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Knowledge Intensive Business Services: Contributing to the firms' New Product Development

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Abstract

Firms increasingly face the challenge of diverse technology and knowledge per product (Pavitt, 1999), and an increase in competitive pressure incites them to place greater emphasis on R&D, technological innovation and new products (Cooper, 1982), that is due to deregulation and rapid technological change and diffusion (D'Aveni, 1994). Firms eventually need to look to external sources for inputs to this process (Bessant & Rush, 1995). One specific type of external sources that received extensive attention within the literature is intermediaries. Studies denote sufficient attention has been paid to the intermediaries' function (Howells, 2006; Mahnke *et al*., 2008), however insufficient attention has been paid to the question when, and how intermediaries add value to the process of product development (Lichtenthaler & Ernst, 2008; Mahnke *et al*., 2008; Tran *et al*., 2011). The value-adding function of the intermediary is in this research advocated to be seen as an input to the process of building up dynamic capabilities. The role of intermediaries has been explored in the context of service innovation, but particularly in relation to the growth of Knowledge Intensive Business Services (KIBS) (Howells, 2006; e.g. Miles *et al*., 1995). This research investigates what aspects are determinative for the choice of using KIBS, in what way they influence the property of KIBS use and what aspects can be used to measure the efficient and effective use of KIBS. In addition, the effect of KIBS on New Product Development (NPD) aspects should point out whether using KIBS contributes to the NPD performance. For this, the statistical program SPSS is used. Results substantiate the theory that synergy and complexity are important aspects for the choice of using KIBS. In addition, results point to the possibility that the motive for using KIBS is important regarding the properties of KIBS use and lastly, both growth in synergy and NPD performance can be used as measures of effective and efficient use of KIBS.

Samenvatting

Bedrijven worden in een toenemende mate geconfronteerd met verschillende technologieën en kennis betreffende een product (Pavit, 1999). Daarnaast zet een toenemende mate van concurrentiedruk de bedrijven aan om meer nadruk te leggen op O&O, technologische innovatie en nieuwe producten (Cooper, 1982), welke in beide gevallen te wijten is aan de deregulering en snelle technologische verandering en diffusie (D'Aveni, 1994). Op den duur moeten bedrijven op zoek naar externe bronnen voor input voor dit proces (Bessant & Rush, 1995). Een specifiek type van externe bronnen die binnen de vakliteratuur veel aandacht heeft gekregen is intermediairs. Verschillende studies geven aan dat er voldoende aandacht is besteed aan de functie daarvan (Howells, 2006;. Mahnke *et al*., 2008), maar er is onvoldoende aandacht besteed aan de vraag wanneer en op welke manier deze intermediairs waarde toevoegen aan het proces betreffende de productontwikkeling (Lichtenthaler & Ernst, 2008; Mahnke *et al*., 2008; Tran *et al*., 2011). Dit onderzoek pleit dat de toegevoegde waarde van intermediairs kan worden gezien als input voor het opbouwen van de dynamische capaciteiten van het bedrijf. De rol van intermediairs is onderzocht in het kader van service innovatie, maar dit had vooral betrekking op de groei van Kennis Intensieve Organisaties (KIOs) (Howells, 2006; e.g. Miles *et al*., 1995). Deze studie onderzoekt welke aspecten bepalend zijn voor de keuze van het gebruik van KIOs; op welke manier zij het gebruik van KIOs beïnvloeden; en welke aspecten gebruikt kunnen worden om het efficiënt en effectief gebruik van KIOs te kunnen meten. Daarnaast moet het effect van KIOs op aspecten van nieuw product ontwikkeling (NPO) aantonen of het al dan niet gebruiken van KIOs bijdraagt aan de prestaties van NPO. Hiervoor wordt het statistische programma SPSS gebruikt. De resultaten onderbouwen de theorie in de zin dat synergie en complexiteit belangrijke aspecten zijn voor de keuze van het gebruik van KIOs. Daarnaast wijzen de resultaten op de mogelijkheid dat het motief voor het gebruik van KIBS belangrijk is met betrekking tot de eigenschappen van het gebruik van KIOs en ten slotte, zowel groei in synergie en de prestaties van NPO kunnen worden gebruikt om de effectiviteit en efficiëntie in het gebruik van KIBS te meten.

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1 Introduction

One specific type of external source that received extensive attention within the literature is intermediaries. Innovation System studies is one of many disciplines that have increasingly focused on organizations that fulfill an intermediary or bridging role (Lundvall, 1992; Nelson & Rosenberg, 1993; Van Lente *et al*., 2003; Toivonen, 2004; Howells, 2006). When taking an economic perspective, the value provided by an intermediary should exceed the cost of using them, but where this tradeoff occurs is poorly understood (Mahnke *et al*., 2008). Studies denote sufficient attention has been paid to the intermediaries' function (Howells, 2006; Mahnke *et al*., 2008), however insufficient attention has been paid to the question when, and how intermediaries add value to the process of product development (Lichtenthaler & Ernst, 2008; Mahnke *et al*., 2008; Tran *et al*., 2011). Tran *et al*. (2011) note their study is among the first that focus on that question. In addition, from the few studies available on intermediaries' contribution, most focus on its benefits, yet there is a lack of attention on the relative costs of using an intermediary (Mahnke *et al*., 2008). Focusing on these aspects is of importance, since expected benefits of outsourcing are often not realized (Tran *et al*., 2011), due to factors like competency gaps (Cusumano, 2006), poor relational capabilities (Lane and Lubatkin, 1998), cultural distance (Gopal *et al*., 2002; Sahay *et al*., 2003, Mahnke *et al*., 2008), lack of experience in using exchange platforms (Lichtenthaler & Ernst, 2009), insufficient technological dialogue (Monteverde & Teece, 1995), and technological uncertainty (Mahnke *et al*., 2008).

In his study towards the role of intermediaries, Howells (2006) finds that intermediaries are more diverse than previous studies have implied and that the range of services being offered appears to be increasing over time. In this research, the scope of diversity in intermediaries is narrowed down. There are broadly three types of intermediary organizations; Knowledge Intensive Business Services (KIBS), Research and Technology Organizations (RTO) and (semi-) public organizations that are involved in policy related work (Van Lente *et al*., 2003). This research focuses on KIBS since they are considered as having an increasingly important role in innovation processes (Smits, 2002), which applies to both the service and industry sector (Den Hertog, 2000). KIBS are defined as: "*Private companies or organizations; relying heavily on professional knowledge, i.e. Knowledge or expertise related to a specific (technical) discipline or (technical) functional domain: and, supplying intermediate products and services that are knowledge based*" (Den Hertog, 2000: p. 505).

National economies differ regarding the structure of the production system and the general institutional set-up (Lundvall, 1992; Nelson & Rosenberg, 1993). In their research on National Innovation Systems, Patel and Pavitt (1994) found that there is considerable diversity among OECD countries in workforce skills, technological learning and institutional settings. It also has been recognized that innovations are localized because of collaboration and interaction between firms and surrounding actors (Andersson & Karlsson, 2004). Above, as much of the relevant knowledge used for innovation is tacit (Andersson & Karlsson, 2004), not surprisingly, knowledge formation and its use largely depend on the social and institutional context in a region (Lam, 1998). Christensen *et al*. (2001) found that technological services largely seem to be appropriated in a national setting. For these and practical reasons, the scope of this research is limited to one nation (The Netherlands).

Further delineation focuses on the machine industry. In recent years, the Dutch machine industry suffered from the 2008-2009 depression. From 2007 the industry saw a reduction in growth of turnover and output until midst 2008 (numbers compared with the previous year). From midst 2008 until midst 2009 it even saw a decrease of 20% in both turnover and output (CBS 2009; 2011a). From midst 2009 until present the industry witnessed an increase in turnover and output. The turnover in February 2011 was even 45% higher than in 2010 (CBS, 2011a). The industry must be innovative to gain and maintain a competitive advantage, especially due to competition from low-wage countries (Rabobank, 2011). According to EIM (2005), the machine industry was the sixth largest innovative sector in the Netherlands in the period 2002-2005. Besides the social relevance to aid in the improvement of this sector, the choice for this sector is also practical due to its high innovativeness. The possible fruitful combination between this innovative sector and it using intermediaries is indicated by Christensen *et al*. (2001), who in their study on KIBS collaboration found that especially manufacturing firms are intensively using KIBS. In their study on several West-European countries, the machine industry was one of the sectors that showed a significant result.

Whether the use of KIBS is justified depends on several factors, but all are product (project) dependent. A branch of literature that focuses on project specific aspects is New Product Development (NPD). A part of this literature focuses on success factors of NPD that are reviewed by Montoya-Weiss & Calantone (1994) and Ernst (2002). Their work provides a starting point to provide a usable framework of factors that captures different

aspects of the NPD. Using those factors in this research enables comparison between KIBS and non-KIBS users in the machine industry on a project level. A new product is seen in this research as: *a completed product that the firm markets/sells and what the firm considers new; either new to the firm, new to the market or new globally*. In addition, this study is among the first to focus on the questions when and how intermediaries add value to the product development, as Tran *et al*. (2011) conclude that: "*Specifically, little knowledge exists on the role of intermediaries in the NPD processes.*" (p. 89). More specifically, Toivonen (2004) notes that studies aimed at empirical investigation on the effect of KIBS on the growth of productivity and competitiveness are rare.

