower quality and financial performance). Eventually, the decision was made to purchase the component from the supplier and invest the available resources in another component. This example shows the possible consequences of focusing purely on exploitative knowledge, it has delivered a short term gain. The director could also have chosen to collaboratively work to improve the component of the supplier and upgrade it to his wish list (i.e. grey box supplier involvement). Effectively raising the quality of the component at the cost of the project planning. Moreover, by helping the supplier improve his product offering it is likely the director could have gotten a favorable deal on the unit price of the component, also raising the financial performance.

In the relationship with suppliers strong personal relationships are important (i.e. trusting and long term relationship), especially when it is desired that suppliers get more responsibility in the innovation project. Contracts have not been shown to influence supplier involvement. However, contracts might have other important functions in the relationship, for instance; show a commitment. This was clearly illustrated in one of the interviews when the question arose: ‘what are contracts good for?’ The director boldly stated; ‘in the end all contracts are blanks’. The director in question elaborated that what is really important is two people trusting each other and shaking each other’s hand, ‘when I can’t pay for his materials he has nothing’. What the director clarified was that when he would default on his payment, because the company might be on the edge of bankruptcy, the supplier would get nothing, and this goes the other way around as well. This example highlights the focus on personal relationship and away from formal contract as means to control a relationship.

Lastly, the timing of supplier involvement was not found to have a significant effect on the outcome of the knowledge sharing with suppliers in the innovation project. Therefore, concrete guidelines cannot be given and what remains is stating the obvious; managers should consider involving suppliers when they are needed. For the majority of innovation projects this will at least be the engineering and design phase of the innovation project.
6.3 Sample size concerns

The analysis of research framework was conducted with a smaller than desired sample size, as stated in chapter 4. Nevertheless, the case will be made that this is not insurmountable. Hair et al. (2010) identified two problems with small samples; too little statistical power and overfitting (i.e. results are statistically significant for the sample, but not generalizable).

The first possible issue, statistical power, is partially overcome by the used statistical method. PLS-SEM has been found to be a good choice when the sample size is small (Hair et al., 2014). Moreover, Kruskal-Wallis tests were informally performed for all effects to doublecheck if the effects analyzed are indeed statistically significant (or insignificant).

The second possible issue is generalizability, because of the small sample size one could be concered that the effect that were found to be significant are only significant for the specific sample (i.e. overfitting). In the presented research this problem is partially obviated through the heterogenity of the investigated sample. The heterogenity mainly stems from the fact that the survey was conducted among three different network organisations that focus on different kinds of companies in different industries. Since the data did not originate from one industries the data is more diverse. Thus, the chance of overfitting is reduced.

6.4 Limitations and future research

The presented study holds promising results for future research but also has limitations, this subchapter will discuss both starting with the limitations. The previous paragraph presented a defense against the possible criticism that the results of this study are meaningless because the of the small sample size. Although, a solid defense was presented, the power of this study should not be overestimated. The small sample size does limit this study in the sense that generalizability (especially outside of the surveyed network organizations) might be problematic. Moreover, the study did report five relationships with p < 0.15 as shown in Figure 9, it is unsure to what extend these effect are false positives or genuine relationships. Clarifying these effects will require a repetition of this research with a larger sample size.

Another limitation of the gathered data is that it is cross-sectional. Therefore, changes that happen over time are not captured. Hence, generalizing the results over the timespan of an innovation project requires caution.
Moreover, the research model does not capture the antecedents or consequences of white box supplier involvement in the context of supplier involvement by SMEs (the finding that white box supplier involvement has no or very limited consequences might be correct). This is a clear limitation of the research, since there is a chance that not the entire spectrum of supplier involvement was captured. Nevertheless, this limitation simultaneously provides an interesting avenue for future research, especially since the majority of the respondents reported the application of white box supplier involvement.

### 6.4.1 Revised Framework

The previous paragraph already highlighted a direction for future research, other directions for future research will be discussed with reference to the revised research framework. The revised framework was created by integrating the gained knowledge from the analysis back into the research framework. The revised research framework is shown in Figure 10 below, in the following paragraph the changes compared to the original research model will be discussed.

![Revised Framework Diagram]

**Figure 10, revised framework**

Firstly, the revised research framework does not contain the constructs phase of supplier involvement and contractual specificity. The hypothesized moderating effect of phase of supplier involvement on the relationship between knowledge sharing and innovation performance was found to be insignificant. Furthermore, phase of supplier involvement was not found to be correlated with any of the other constructs, it therefor appears to fit poorly in the research model.