So, more insight is needed regarding how and when value is added by intermediaries. In particular, this research focuses on the use of KIBS in the machine industry within the Netherlands. The financial aspects of KIBS are not incorporated within the research. As Tran *et al*. (2011) notes, intermediaries add value by offering a set of capabilities that are idiosyncratic to their clients. The complex relation between the intermediary and its clients does not take place through structured standard interfaces as with the trading of financial assets (Mahnke *et al*., 2008). Incorporating the financial aspect would increase the complexity of the research to the extent that it is beyond the scope of this research. This poses the general question of this research alongside sub-questions. The general question to be answered is:

To what extent does the use of KIBS contribute to the new product development performance of a firm within the machine industry in the Netherlands?

The focus lies on what aspects are determinative for the choice of using KIBS, in what way they influence the property of KIBS use and what aspects can be used to measure the efficient and effective use of KIBS. These combined will provide a set of circumstances that firms can use to see whether they should use KIBS or not. In addition, the effect of KIBS on NPD aspects should point out whether using KIBS contributes to the NPD performance. For this, the work of Tran *et al*. (2011) on classifying the intermediaries' value-adding function and the theory of Tordoir (1993) is used. Sub-questions will be dealt with to provide the basis for the general research question and will be answered by conducting a structured questionnaire, where literature can be used to substantiate any findings. Using questionnaires is an appropriate method when gathering knowledge or opinions (Baarda & de Goede, 2001).

I. *What/which non-financial aspect(s) are/is important for the choice of using KIBS?* [i]
II. *In what way are/is the aspect(s) determinative for the choice of using KIBS?*[ii]
III. *What/which non-financial aspect(s) are/is important for the property of KIBS use?*[iii]
IV. *In what way do/does these/this aspect(s) influence the property of KIBS use?*[iv]
V. *What/which non-financial aspect(s) can be used to measure the efficient and effective use of KIBS?*[v]
VI. *In what way do/does these/this aspect(s) measure the efficient and effective use of KIBS?*[vi]
VII. *What does the use of KIBS has for effect on NPD performance compared for firms who do not use KIBS?*[vii]

Before dealing with the sub-questions though, a number of concepts need to be clarified first, since many are diverse of nature. This is done through a literature study. Questions related to this part are denoted by the alphabetic list. The main part is denoted by its numerical list.

A. Why do firms need external sources?
B. What are 'Knowledge Intensive Business Services' and what is their function?
C. How does the function of KIBS relate to the new product development of a firm?

[i] For matters of convenience, regarding each sub-question, its relation towards a part of the research is already given. In this way the reader is better able to link the related components throughout the research upon dealing with them. This is also done because the framework follows a different order than the questions, since parts of the framework build on previous elements. This question relates to the theoretical framework part II, prior to the suggested relations R2 and R3.
[ii] Relates to the suggested relations R2 and R3.
[iii] Relates to theoretical framework part II, prior to the suggested relation R1.
[iv] Relates to the suggested relation R1.
[v] Relates to the theoretical framework part II, prior to the suggested relation R4 and R5.
[vi] Relates to the suggested relation R4 and R5a.
[vii] Relates to the suggested relation R5b.

Combining the results of the first and second part of the study gives a comprehensive insight regarding the use of KIBS, particularly regarding the value-adding function in respect to the product performance. A better understanding in when and how value is added is helpful in improving the use (mismatch) of KIBS. As Bessant and Rush (1995) note, there is the problem of matching intermediaries with users. This research not only adds to the intermediaries' literature, but also to the NPD literature, since intermediaries are not or underrepresented in NPD performance indicator studies. This study sheds light on a distinct type of external sources.

The research structure is clearly descriptive, since it lays out the circumstances under which firms engage in KIBS and to what extent KIBS contribute to the new product development performance. The function of the research question is explanatory though, as a comprehensive insight is given regarding the use of KIBS and its value-adding function in respect to the product performance. The achieved domain is restricted towards the machine industry in the Netherlands where the focus is on the use of Knowledge Intensive Business Services (KIBS). As apparent, the independent variable is the use of KIBS. The dependent variables are the performance indicators of the manufacturing firms in the machine industry.

When focusing on the machine industry, comparing the performance of firms using KIBS and those not, shows whether the use of KIBS enhances the new product development (NPD) performance of the firm. In turn, it also answers whether the use of KIBS adds to the performance of the sector in question and consequently contributes to the overall innovation system (Netherlands) performance. The Netherlands has an open economy that strongly depends on its export (Volberda, 2008; Agentschap NL, 2010). Its goal is to create a knowledge economy and position itself among the top innovative countries worldwide. To compete internationally investments are needed in innovation to achieve targets made, which is an important task since a decline in the competitive position can lead among others to higher unemployment, a decreasing export, a decline in consumer demand and decreasing investments (Volberda, 2009). According to the Dutch department of Economic Affairs, when companies invest in innovation, they invest in their future competitive position (Agentschap NL, 2010). If they fail to innovate, they will fall behind and lose ground (Lundvall, 1992; Utterback, 1996). As an advocate of innovation, the goal to pursue is improving aspects of innovation where possible. In that sense this research adds to the innovation struggle of the Netherlands by contributing to a link (using KIBS in the machine industry) in the overall system.

Before starting with the theoretical framework, the notion of NPD is briefly introduced. Afterwards, the first part of the theoretical framework is dealt with in chapter 2. Chapter 3 subsequently deals with the second part of the theoretical framework. The methodological section is dealt with in chapter 4, followed by the results in chapter 5. Finally, the study discusses several issues in chapter 6, and concludes the findings in chapter 7.

1.1 Introducing New Product Development

"*New product development is critical to the success, profitability, and growth of many industrial firms.*" (Cooper, 1982: p. 215). Continuous development and market introduction of new products are important determinants of the competitive advantage of firms, or in other words, of sustained company performance (Ernst, 2002). The rise of the NPD literature is due to increased competitive pressure that incites managers to place greater emphasis on R&D, technological innovation and new products (Cooper, 1982), and it kept retaining a high level of popularity (Ernst, 2002). Even though new products create opportunities, empirical studies point to the high failure rates of new products (Cooper, 1982; Ernst, 2002), which has led to a demand to reexamine the alarmingly high failure rate (Cooper, 1982). Past New Product Development (NPD) literature focused on three domains which are: factors leading to success; factors leading to failure; and factors that distinguish between success and failure (Montoya-Weiss & Calantone, 1994). These domains led to the identification of various determinants of new product performance (Ibid.) that can be used by managers to improve their NPD activities in the firm (Ernst, 2002). The spectrum is divided into five broad categories (Cooper & Kleinschmidt, 1995): NPD process; organization; culture; role and commitment of senior management and strategy. Results from NPD studies show that the NPD process focuses on pre-development activities (homework) (e.g. Cooper & Brentani, 1991; Parry & Song, 1994; Cooper & Kleinschmidt, 1995; Calantone *et al*., 1997; Souder *et al.*, 1997), but aspects that have figured prominently in studies of new product success focus on the skills and resources of the company (Song & Parry, 1997). Many NPD studies emphasize technical aspects of NPD (e.g.Cooper, 1979a; Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Cooper & Kleinschmidt, 1995; Song & Parry 1997; Souder *et al.*, 1997), but they also focus on marketing aspects

(e.g. Cooper, 1979a; Maidique & Zirger 1984; Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Cooper & Kleinschmidt, 1995; Song & Parry 1997; Balbontin et al 1999). Each of the five categories consists of a number of indicators that empirical research found critical as success factors of new products. Although many indicators are recurrent and consensuses exist on those categories that are of influence (Montoya-Weiss & Calantone, 1994; Ernst, 2002), still the list of indicators used per category varies. Chapter 3.4.2 elaborates on the range of indicators and makes a considered choice which indicators to take along in this research.
NPD research is conducted both at the program and project level. Program-based studies focus on generalizations regarding a firm's process of new product development (Montoya-Weiss & Calantone, 1994). It concerns a firm's research program, or how 'things are done here'. The latter concerns a specific product (project), whether successful or not. This research follows a project based approach regarding the NPD indicators used.

2 Theoretical framework part I

The study is divided into two parts. Before the elaborating on the framework that poses the basis of the research, first some basic elements are dealt with that are necessary to better understand the framework. After clarifying the main concepts, the work of Tran *et al*. and the theory of Tordoir are used to create the framework. The next sub-questions are dealt with throughout this part:

A. *Why do firms need external sources?*
B. *What are 'Knowledge Intensive Business Services' and what is their function?*
C. *How does the function of KIBS relate to the new product development of a firm?*

In addition, this part deals with the general concept of intermediaries and indicates that the research follows a knowledge-based view.

2.1 Following a knowledge-based view

The Netherlands can be seen as a system that involves the creation, diffusion and use of knowledge (Carlsson *et al*., 2002). For actors within an innovation system, gaining and maintaining a competitive position is subject to their innovative performance, which in turn depends on the dynamic capabilities of the firm (Teece *et al.*, 1997). Capability is seen as: "*…appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment*" (Teece *et al*., 1997: p. 515). This view is in line with the Resource Based theory that denotes that firms' specific assets and capacities, and the ability to create entry barriers are the most important determinants of the performance of an organization (Wernerfelt, 1984). To provide an example, many large internationals like IBM, Texas Instruments or Philips owe their success by apparently pursuing a 'resource based' strategy through accumulation of technological knowledge (Teece *et al*., 1997). However, according to Teece *et al*. (Ibid.) only pursuing a 'resource based' strategy is insufficient to explain their success. Although knowledge is a source of lasting competitive advantage (Nonaka, 1991), companies still fail to exploit it due to a lack of dynamic capabilities (Teece *et al*., 1997). The core of dynamic capabilities is seen by Leonard-Barton (1992) as the knowledge set that distinguishes and provides competitive advantage. The task is thus to ensure an efficient and effective exploitation of that knowledge; they are two sides of the same coin. Successful companies are the ones that continuously create new knowledge and can disperse and apply it quickly throughout the company (Nonaka, 1991). Developing, maintaining and enhancing the knowledge base can be done by building dynamic capabilities through learning (Nonaka, 1991). Not surprisingly, learning is seen as an important process in the innovation process (Lundvall, 1992; Andersson & Karlsson, 2004). The creation of knowledge is a matter of learning (Miles *et al*., 1995), but it is not simply a matter of processing objective knowledge, it also depends on tacit knowledge incorporated within the firm (Nonaka, 1991). Knowledge can be either explicit (formal) or tacit (informal) whereas the former refers to hard data, typically codified in books, reports, patents, etc. (Nonaka, 1991; Miles *et al*., 1995). Tacit knowledge is more difficult to identify, since it partly encompasses technical skills and routines, or the so called 'know-how' (Nonaka, 1991; Miles *et al*., 1995). Knowledge of this kind is highly personal, making it difficult to formalize and communicate and is most often acquired by learning-by-doing (Nonaka, 1991; Miles *et al*., 1995).

Firms increasingly face the challenge of diverse technology and knowledge per product (Pavitt, 1999), and an increase in competitive pressure that incites them to place greater emphasis on R&D, technological innovation and new products (Cooper, 1982), that is due to deregulation and rapid technological change and diffusion

(D'Aveni, 1994). As dynamic capabilities can be built up internally through various organizational learning processes (Nonaka, 1991), firms eventually need to look to external sources for inputs to this process (Bessant & Rush, 1995). Outsourcing can be seen as an organizational response to the knowledge-based competition as Mahnke (2001) notes: "*A need to compete based on focused and integrative learning, accessing external specialized-knowledge, and developing relational advantages through inter-firm cooperation.*" (Mahnke, 2001: p. 355). One specific type of external sources that received extensive attention within the literature is intermediaries. The contribution of intermediaries is based on the fact that firms are not able to adopt external knowledge, (that is important for innovation) into practice and by themselves (Toivonen, 2004). Sapsed *et al*. (2007) and other literature (e.g. Bessant & Rush, 1995; Howells, 2006; Love & Mansury, 2007) have suggested that intermediaries primarily exist to compensate for structural weaknesses in systems; to overcome market imperfections. The value-adding function of the intermediary is in this research advocated to be seen as an input to the process of building up dynamic capabilities whether they are used as mediators or when supplying services themselves. Research indicates that activities may be attractive for outsourcing by stressing efficiency gains in terms of transaction and production costs, and access to higher levels of expertise (Mahnke, 2001; Mahnke *et al*., 2008). Intermediaries create opportunities for firms to outsource innovation while mitigating associated costs (Tran *et al*., 2011). Increasing degrees of outsourcing even may contribute to curing the learning trap of over-exploitative learning (Mahnke, 2001) or as Levinthal and March (1993) call it, competence traps. They are a result of positive findings between experience and competence. Firms will more frequently carry out activities in which they are competent, thus exploiting past learning and not engaging in risky exploration (Mahnke, 2001).

According to Howells (2006), interest in the role of intermediaries has emerged from four sources. A first real interest in intermediaries rose from the field of diffusion and technology (e.g. Rogers, 1962). Initially, the contribution of third parties was sought to be in the dissemination of information and their impact on adoption rates (technology transfer) (Howells, 2006). Later studies (e.g. Hargadon & Sutton, 1997) altered the focus more in to what type of activities intermediaries are involved. Nevertheless, their role in the technology transfer process was acknowledged (Howells, 2006). Third, the Systems of Innovation literature is one discipline that has increasingly focused on organizations that fulfill an intermediary or bridging role (Lundvall, 1992; Nelson & Rosenberg, 1993; Van Lente *et al*., 2003; Howells, 2006), and last, research into service activity and service organizations, particularly in relation to KIBS (Howells, 2006). Others designate the increasing focus to a key trend of the broadening of decision-making processes and the knowledge society where networking becomes increasingly important (Smits, 2002), together with an increasing need for OECD firms in the 1980s to become more market oriented and to put themselves in front of the international market with better products (Van Lente *et al*., 2003). This trend relates to what is known as the transition from mono-disciplinary 'mode 1 science' to the multi-disciplinary 'mode 2 science' (Gibbons *et al*., 1994). In mode-2 various interactions between users and the world of research are common practice (Van Lente *et al*., 2003).

Studies denote sufficient attention has been paid to the intermediaries' function (Howells, 2006; Mahnke *et al*., 2008), however insufficient attention has been paid to the question when, and how intermediaries add value to the process of product development (Lichtenthaler & Ernst, 2008; Mahnke *et al*., 2008; Tran *et al*., 2011). Tran *et al*. (2011) note their study is among the first that focus on that question. Their framework is therefore used as a starting point in this research. When taking an economic perspective, the value provided by an intermediary should exceed the cost of using them, but where this tradeoff occurs is poorly understood (Mahnke *et al*., 2008). In contrast to trading financial assets, the complex relation between the intermediary and its clients does not take place through structured standard interfaces (Mahnke *et al*., 2008). There are, besides being financial, different costs associated with intermediaries that hinder firms in their innovation processes' progress. It shows that expected benefits of outsourcing are often not realized (Tran *et al*., 2001). For instance, switching costs during governance change like complementarity of capabilities (Mahnke, 2001). The latter states that whenever firms' capabilities differ from that of the intermediary, time and effort is needed to change to the appropriate level. As said above, the creation of knowledge also depends on tacit knowledge incorporated within the firm. As of such, it is apparent why incorporating an intermediary in the new product development process raises issues as switching costs during governance chance. Intermediaries add value by offering a set of capabilities that are idiosyncratic to their clients (Tran *et al*., 2011). As knowledge transfer requires common understanding and elaboration on both sides of the transaction, it requires more interaction between participants than with information exchange (Miles *et al*., 1995). The two-dimensional nature of knowledge makes this even a more complex task. Or as Lichtenthaler and Ernst (2008) put it: "*Besides the challenges of actually transferring technology, the characteristics of technological knowledge lead to*

appropriability issues…" (p. 21). Other factors are: competency gaps between contracting partners (Cusumano, 2006), poor relational capabilities (Lane and Lubatkin, 1998), cultural distance (Gopal *et al*., 2002; Sahay *et al*., 2003, Mahnke *et al*., 2008), lack of experience in using exchange platforms (Lichtenthaler & Ernst, 2009), insufficient technological dialogue (Monteverde & Teece, 1995), technological uncertainty (Mahnke *et al*., 2008), and that finding the right providers will not be easy (Tordoir, 1993).

In his study towards the role of intermediaries, Howells (2006) finds that intermediaries are more diverse than previous studies have implied and that the range of services being offered appears to be increasing over time. This is also apparent from his broad definition of an innovation intermediary: "*An organization or body that acts an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations.*" (Howells, 2006: p. 720). Although this definition was used as a first working definition in the study, Howells (2006) notes that innovation intermediaries were often not only involved in providing mediating services involving third parties, but also supplying services one-to-one without third party involvement. His advice is that further research into the range of intermediaries, the role they offer, and how this evolved over time still needs to be done. Due to the diversity of the concept intermediaries, it is imperative to make a choice regarding the type of intermediaries, to avoid the concept being too tenuous and leading to biased results. According to Van Lente *et al*. (2003), there are broadly three types of intermediary organizations, namely Knowledge Intensive Business Services (KIBS), Research and Technology Organizations (RTO) and (semi-) public organizations that are involved in policy related work. The role of intermediaries has been explored in the context of service innovation, but particularly in relation to the growth of KIBS (Howells, 2006; e.g. Miles *et al*., 1995). In addition, KIBS are considered as having an increasingly important role in innovation processes (Smits, 2002), which applies to both the service and industry sector (Den Hertog, 2000). This provides the rationale for the choice of KIBS in respect to RTO's and (semi-) public organizations.

2.2 Knowledge Intensive Business Services

When looking to the notion of services and to give an initial idea of the KIBS' function, the definition of Gadrey *et al*. (1995) of services provides a good starting point. To produce a service is: "*to organize a solution to a problem (a treatment, an operation) which does not principally involve supplying a good. It is to place a bundle of capabilities and competences (human, technological, organizational) at the disposal of a client and to organize a solution, which may be given to varying degrees of precision*." (Gadrey *et al*., 1995: p. 5). Although this definition emphasizes that not only technological, but also human and organizational capabilities are important for providing services, this view initially did not hold. In past decades, the view on services and service innovations has changed. Over a long period, they were discounted in terms of technological innovation (Den Hertog, 2000), and were mainly portrayed as a supplier-dominated sector (e.g. Pavitt, 1984; Barras, 1990). However, as the field of service innovation studies expanded, two important results emerged (Den Hertog, 2000). First, as services contribute to innovation processes, they cannot be regarded as mere passive recipients of others' innovations (Den Hertog, 2000). Second, due to the recognition of non-technological elements of service innovation, the focus on technological innovation has been moderated (Ibid.). These results point to the increasing recognition and support of the importance of service innovation in the realm of innovation itself.