Secondly, contractual specificity is no longer included in the revised research model. Contractual specificity does not seem to correlate with the other constructs in the research model. Moreover earlier
studies, by for instance Ellegaard (2006), did not find support that contracts play a major role in the relationship between buyers and suppliers.

Thirdly, the relationships of white box supplier involvement with other constructs of the research model were altered. Relational factors leading to white box supplier involvement were all found to be non-significant. Furthermore, the effect of white box supplier involvement on knowledge sharing was found to be of dubious statistical significance. Nevertheless, a correlation to planning does exist. Therefore, this relationship has been added to the revised research framework. However, a question mark has been added because a direct relationship is questionable, because it is unlikely that informally consulting with suppliers leads to increased project planning performance. There seems to be a missing moderating variable.

Fourthly, some relations from the original research framework that were found to be insignificant were nonetheless upheld in the revised research framework. Removing these possible relationships on the basis of a small data sample seems premature, especially when considering the theoretical foundation for these effects.

Apart from the removal of two construct, future research should consider expanding the research framework in two ways. The first interesting expansion of the research model could be closer scrutiny of the effects of exploratory knowledge sharing. The current research framework does not include the possible effects of explorative knowledge sharing outside of the innovation project.

In the current research model, the three types of supplier involvement are the constructs for which the research models hold the least predictive relevance. Therefore, the second interesting expansion of the research framework concerns a possible antecedent of supplier involvement. Eisenhardt & Schoonhoven (1996) extended the resource based view of the firm to the realm of strategic alliances. They found that strategic alliances arise from strategic needs and social opportunities. Social opportunities have been translated to trust and age of relationship in this study. Nevertheless, strategic needs are currently not covered by the research framework.
BIBLIOGRAPHY


APPENDIX A, INTERVIEW STRUCTURE

General questions

Context:
- Age of the firm
- Number of employees
- Number of hours per week on innovation
- Number of products
- Percentage of sales from products introduced in the last 3 years
- Expected new products in the coming year

Who performs the purchasing within the company?
- Do other employees have contact with the suppliers? If so, with whom (function) within the supplying company?

Approximate number of supplier which whom you have a close relationship (trusting, personal, frequent contact).
- What types of products are typically bought from these suppliers?
- How these relationships are governed (stability)

Approximate number of suppliers which whom you have a distant relationship (infrequent contact, non-personal).
- What types of products are typically bought from these suppliers?
- How these relationships are governed (stability)

Chronological walkthrough of one innovation project

Pay special attention to:

- Relationship before collaborating vs. relationship after.

- Governance of the relationship during collaboration

- When and how suppliers involved
## APPENDIX B, ORIGIN SURVEY QUESTIONS

<table>
<thead>
<tr>
<th>Measures</th>
<th>Number of questions</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
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<td>General questions innovation project</td>
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<td>Timing of supplier involvement</td>
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Table 13, questions used in questionnaire, including the origin
APPENDIX C, OUTER LOADINGS

Raw output of the analysis of the outer loadings, as taken from SmartPLS

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<th>Outer Loadings</th>
<th>Capabilityitrust</th>
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Financial performance = 0.093 + 0.403exploit + 0.336explor – 0.024exploit² + 0.620 (exploit x explor) – 0.428explor²
Quality = -0.078 + 0.381exploit + 0.324explor + 0.249exploit^2 - 0.269 (exploit x explor) - 0.016explor^2
Planning = 0.322 + 0.634exploit - 0.265explor - 0.397exploit^2 + 0.425 (exploit x explor) – 0.131explor^2
APPENDIX E, QUESTIONNAIRE

Algemeen
De volgende vragen zijn bedoeld om een algemeen beeld te scheppen van uw bedrijf.

1. Wat is uw functie?
   *Markeer slechts één ovaal.*
   - Algemeen Directeur
   - Technisch Directeur
   - Projectmanager
   - Inkoopmanager
   - Innovatiemanager
   - Anders:

2. Wat is uw hoogst afgeronde opleiding?
   *Markeer slechts één ovaal.*
   - MAVO/VMBO
   - HAVO
   - VWO
   - MBO
   - HBO
   - WO
   - Post doctoraal
   - Anders:

3. Wat is uw leeftijd?
   *Markeer slechts één ovaal.*
   - Jonger dan 25 jaar
   - 25-35
   - 36-45
   - 46-55
   - 56-65
   - Oudere dan 65 jaar
4. In welk jaar is uw bedrijf opgericht?