Den Hertog (2000) introduced a four dimensional model of service innovations to better analyze and map their diversity. The first dimension refers to the concept of services self. Regarding manufactured products, services are often not tangible and visible (Ibid.), although there are exceptions (e.g. bellhop). A key aspect of services is that their application needs to be novel within a particular market (Ibid.). Recall that this view is largely in line with the definition of a new product in this research; a completed product that the firm markets/sells and what the firm considers new; either new to the firm, new to the market or new globally. The second dimension focuses on the client interface. There is a high degree of interaction between users and producers of service products (Miles, *et al*., 1995; Den Hertog, 2000). Depending on the type of services, the close relations and high interaction between user and producer varies from service to service (Miles *et al*., 1995). Upon introduction to the market, a typical good or service that is standardized will have a high interaction between producer and user, which declines as the product becomes standardized. A typical service or customized manufactured good still demands high interaction (Miles *et al*., 1995). Increasingly, the interaction between the user and producer is becoming less clear; there is not clearly an identifiable point where the producers' activity stop, and the

users' activity begin (Den Hertog, 2000). The third dimensions relates to the service delivery system and organization. This dimension is closely related to the previous one, since it refers to the link between the client and service provider. It is not to be confused with delivery itself, as one specific type of interaction, but it refers to the internal organizational arrangements (Ibid.). As Den Hertog (2000) notes, it is closely related to the question of: "*…how to empower employees, to facilitate them so that they can perform their jobs and deliver service products adequately*." (p. 497). An example is the emergence of home shopping services that caused a substantial change in the user-producer relation (ibid). The last dimension refers to technological options. Although, as indicated above, service innovations do not only require technology as a dimension, there still is a wide range of relationships between them. In addition, technology innovations regarding services are considered to be mainly user-dominated (Ibid.). Den Hertog (2000) states that particular service innovation may display one dominant feature that relates to one of the above domains. However, mostly a combination of the four dimensions characterizes each particular service innovation, where the weight of each dimension and the linkages between them vary according to type of service, innovation of firm (Ibid.).

A particular form of service activities are Knowledge Intensive Business Services. KIBS are defined as: "*Private companies or organizations; relying heavily on professional knowledge, i.e. Knowledge or expertise related to a specific (technical) discipline or (technical) functional domain: and, supplying intermediate products and services that are knowledge based*" (Den Hertog, 2000: p. 505, original definition from Miles *et al*., 1995). It shows that the KIBS' function remains broad as it still covers a wide range of services (Den Hertog, 2000). KIBS either function as facilitator, carrier or source of innovation, and besides are often highly innovative themselves (Miles *et al*., 1995; Den Hertog, 2000). Toivonen (2004) notes that a uniform definition of KIBS is still missing, however the definition from Miles *et al*. (1995) provides a very good basis and is therefore also used for this research.
As the name implies, knowledge is the most important input regarding firms that are labeled knowledge-intensive and should not to be confused with information (Starbuck, 1992). For firms that encounter any problems it is not simply seeking support from a KIBS that provides the necessary information. On the contrary, knowledge transfer requires common understanding and elaboration on both sides of the transaction and therefore requires more interaction between participants than with information exchange (Miles *et al*., 1995). Knowledge is not just organized information but involves the ability to organize information and applying it (Toivonen, 2004) and thus is a matter of learning (Miles *et al*., 1995). As said above, developing, maintaining and enhancing the knowledge base can be done by building dynamic capabilities through learning (Nonaka, 1991). To be more specific, the interaction between KIBS and its client is captured by the notion of 'interactive learning'. The clients' knowledge base increases due to interaction with the KIBS, whereas the KIBS on its turn gains experience within their specific field of expertise (Den Hertog, 2000). Seen the definition of capabilities given earlier, KIBS thus contribute to the firms' skills, resources and competence (building dynamic capabilities), thereby enhancing the knowledge base that indirectly influences the eventual performance of new products. They thus contribute to strengthen the competitive position of the firm (Miles *et al*., 1995). As Bessant and Rush (1998) note, within the innovation process, gaps occur in firms' resources and capabilities, were intermediaries (and KIBS) direct or indirectly contribute to help firms bridge those gaps. In addition, KIBS enhance a firm's ability to adjust more rapidly to a continuous changing environment (Christensen *et al*., 2001). According to Den Hertog (2000) KIBS have a symbiotic relation with the client firms; they are mutually depended. Without the use of KIBS, client firms would struggle to acquire the necessary capabilities within a certain time span or are not able to acquire them at all. KIBS on the other hand would not exist without firms seeking their expertise. In addition, an important part of their function is that they provide a point of fusion between information that is more generally available throughout the economy and firm specific problems or more local requirements (Den Hertog, 2000). The aspect of knowledge-intensive thus concerns the development of knowledge through learning in networking (Miles *et al*., 1995), which especially regards innovation networks on a regional level as KIBS' markets are local or regional (Toivonen, 2004). However, this does not mean that every firm with a set of knowledge can be labeled KIBS. Firms should only be labeled KIBS if expertise makes an important contribution; it regards exceptional and valuable expertise that dominates commonplace knowledge (Starbuck, 1992).

Looking at the definition given earlier, KIBS can be further divided into two groups (Miles *et al*., 1995: p. 28-30):

- Traditional professional services, liable to be intensive users of new technology and;
- New Technology-based KIBS (T-KIBS).

Traditional professional services typically are users of new technology, rather than agents in development and diffusion (Miles *et al*., 1995). Examples of this kind of firms are (from Miles *et al*., 1995):

- Marketing/advertising;
- Some financial services (e.g. securities and stock-market-related activities);
- Accounting and bookkeeping and;
- Legal services.

But the main interest regarding KIBS particularly relates to the development of new services that are linked to technology, and the transfer and production of knowledge regarding new technology (Ibid.). Examples are (from Miles *et al*., 1995):

- Computer networks/telematics (e.g. VANs, online databases);
- Some telecommunications (some new business services);
- Software;
- Other computer-related services (e.g. Facilities Management)
- Training in new technologies;
- Design involving new technologies;
- Technical engineering and;
- R&D consultancy and 'high-tech boutiques'.

The division into technology-based and non-technological KIBS is especially applied in studies that emphasize the linkages between KIBS and innovation (Toivonen, 2004). The division between these two types also allows for examination according to different branches of industry (Werner, 2001). This research is therefore delineated by focusing on T-KIBS. Henceforth, when referring to KIBS, the focus is on T-KIBS, unless otherwise specified. Focusing on this specific type of KIBS adds to the scientific relevance of this research, as Den Hertog (2000) notes, this sub-category is only occasionally considered within the existing literature and policy practice on technological innovation.

3 Theoretical framework part II – Classifying KIBS value adding functions

The second part of the study focuses on what aspects are determinative for the choice of using KIBS, in what way they influence the property of KIBS use and what aspects are important for efficient and effective KIBS use. In addition, the effect of KIBS on NPD aspects should point out whether using KIBS contributes to the NPD performance. Recall that NPD research makes a distinction between program and project level based studies. Since this research follows a project-based approach regarding the NPD indicators used, factors that determine the outcome of the product development are all product (project) dependent. First, the work of Tran *et al*. (2011) and Tordoir (1993) is explained, after which they are combined into the framework as used in this research. The latter part thus deals with the sub-questions I till VII.

3.1 Tran *et al.*'s framework

For the framework in the next part of this study, the work of Tran *et al*. (2011) is used as a starting point. They developed a framework (Table 1) for classifying intermediary value-added functions based on a detailed case study. The framework distinguishes between the scope of intermediary involvement and the NPD speed that result in four types of value-adding capabilities or motives for firms to use KIBS. Tran *et al*. (2011) is rather straightforward about the distinctions. The idea behind the first aspect is that depending on the complexity of the services delivered by the intermediaries and the number of involvement points, the scope of intermediary involvement can be either simple or complex (Tran *et al*., 2011). In case of a simple scope, it denotes a value-added task where the intermediary is involved in one (or few) stage(s) of the process (Ibid.). In case of a complex scope, it denotes specialized tasks where the intermediary is involved in all or multiple stages (Ibid.). The second aspect focuses on the speed of the NPD. The fashion industry used by Tran *et al*. (2011) is characterized by its rather different NPD speeds. Fashion styles range in product life cycles from 15 to 30 days, approximately 90 days, to cycles larger than one year (Ibid.). Products with a short life cycle require a fast NPD where products with a long(er) life cycle require a slow NPD speed. The fashion industry makes a distinction between 'basic' and 'fast' items (Ibid.). Basic items are for instance t-shirts which are less subject to trends and have predictable demand patterns (Ibid.). Fast items are more known as trend related, as of such those items need to be manufactured quickly and cheaply (Ibid.).

This provides four value-adding capabilities of an intermediary that are: best cost, product solution, timing, and market response. Regarding the first, intermediaries help reducing costs in finding the best-cost suppliers for

basic items such as t-shirts. Examples of cheap manufacturing are locations as China or India. The second aspect is sought by firms in the high-end segment. These firms focus on high quality and innovative styles and only offer a few collections per year. Intermediaries can focus here on providing new materials or new ways of tailoring. Timing refers to intermediaries that help the firm in getting the product in stores on time. Client firms thus outsource a logistic part in the NPD process. The last aspect is a mixture of product solution and timing. Firms who seek market-responsiveness demand products with good quality and innovative styles, alongside with swift delivery to stay ahead of market trends (Tran *et al*., 2011)

However, the framework is only partly used for two reasons. First this research focuses on T-KIBS, which means that all usage of KIBS relates to the technical side of the product and not timing or market response services that focus more on logistic issues rather than on technological aspects. A second issue relates to a difference in the characteristics of the sector used. The fashion industry researched by Tran *et al*. (2011) is characterized by its rather different NPD speeds. Fashion styles range in product life cycles from 15 to 30 days, approximately 90 days, to cycles larger than one year (Tran *et al*., 2011). Seen the type of firms categorized in the machine industry (appendix 9.1) it is assumed that in respect to the fashion industry life cycles in the machine industry are less determinative.

Table 1 – Framework for classifying intermediary value-adding functions (Source: Tran *et al*., 2011).

		Scope of intermediary involvement	
		Simple	Complex
NPD Speed	Slow	**Best Cost** Decreasing costs of product development	**Product Solution** Offering new and enhancing current product attributes
	Fast	**Timing** Increasing product development and scaling speed	**Market Response** Reducing hit/miss risk Improving fashion actuality Offering new product attributes

3.2 Tordoir's theory

The framework of Tran *et al*. (2011) has its limitations though, since it only makes a difference between the scope of involvement and NPD speed. What is more interesting is under which circumstances the firm is triggered to engage in cost reduction and/or product solution motives. The theory of Tordoir (1993) shows similarities with the framework of Tran *et al*. (2011) and can be used to further elaborate on both motives. In his book on The Professional Knowledge Economy, two main hypotheses are followed that are related to the general function of professional work; the complexity and compatibility hypothesis. Professional knowledge is seen as: "*the articulation of science, personal skill and experience, and organizational routine*." (Tordoir, 1993; p. 21). A difference with knowledge of firms is that professional knowledge is rather lateral than vertical (Ibid.). Knowledge of the firm is stored in organizational routines as viewed by the economic theory of knowledge and innovation. This refers to what is said above about tacit knowledge, that partly encompasses technical skills and routines, or the so called 'know-how'. Vertical knowledge is firm specific, whereas professional knowledge is lateral, which means its development and value depends on exchange of professional experience throughout different sectors (Ibid.).

The first hypothesis focuses on the development of professional support within the firm and concerns the operations in a firm, human relations, and the relations with the external environment. To clarify the contrast between internal and external professional support, Tordoir uses the former Mintzberg's basic model of the organization to distinct between use of professionals in different divisions in the organization. External support is seen as buying professional support from external sources via market transactions, whereas internal support takes place within the organization primarily for internal users (Ibid.). The development of professional support is seen as a result of the interplay between three aspects: mechanistic complexity, voluntary complexity and coupling (Ibid.). First, coupling is the degree of interdependency between systems within a firm. Tordoir predicts that tight coupled systems require more professional support than loosely coupled systems. In tight coupled systems, changes in one part of the firm or in the environment affect other parts, and therefore the

requirements and value for internal and external support is higher (Ibid.). Complexity is not only seen as intricacy in a mechanistic way, but also, as Tordoir calls it, voluntary complexity. The difference is that mechanistic complexity refers to the intricacy like the technology of a watch (hence mechanistic), where voluntary complexity refers to the plurality of human intentions and cultures (Ibid.). This is in line with the view of March and Simon (1958) that note that firms are often a mixture of different conflicting intentions and cultures.

Tordoir (ibid.) states that the combination of complexity and coupling can hypothetically be related to the professional knowledge requirements. In tight coupled systems, an increase of mechanistic and voluntary complexity of operations and development requires a higher professional support, the effect of the latter being even more profound (Ibid.). As example, Tordoir gives the chemical plant and the launch of a manned spacecraft. Regarding the first, the system is tightly coupled, but since process techniques are standardized and products are relatively easy, the requirements for professional support would be much lower compared to the case of a high complex and tight coupled project such as the launch of a spacecraft. In loosely coupled system, a different relation is expected, though in any case the requirements for professional support are lower than in tight coupled systems (Ibid.). Professional support requirements will rise in case of the loosely coupled system being both intricate and standardized, but will fall again if voluntary complexity increases beyond a certain threshold within loose systems (Ibid.). An example is car manufacturers where the process itself is complex of nature, but which is standardized for wide production possibilities. A multi-divisional firm is an example of a loosely coupled system where voluntary complexity is high (Ibid.).

How this relates to external professional support is further elaborated by the mainstream market theory and the 'demand threshold' argument. Derived from the neoclassical theory of the firm (mainstream market theory), it appears that economies of scope play a crucial role in professional services (Ibid.). Scope economies are reached when a professional service is used throughout different markets that are partly independent of each other (Ibid.). In that way, when demand in one market is low, this can be compensated by peaks in other markets (Ibid.). The same idea holds for internal support functions. The key notion is the smoothening out of demand fluctuations over different markets (Ibid.). The organization faces the challenge to create a critical mass for a productive professional support unit, which can be seen as a challenge since the demand for professional support differs per individual and those services can hardly be stored (Ibid.). If the threshold is not reached, firms can either restructure to change internal demand or look for external professional support (Ibid.). In the latter case, a collective of firms can generate the required conditions that one firm cannot meet, in order to provide a market for an independent supplier (Ibid.). Professional support is then externalized when the collective demand of all firms provide better opportunities for economies of scope and specialization economies than the demand generated by one firm alone (Ibid.). So, external suppliers compete with internal suppliers, however, this does not imply that the demand threshold for both is the same. When the quality and efficiency of both suppliers are the same the demand threshold differs, since there is a loss of efficiency when externalizing activities, as a result of transaction costs (Ibid.). The transaction costs theory suggests that outsourcing entails transaction costs such as searching, contracting, controlling, and recontracting (Mahnke, 2001). Whenever a certain threshold of transaction costs is reached, it becomes more efficient to internalize activities (Tordoir, 1993). Whenever those costs are lower than with internalization, externalization proves a possible efficient option (Tordoir, 1993; Mahnke, 2001).

As noted earlier, finding the right providers is not easy and forging an external relation demands client investments (Tordoir, 1993). In addition, it is expected that the threshold to externalization is especially high for professional services (Ibid.), so why do external suppliers still have success? For this, Tordoir introduced the second hypothesis. The idea of compatibility lies in the aspect that those organizations that through time developed competencies specific for a certain professional field, will find it easier to use external suppliers in the same field (Ibid.). The underlying idea of Tordoir's hypothesis and which this research also uses is the aspect that he notes: "*…firms can only externalize professional work if they have adequate internal professional capacities –they must be compatible.*" (p. 196).

3.3 Combining two works

As Bessant and Rush (1995) note, there is the problem of matching intermediaries with users. If so, the effectiveness of using intermediaries is subject to firms' activities before and during the project. This research focuses on aspects of intermediary involvement as a starting point to classify the different situations in which KIBS are used. These 'standard' or 'reference' situations will provide a better insight regarding NPD performance, usage of KIBS and the circumstances that induced those results. In other words, it can be seen what circumstances lead to successful or less successful outcomes. There are different motives for firms to engage in outsourcing (e.g. Tordoir, 1993; Mahnke *et al*., 2008), however, here they are narrowed down to those that are only product related (technology). In that case two main motives stand out in the literature, which are product solution and cost reduction (Tordoir, 1993; Mahnke, 2001; Mahnke *et al*., 2008; Tran *et al*., 2011). Regarding the former, the motive of the firm to engage in outsourcing is when their set of capabilities is inadequate (at least they believe it is) for the development of the product. The latter is self-evident.

The idea behind the scope of intermediary involvement is that depending on the complexity of the services delivered by the intermediaries and the number of involvement points, the scope of intermediary involvement can be either simple or complex (Tran *et al*., 2011). In case of a simple scope, it denotes a value-added task where the intermediary is involved in one (or few) stage(s) of the process (Ibid.). In case of a complex scope, it denotes specialized tasks where the intermediary is involved in all or multiple stages (Ibid.). 'Complex' is thus linked to product solution and 'simple' to cost reduction. Manufacturing firms with a complex product thus require a higher KIBS involvement than firms with a simple product. Recall that knowledge transfer requires common understanding and elaboration on both sides of the transaction. In relation to information exchange this means that more interaction is needed between participants. However, when the level of complexity increases it becomes more difficult to acquire knowledge which means the level of interaction should also increase. It takes more time for participants to understand each other. The two-dimensional nature of knowledge makes this even a more complex task, especially in the case of KIBS, were experts hold tacit knowledge that is more difficult to identify, since it partly encompasses technical skills and routines or so called 'know-how' (Nonaka, 1991; Miles *et al*., 1995). Knowledge of this kind is highly personal, making it difficult to formalize and communicate and is most often acquired by learning-by-doing (Nonaka, 1991; Miles *et al*., 1995). The non-financial aspect that is thus important for the property of KIBS use is the motive of the firm. Depending on the reason, the property of KIBS use should be so accordingly. This provides the first relational suggestions.

R1a: The KIBS usage of firms engaging in outsourcing for product solution motives involves significantly more stages than firms with cost reduction motives.

The Product Development Survey conducted in 1995 distinguished seven phases in manufacturing firms: identification of new or improved products, prototype development, final product development, product testing, production engineering, market research and marketing strategy (Love & Roper, 1999). These phases are used to identify between different stages where KIBS can be used. However, besides involvement per stage, the scope of intermediary involvement can also be related to the number of involvements per stage throughout the process. A complex NPD requires more KIBS involvement, which means firms need a higher involvement frequency in each phase.

R1b: The KIBS usage of firms engaging in outsourcing for product solution motives involves a significantly higher frequency per stage than firms with cost reduction motives.

By answering the suggested relations R1, the fourth sub-question is dealt with. The reason for dealing with the sub-question in this order is because the framework builds on previous elements, while the questions follow a different order as indicated in footnote i.