______________________________________________

5. Hoeveel medewerkers telt uw totale bedrijf in 2014 (in FTE)?

______________________________________________

6. Wat is de geschatte omzet in 2014 in miljoenen euro’s (incl. BTW)?

______________________________________________

7. In welke branche(s) is uw bedrijf actief?

(meerdere antwoorden mogelijk)

Vink alle toepasselijke opties aan.

☐ Automatisering
☐ Chemie
☐ Foodtechnology
☐ Semiconductor
☐ Imaging & printing
☐ Mechatronica & productie
☐ Machinebouw
☐ Anders: ________________________________________________

8. Zijn er door uw bedrijf nieuwe producten, oplossingen of werkmethodes geïntroduceerd in de afgelopen 3 jaar (2012 - 2014)?

*Markeer slechts één ovaal.*

☐ Ja
☐ Nee

9. Zo ja, kunt u een schatting geven op hoeveel procent van omzet die producten, oplossingen en/of werkmethodes betrekking hadden tijdens het jaar 2014

______________________________________________

10. Wat is het geschat aantal FTE’s (fulltime-equivalent) dat besteed werd aan innovatie en product- of procesvernieuwing binnen uw onderneming in 2014?

______________________________________________
Innovatieproject
De resterende vragen in de enquête gaan over het laatst door uw bedrijf afgeronde project waarin nieuwe producten, oplossingen of processen zijn ontwikkeld of toegepast. Hierna innovatieproject te noemen.

11. Heeft u een innovatieproject afgerond?

*Markeer slechts één ovaal.*

- Ja
- Nee (laat onderstaande velden leeg en druk op doorgaan) *Na de laatste vraag in dit gedeelte stop je met het invullen van dit formulier*

12. Zo ja, kunt u het laatst afgeronde innovatieproject kort omschrijven

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

13. Wat is het geschatte percentage van de ontwikkeling van bovenstaand innovatieproject dat door derde(n) is uitgevoerd.
   *(bv. door adviseurs, leveranciers en/of kennisinstellingen)*

*Markeer slechts één ovaal.*

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

14. Hebben leveranciers een bijdrage geleverd aan de ontwikkeling van het innovatieproject?
   *(bijvoorbeeld door het [informeel] geven van advies)*

*Markeer slechts één ovaal.*

- Ja
- Nee *Na de laatste vraag in dit gedeelte ga je naar vraag 43.*
Leveranciers
De resterende vragen van de enquête gaan over het laatst door uw bedrijf afgeronde innovatieproject.

De volgende vragen gaan over de mate waarin u leveranciers hebt betrokken tijdens het innovatieproject. Kunt u aangeven in welke mate u het eens bent met de volgende stellingen?

15. Wij hebben leveranciers informeel om advies gevraagd
-Markeer slechts één ovaal.

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16. Leveranciers hebben input geleverd op het technisch ontwerp of de processen
-Markeer slechts één ovaal.

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17. Leveranciers hebben expertise geleverd tijdens het ontwikkelen of ontwerpen van de opdracht, processen, producten of onderdelen
-Markeer slechts één ovaal.

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18. Leveranciers hebben producten, componenten of processen voor ons ontworpen
-Markeer slechts één ovaal.

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19. Leveranciers hebben subassemblages voor ons ontwikkeld

*Markeer slechts één ovaal.*

1 2 3 4 5

Helemaal oneens □ □ □ □ □ Helemaal eens

20. Een innovatieproces kan opgedeeld worden in verschillende fasen. Onderstaand is hiervan een voorbeeld gegeven. In welke fase van het project heeft u leveranciers betrokken?
(niet alle fases zijn van toepassing voor ieder project)

*Vink alle toepasselijke opties aan.*

☐ Ideegeneratie
☐ Zakelijke en technische evaluatie
☐ Technisch ontwerp/ concept ontwikkeling
☐ Prototypen bouwen, testen en/of uitvoeren pilot
☐ Productie
☐ Anders: __________________________

Kennisdeling

De volgende vragen gaan over kennisdeling tussen uw bedrijf en leveranciers tijdens het innovatieproject. Kunt u aangeven in welke mate u het eens bent met de volgende stellingen?

21. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...