The work of Tordoir (1993) shows similarities with that of Tran *et al*. (2011) as Tran *et al*. classified complexity into a tangible aspect. Product solution and cost reduction are therefore part of complexity, but the vision of Tran *et al*. cannot be used for all circumstances regarding the use of KIBS. There is a possibility that products are seen as complex, while the motive for using KIBS is cost reduction. To cover for the possibility this occurs, and to provide a more comprehensive theory, the notion of complexity of Tordoir (1993) is used. He states that the combination of complexity and coupling can hypothetically be related to the professional knowledge requirements. A high complexity and tight coupling requires a high degree of internal professional support. However, as he notes, if complexity is relevant for internal support, it should either be for the use of external

professional support (Tordoir, 1993). This vision of complexity is in line with the view of Tran *et al*. (2011). A high complexity requires a high degree of support, whether internal or external. Note that complexity is not an absolute value but refers to the relative complexity as seen by the firm. Depending on the firms' reflection of their dynamic capabilities and the characteristics of the new product, the firm determines its complexity. In part, knowledge exists of tacit knowledge that partly incorporates technical skills and routines. This kind of knowledge is highly personal, making it difficult to formalize and communicate and is most often acquired by learning-by-doing (Nonaka, 1991; Miles *et al*., 1995). The requirements for professional support are thus firm specific and that is why complexity is one of the two important non-financial aspects for the choice of using KIBS. The distinction of coupling within a firm is not taken along in this research in order to keep the theoretical framework from becoming too complex and time consuming. Regarding complexity, this research goes a step further though. When combining the Tran *et al*. and Tordoir's theory, products that are complex not only induce externalization but when outsourcing, firms need a higher KIBS involvement either.

R2a: The perceived complexity of a firms' product has a significant positive correlation with engaging in KIBS outsourcing.

R2b: The perceived complexity of a firms' product has a significant positive correlation with the frequency of engaging in KIBS outsourcing.

The demand threshold and the mainstream market theory further explain the use of external professional knowledge, but on the basis of the transaction costs theory, it can also be expected that the threshold to externalization is especially high for professional services (Tordoir, 1993). Clients of outsourcing face different costs like searching, contracting, controlling and recontracting, as suggested by the transaction costs theory (Manhke, 2001). The supplier market is therefore not without risk for the clients, in respect to price, quality and time, which suggests that where costs are low, internal activities qualify for external procurement (Mahnke, 2001). A problem of the transaction cost theory is that it does not incorporate the past of the company (Mahnke, 2001), an idea also known as path dependency (e.g. David, 1985; Arthur, 1989). Firms that are not familiar with the new technology, due to choices made prior to the NPD, are more likely to lack the required set of skills and resources and therefore should find it more difficult to efficiently and effectively attain and exploit new technological knowledge. This is the same line of thought as with the compatibility hypothesis, however in this case it refers to technological compatibility. The distance between a firms' set of skills and resources, required for the development of the new product is firm specific. Note that as stated earlier, in the conquest of competitive advantage, it is the task to ensure an efficient and effective exploitation of knowledge. This means companies need the right dynamic capabilities to do so. In the NPD literature, one aspect that determines the performance is synergy, which is part of a comprehensive list that serves as a measurement for NPD performance. Synergy means keeping close to the company's core business, it is therefore important not to seek opportunities far from one's experience and resource base (Peters & Waterman, 1982). The difference with complexity is that complexity refers to the difficulty of the product relative to the competencies of the firm or in other words, relative to the dynamic capabilities of the firm. So synergy captures the gap that needs to be overcome by the firm to reach the required knowledge for the project and the level of complexity determines the difficulty to overcome that gap, or how much effort is needed to bridge that gap. In other words, synergy measures the degree to which the firms' capabilities match the required capabilities necessary for the NPD and that is why synergy is seen as the second important non-financial aspect for the choice of using KIBS. It is then expected that firms with a low synergy are less compatible to efficiently and effectively exploit the required knowledge and are therefore more likely to engage in outsourcing to bridge that gap. Following the transaction costs view this also holds. A too low synergy will retain firms from using internal professional knowledge since the gap that must be bridged is a too high a challenge or is not feasible due to time or cost constraints. The use of external professional knowledge can provide a solution in that case. This suggests the next relation.

R3: The synergy of the firm before entering the NPD has a significant negative correlation with engaging in KIBS outsourcing.

R2 and R3 combined thus answer the second sub-question. But what do these relations say about the situation where firms benefit the most from using external help? Proceeding with the same line of thought, this would give the impression that firms with the lowest synergy could reap the most benefit from outsourcing. However, this relation may not be that linear. As noted earlier, finding the right providers is not easy and forging an

external relation demands client investments (Tordoir, 1993). In addition, it is expected that the threshold to externalization is especially high for professional services (Ibid.), so why do external suppliers still have success? For this, Tordoir introduced the second hypothesis. The idea of compatibility lies in the aspect that those organizations that through time developed competencies specific for a certain professional field, will find it easier to use external suppliers in the same field (Ibid.). This view is shared more throughout the literature. Lichtenthaler and Ernst (2008) suggested a relationship between internal competencies and organizational boundaries. They note that internal capabilities are important for co-ordinating external service providers (Lichtenthaler & Ernst, 2008).The underlying idea of Tordoir's hypothesis and which this research also uses is the aspect that he (Ibid.) notes: "*…firms can only externalize professional work if they have adequate internal professional capacities –they must be compatible.*" (p. 196). Why the relation would not be as linear is best described by introducing the notion of cognitive distance here (Nooteboom, 1999). Figure 1 shows the coherence between absorptive capacity, learning performance, novelty value and cognitive distance. The idea is when the cognitive distance is low, firms are easily able to absorb knowledge, but in return hand in value. On the other hand, would the cognitive distance be high the novelty value would be also, but this comes at the costs of a low absorptive capacity to the extent that the firm is unable to attain the knowledge at all. So the ideal situation for the firm is to find the delicate balance between the novelty value of the knowledge and the rate and costs at which the firm is able to absorb that knowledge, hence where the learning performance is optimal. Note that synergy relates to the firms' product as it measures the degree to which the firms' capabilities match the required capabilities necessary for the NPD. It is therefore expected that firms whose synergy is too low, and have externalized professional services, have a higher chance of cooperation failure, due the fact they are unable to efficiently and effectively exploit the knowledge of the intermediary. It is thus synergy that can be used as a non-financial aspect to measure the efficient and effective use of KIBS among KIBS users.

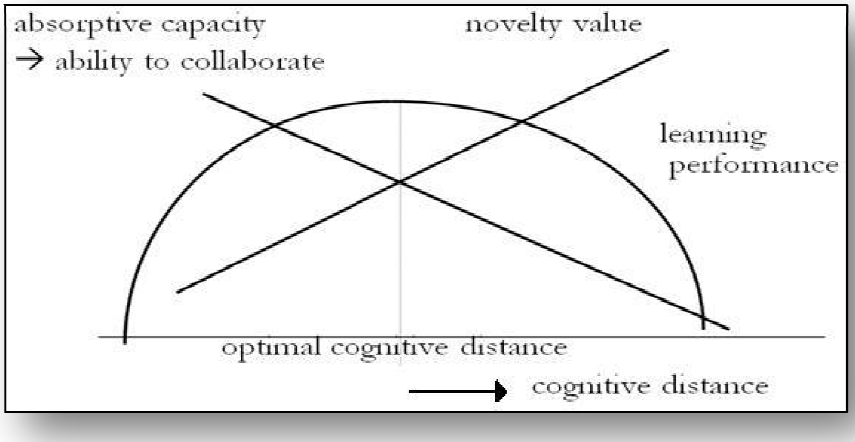

Figure 1 – Inter-firm alliances: analysis and design (Source: Nooteboom, 1999).

A similar idea is also noted by Mahnke (2001) with complementarity of capabilities. This means that whenever firms' capabilities differ from that of the intermediary, time and effort is needed to change to the appropriate level. Knowledge transfer requires common understanding and elaboration on both sides of the transaction and therefore requires more interaction between participants than with information exchange (Miles *et al.*, 1995). So, combined this means that the larger the difference in the capabilities of the firm and intermediary (high cognitive distance), the more time and effort is needed to change to the appropriate level.

The attentive reader may notice that the cognitive distance here refers to the distance between the client and the intermediary, while the suggested relation above (R3) is related to the distance between the firms' capabilities and the required capabilities for the successful development of the product. However, the notion of cognitive distance introduced here is only to show the nature of the relation. If a firms' synergy is that low, outsourcing any aspect would result in a failure, since the task they put themselves up with transcends their scope, which can happen when firms overestimate their own capabilities. So, the lower the synergy of the firm, the higher the chance that the cognitive distance between them and the KIBS would be too large due to possibilities of overestimation. Therefore, it is expected that the relation in which using a KIBS is most effective and efficient is not linear, but follows an inverted U-shape. In that case, firms with an average synergy would benefit the most by outsourcing, in respect to firms with a low synergy for which the absorptive capacity would

be too low and regarding firms with a high synergy for which the novelty value would be too low. This provides the next set of suggested relations.

R4a: Regarding firms engaged in KIBS outsourcing, firms with a medium synergy (before entering the NPD) show the lowest failure rate in terminating KIBS usage. [viii]

R4b: Regarding firms engaged in KIBS outsourcing, firms with a medium synergy (before entering the NPD) show a larger growth in synergy compared to firm with a low or high synergy.

The relations R4 thus provide the answer for the sixth sub-question. Lastly, the final issue regarding sub-question VII is whether the use of KIBS improves the performance of new product development compared to non-KIBS users. The value-adding function of the intermediary is in this research advocated to be seen as an input to the process of building up dynamic capabilities. As the core of dynamic capabilities is seen as the knowledge set that distinguishes and provides competitive advantage (Leonard-Barton, 1992), the task of firms is to ensure an efficient and effective exploitation of that knowledge. Successful companies are the ones that continuously create new knowledge and can disperse and apply it quickly throughout the company (Nonaka, 1991). As is dealt with above, the contribution of intermediaries is based on the fact that firms are not able to adopt external knowledge into practice and by themselves (Toivonen, 2004). In the case when firms must choose between the option to internalize or externalize, they have to weigh the pros and cons of both before making a decision. The ideal situation in which the real contribution of KIBS can be seen is to compare two identical firms, whose features are the same in all aspects, except that both firms pick the other option. When assuming that the firm who chooses to externalize did so because it is not able to overcome the knowledge gap required for the project, KIBS would appear to contribute when the new product development performance of both firms is found to be the same. In that way, the KIBS would function as they expect it to function, by contributing to the firms' knowledge base so that it can compete on a same level with the firm that did not used KIBS. Which choice would be wisest is beyond the contemplation of this research, since then for instance, transactions costs must be taken into account. Although this idea does not hold when looking at individual firms specifically, this do holds when comparing a large amount of firms. The value contribution of KIBS would only be to the extent that it helps firms who are less able to acquire the required knowledge base, to reach that level. Individually seen, the use of KIBS could result in various performance outcomes, compared to the situation where the firm did not used KIBS, but overall seen, one would expect to find no performance difference between non-KIBS users and KIBS users. After all, would this not be the case, the choice of using a KIBS (or intermediary) would be obvious. So, for this research, where the situation of firms is divergent, it is expected that no difference will be found in NPD performance. Whenever a difference does occur this calls for further investigation; for example, it could appear that firms using KIBS perform less than those firms without KIBS when the motive for its use and the properties of its use do not correspond. Additionally, when the synergy of the firm before entering the NPD indeed has a significant negative correlation with engaging in KIBS outsourcing (R3), firms who engaged in KIBS outsourcing would show a larger growth in synergy compared to firms that did not used KIBS. Non-KIBS users begin with a higher level of synergy, but eventually, both non-KIBS and KIBS users on average should be on the same level of synergy. The KIBS function is thus to enable the firm to acquire the required knowledge base which is captured by the difference in synergy before and after the NPD. Note that firms are asked to indicate the level of synergy after finishing the project, when the theory holds, it is expected that on average both KIBS and non-KIBS users are on the same required knowledge base level (as captured by synergy). So, not only the NPD performance can be used as a non-financial aspect to measure the efficient and effective use of KIBS between KIBS and non-KIBS users, but synergy as well. This poses the next relations regarding the seventh and last sub-question.

R5a: Firms that engaged in KIBS outsourcing show a larger growth in synergy, compared to firms that did not engaged in KIBS outsourcing.

R5b: KIBS outsourcing has no correlation (neither negative nor positive) with the overall NPD performance of the firm.

[viii] To check whether the variable regards an inverted U-shape, the relation is stated this way to circumvent issues that arise when checking the relation directly for an inverted U-shape. This is due to the nature of the variables, the data size and the statistical methods used in the research. The same holds for R4b.

3.4 Conceptual model

The relation of KIBS regarding its clients and NPD performance is elaborated in the theoretical framework parts I and II. To indicate how this relates to each other, a conceptual model is constructed, displayed in Figure 2. As stated above, the task for firms is to ensure an efficient and effective exploitation of technological knowledge, which can be done by building dynamic capabilities through learning. On the one hand this can be done internally. In that way, the firms' dynamic capabilities determine the performance of the NPD. This is displayed in Figure 2 by line A. To indicate how this relates to the aspects of this research some parts are included in brackets; the score of the NPD performance is calculated by the sum of all NPD indicators, displayed in appendix 9.2. The exact calculation and methods regarding the sub-questions and this score will be dealt with in the method. As dynamic capabilities can be built up internally, firms eventually need to look to external sources for inputs to this process (Bessant & Rush, 1995), line B. The reason for this line to be dotted is the idea that KIBS influence the capabilities of the firm, thereby not directly but indirectly contributing to the firms' NPD performance. This leaves line C, which denotes the motivation of firms for using KIBS. Depending on its dynamic capabilities or financial assets, firms can have different motives for engaging in outsourcing. For instance, firms can use KIBS for a lack of knowledge (C), which provides additional technological knowledge for the firms' capabilities (B), and in the end result in the firm having a different NPD performance due to its changed set of capabilities (A).

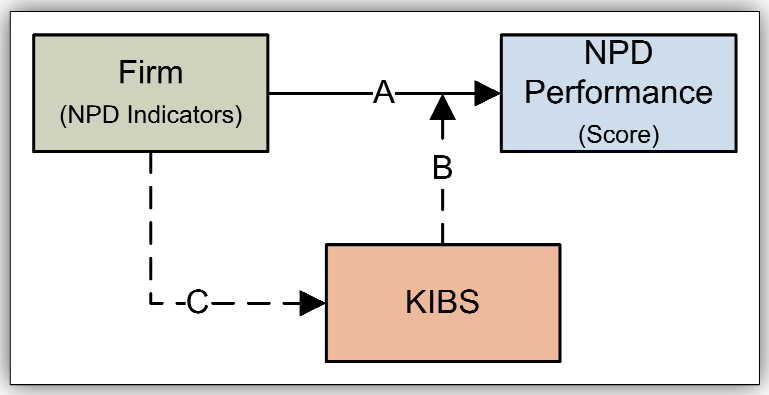

Figure 2 – Conceptual model.

3.4.1 Operationalization

An extensive literature exists on drivers of new product performance. When talking about NPD performance, the performance should reflect: "*the efficiency and effectiveness in producing, diffusing and exploiting economically useful knowledge*." (Lundvall, 1992: 6). Hence, this definition shows large similarity with the definition of capabilities of the firm, which covers the whole spectrum of the firm. It is preferable to combine multiple indicators when measuring the innovative performance of firms to increase the validity of the results, since each indicator has its own weaknesses (Lundvall, 1992; Carlsson *et al.*, 2002). The same holds for new product performance (Cooper & Kleinschmidt, 1995). Although many indicators are recurrent and consensuses exist on those categories that are of influence (Montoya-Weiss & Calantone, 1994; Ernst, 2002), the list of indicators used per category still varies. In addition, Cooper & Kleinschmidt (1995) note that many of the measures used in their study are interrelated. Therefore, this research made a selection of only the most common and significantly found drivers of new product performance. In addition, two major studies NewProd and SAPPHO clearly influenced researchers due to being systematically replicated, leading to a series of highly intercorrelated results (Montoya-Weiss & Calantone, 1994). This provides an extra incentive to select only the most common and significant drivers. Two extensive literature reviews (Montoya-Weiss & Calantone, 1994; Ernst, 2002) were used as a starting point to provide a useable framework. The framework that captures the different aspects of NPD was originally organized into five broad categories (Cooper & Kleinschmidt, 1995): NPD process; organization; culture; role and commitment of senior management and strategy. Of these, culture, role and commitment of senior management, and strategy are not incorporated, because the first and latter have not been sufficiently analyzed while the second is debatable (Ernst, 2002) and therefore cannot be used as significantly found drivers. The complete list of indicators is displayed in appendix 9.2.

3.4.2 Indicator clarification

The list of indicators mainly exists of NPD related indicators that need some clarification despite the recurrence and consensus on the categories within the NPD literature. Additionally, the main concept 'Use of KIBS' and the single indicator 'Complexity' are included in the complete list. Indicators that reflect the main concept are self-evident. As for complexity, besides being a variable, it adds an extra dimension to the notion of synergy as explained above.

To a large extent, NPD studies refer to technical or market synergy as it is seen as a key factor in success (Cooper & Kleinschmidt, 1987). In case of project-based approaches as in this research, these factors need to be included since they are project specific. As explained above, program-based studies focus on generalizations regarding a firm's process, for studies of this type, these factors should be excluded.

One part on which the NPD literature is not clear is indicators like preliminary assessments (e.g. market or technical) or detailed research/studies. Results from different studies show that pre-development activities like preliminary market, technical and financial assessment, and a detailed market study are not only considered important, but found significant (e.g. Cooper, 1979; Cooper & Brentani, 1991; Cooper & Kleinschmidt, 1995; Song & Parry, 1997'. Although throughout these studies, different aspects are found significant and the indicator coverage differs. The distinction between pre-development activities and ´normal´ activities lies in the notion of 'homework'. The idea is that companies, before entering the development phase, conduct financial, market and technical assessments before proceeding with the project. Pre-development activities help the firm to decide to proceed with which projects. However, this decision not only needs to be taken up front, but also should be incorporated throughout all phases. Before elaborating further on this issue, another aspect needs to be introduced.
One subject that is frequently referred to in studies on the success of new products is the understanding of customer needs (e.g. Cooper, 1979a; Cooper & Brentani, 1991; Souder *et al.*, 1997) but, as Ernst (2002) rightfully denotes this aspect is methodologically and substantively not substantially analyzed except by Gruner and Homburg (1999). In their study the interaction between manufacturer and customer is analyzed on the basis of constructs measured in the different phases of the NPD process (Ernst, 2002). Ernst (ibid.) concludes that as such, conclusions of less precise NPD studies are less meaningful. Therefore, this study omits the factor customer integration in measuring the NPD performance. However, as Ernst (ibid.) notes, the way in which different studies measure customer orientation, is in principle intended to capture the alignment of the needs of the market and/or customer with the NPD process. Therefore, the importance of market orientation for NPD success is assumed to reflect the consistently positive findings of customer needs (ibid.). So, the influence of customer integration on the success of new products is assumed to be (partially) reflected by market orientation into NPD. To get back to the distinction between preliminary activities and market/technical activities; this research uses the preliminary activities technical, financial and market assessment as literature agrees on its importance. In addition, also the indicator market study/research is used, due to it reflecting the positive findings of customer needs. Namely, the difference between a market assessment and study lies in the aspect that an assessment is seen as a first peek, to find out whether or not there could be a window of opportunity. The reason to check if a study/research was carried out is because the needs of the market (this can also be read as customer according to Ernst (2002)) need to be figured out in detail.