... waren cruciaal voor de samenwerking

*Markeer slechts één ovaal.*

1 2 3 4 5

Helemaal oneens □ □ □ □ □ Helemaal eens
22. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor besparing in materiaal
   Markeer slechts één ovaal.

23. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor kostenbesparingen
   Markeer slechts één ovaal.

24. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor een efficiëntere uitvoering van het project
   Markeer slechts één ovaal.

25. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor een verbeterde processen
   Markeer slechts één ovaal.
26. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor langdurige samenwerking
   Markeer slechts één ovaal.

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27. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor nieuwe opdrachten, afzetmarkten of -kanalen
   Markeer slechts één ovaal.

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28. Kennisdeling en informatie-uitwisseling met leveranciers tijdens het innovatieproject...
   ... hebben gezorgd voor meer continuïteit op de lange termijn in de gehele keten
   Markeer slechts één ovaal.

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Innovatieproject

De volgende stelling gaat over de gevolgen van het betrekken van leveranciers tijdens het innovatieproject. Kunt u aangeven in welke mate u het eens bent met de volgende stellingen.

29. Zonder het betrekken van leveranciers was het...
   ... innovatieproject niet tot stand gekomen
   Markeer slechts één ovaal.

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De volgende vragen gaan over de relatie tussen uw bedrijf en de leverancier met de grootste impact op het innovatieproject.
33. Hoelang heeft u zaken gedaan met de leverancier voordat deze betrokken werd bij het innovatieproject?

Markeer slechts één ovaal.

☐ 0-1 jaar
☐ 1-2 jaar
☐ 3-5 jaar
☐ Langer dan 5 jaar

De volgende vragen gaan over het vertrouwen dat uw bedrijf heeft in de leverancier die de grootste impact had op het innovatieproject. Kunt u aangeven in welke mate u het eens bent met de volgende stellingen?

34. Onze wederzijdse relatie wordt gekenmerkt door een hoge mate van vertrouwen

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35. Wij vertrouwen erop dat de leverancier niet van het contract/afspraken afwijkt

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36. Wij zijn sceptisch over de informatie die de leverancier ons verstrekt

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37. Wij vertrouwen erop dat de leverancier de benodigde middelen heeft (bv. kapitaal, arbeidskrachten) om zijn taken in dit project uit te voeren

_**Markeer slechts één ovaal.**_

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38. Wij erkennen de reputatie en capaciteiten van de leverancier

_**Markeer slechts één ovaal.**_

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De volgende vragen gaan over de (contractuele) afspraken tussen uw bedrijf en de leverancier met de grootste impact.

39. Wat voor schriftelijke (contractuele) afspraken zijn er gemaakt met de leverancier?

(Meerdere antwoorden mogelijk)

_Vink alle toepasselijke opties aan._

- [ ] Geheimhoudingsverklaring
- [ ] Ontwerpcontract
- [ ] Levercontract
- [ ] Raamcontract
- [ ] Anders: ____________________________

40. We hebben formeel vastgelegd...

... wat de consequenties zijn wanneer gewenste prestaties niet geleverd worden _**Markeer slechts één ovaal.**_

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41. We hebben formeel vastgelegd...
   ... wat zal gebeuren ten gevolge van een onvoorziene gebeurtenis
   *Markeer slechts één ovaal.*

   1 2 3 4 5
   Helemaal oneens Helemaal eens

42. We hebben formeel vastgelegd...
   ... hoe conflicten worden opgelost
   *Markeer slechts één ovaal.*

   1 2 3 4 5
   Helemaal oneens Helemaal eens

**Innovatieprestaties**

De volgende vragen gaan over de resultaten van het innovatieproject. Kunt u aangeven in welke mate u het eens bent met de volgende stellingen?

43. Het project was eerder afgelopen dan gepland
   *Markeer slechts één ovaal.*

   1 2 3 4 5
   Helemaal oneens Helemaal eens

44. De winstmarge van het project was hoger dan gepland
   *Markeer slechts één ovaal.*

   1 2 3 4 5
   Helemaal oneens Helemaal eens

45. De kwaliteitsdoelstellingen van het project zijn overtroffen
   *Markeer slechts één ovaal.*

   1 2 3 4 5
   Helemaal oneens Helemaal eens
46. Het project is goedkoper uitgevoerd dan vooraf was begroot

_Markeer slechts één ovaal._

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47. Heeft u nog op- of aanmerkingen met betrekking tot dit onderzoek of deze enquête?

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