A noteworthy aspect is the absence of financial resources. Studies show no significant results of the financial strength of companies (Cooper, 1979b; Parry & Song, 1994). As Cooper (1979b) notes, it is not that the financial strength is unimportant, but it is not of significant importance in the success or failure of new products; other factors are much more closely related. One financial aspect that is included, and herewith returning to the pre-development category, is financial assessment. Studies show significant results, both as part of the pre-development category (Cooper, 1979a; Cooper & Brentani, 1991) as separately (Parry & Song, 1994).

Several control variables are used: formal R&D (Rothwell, 1974); R&D expenditure in % per employee (Rothwell, 1974; Cooper & Kleinschmidt, 1995); the number of new products launched during the last five years (Souder *et al.*, 1997); and basic control variables like firm size, firm age. However, on the advice of respondents in the personal interviews, R&D expenditure in % per employee was altered to average R&D expenditure in % for the periods 2009, 2010 and 2011 of the entire company in relation to sales. Respondents noted employees would have rather insight into the R&D expenditure in relation to sales than the total amount of R&D expenditure (the size of the firm is in number of employees, so asking for the total amount of R&D would have been sufficient), let alone in R&D % per employee. In addition, on the advice of the personal interviews, the

lead-time of the project (in months) was added. A large difference in lead-time could influence the research outcome. Finally, an optional control variable was added. It regards the project R&D expenditure in euros per year. During the personal interviews, interviewees noted this question could pose some problems since not all respondents have insight into the data concerning project spending, let alone they know the average amount of R&D expenditure, therefore it was added as an optional question.

4 Method – research design: survey study

For the second part of the study a structured questionnaire is used. Survey studies are characterized by a large set of research units, for which using questionnaires is an appropriate method when gathering knowledge or opinions (Baarda & de Goede, 2001).

The survey contains questions that only relate to the operationalized variables and control variables. Much effort is put into the design of the survey. This varies from the choice in type of survey to the layout of the survey. For this, the work of Fowler (2009) is used as the main guideline, where Baarda en de Goede (2001) and Henn *et al*. (2006) are used to check for deficits in Fowler's work and to reconfigure aspects where necessary. The next paragraphs elaborates on specific aspects and choices made regarding the design of the survey.

4.1 Survey design

When conducting a survey, a few aspects need to be kept in mind during the process. In an optimal design the next aspects will be taken into account:

- The choice of whether or not using a probability sample;
- Sample frame (those people who can be sampled);
- Size of the sample;
- Sample design (strategy used for sampling people);
- Rate of response (Fowler, 2009).

An error that is often made is that researchers attend to one or a few of these aspects, where the current practice is to examine all aspects (ibid.).

In this study the probability sample that is used is known as simple random sampling (Fowler, 2009). The basics of the approach are the same as drawing from a hat. Members are selected one at a time, independent of another and without replacement (ibid.). An equivalent result is produced and which is also used in this study is when a list would be numbered in a computerized data file (in this case excel), randomizing the list and then picking the first people of the reordered list.

How well the population is represented within the study depends on the sample frame, size of the sample and the design of selection procedures (ibid.). For the sample frame, three characteristics need to be evaluated; comprehensiveness, whether or not the probability of selection can be calculated and efficiency (ibid.). The probability of selection of each respondent sampled can easily be calculated when using a simple random sampling and therefore poses no issue in this research.
Comprehensiveness refers to the population that actually has a chance to be sampled. In this study a couple of decisions are made that affect the comprehensiveness. For gathering the data of firms in the machine industry, the Dutch industry classification SBI 2008 was used[ix]. In 2010, the sector counted 2,825 firms (CBS, 2011b). Company information was gathered from the database of the Dutch Chamber of Commerce by obtaining an address file. Here, companies were selected who are economically active, who provided a phone number and a contact person and who have a minimum of five employees (part timers included). In addition, only parent companies were selected, but during the actual calling it appears several subsidiaries still were incorporated, therefore this selection should be neglected. The selections provided a total sample frame of 665 companies. In comparison, would no selection be made, the sample size would be 3,629 companies. A possible explanation for the difference with the 2,825 from the Dutch Bureau of Statistics is that errors occur in the database such as firms that are still listed as active while some have gone bankrupt or who are registered under multiple departments (larger companies). Even the sample size of 665 appeared to still contain errors such as companies who have gone bankrupt (two out of the 320 firms contacted did not exist) or incorrect references to phone

[ix] For more information, see appendix 9.2.

numbers (two occasions). The reasons for using these selections are to keep the dataset clean, but also to attain a smaller one to keep costs at a minimum. The assumption was made that 665 companies would be sufficient to reach the desired sample size.
Efficiency regarding the sample frame refers to the rate at which members of the target population can be found among those in the frame (ibid.). Depending on the type of survey and target population, sometimes people that are not members of the target population can be found in the sample frame. In this study the target population is companies registered with SBI number 28 that also develop new products. By using the database of the Dutch Chamber of Commerce, no other companies other than those with SBI number 28 can be found in the sample frame. However, the frame also incorporates companies that do not occupy themselves with the development of new products. They cover a large part of the companies that do not cooperate and therefore contribute to a lower efficiency in gaining respondents. This is dealt with further in the section data collection below.
The sample size must be large enough to use for statistical analysis (Baarda & de Goede, 2001), plus it must be representative for the target group (Henn et al., 2006), therefore the goal was to attain at least 50 responses. Although literature agrees on the fact that a larger sample increases precision, this only adds up to samples of 150 to 200 (Fowler, 2009). As Fowler (2009) notes: "*A sample of 150 people will describe a population of 15.000 or 15 million with virtually the same degree of accuracy, assuming that all other aspects of the sample design and sampling procedures are the same.*" (p. 44). What is meant is that the impact the fraction of a population sampled has on sampling errors, is trivial. For mail surveys particularly, the generalization seems to holds up that people with a particular interest in the subject of matter, will sooner cooperate (Groves *et al*., 2006). So, it is not only important to have a large enough sample, but also to attain a high response rate, since this will increase the precision with which the sample data will describe the target population. Therefore, this study put considerable care into the design of the survey and questionnaire.

4.2 Data collection

Directly related to the sample frame, sample characteristics, research topic and available resources is the choice of data collection (Fowler, 2009). It is evident that a potential major source of survey error can be found in failure to collect data from a high percentage of those selected to be in the sample (ibid.). Therefore, it is important to implement a sample design (strategy). In this study, different media were used in the process of data collection. Company information was gathered from the online database of the Dutch Chamber of Commerce by obtaining an address file. Since personal contact is significantly more effective than mailing (ibid.), the first step was to make contact by calling the companies. In most cases, the person who answers the phone is not the required respondent. To gain access to the required respondent and to avoid a biased response, a calling protocol was followed. This protocol is displayed in appendix 9.3. In this way it was ensured that the company is a member of the target population and that the respondent meets the necessary requirement that is, they need to be strongly involved or responsible for the development of new products within their company. In both cases, persons themselves noted whether the company developed new products (at all) or whether they are the right person. In some cases this required some clarification, but mostly did not pose a problem.

For the enlisting of respondents, a structured excel file was used to keep track of the firms already contacted, that need to be contacted again and by which means they preferred to be contacted again. Some companies for example preferred receiving an email, where others preferred to be called back. Regarding mailing, a reminder email was sent eight days after sending the initial request without receiving any reply. Collecting all data by phone or by personal interviews would not be feasible though due to time and money constraints. On the other hand, mailing is also not desirable due to its low effectiveness (Fowler, 2009), therefore once respondents were enlisted for cooperation, a second media was used. The choice was made to initiate an online questionnaire. In case of a self-administered questionnaire one must reconcile oneself to closed questions. This is because open questions often do not produce useful data and the ease of just checking boxes increases the response rate (Ibid.). These features are retained as much as possible. Questionnaires are particular suited to be self-administered when they contain a large number of questions that are similar in form (ibid.). In a personal interview, this could be awkward and tedious (ibid.).

Once respondents indicated they would cooperate, their information would be put into the online program "Enquetelink". With this program the questionnaire was constructed, invitations and emails were distributed and data was collected. Once added, respondents received an email with the link to the online questionnaire.

Since online data collection is comparatively new, there lacks a large amount of experience that exists for mail and interview surveys (Fowler, 2009). It seems that it shows similarities with mailing though, however the advantage of an online questionnaire over mailing is clear. The threshold to participate is rather low, since respondents merely have to 'click' there way through the questionnaire. This is much less cumbersome than mailing. The potential disadvantage that samples are limited to internet users is arguably outdated, as the Netherlands has the highest percentage internet users of the European Union; 94% of Dutch households have an internet connection (Eurostat, 2011). Also, computer-based surveys can follow complex patterns to skip questions that are difficult in a paper-and-pencil version (Fowler, 2009); a feature also used for the online questionnaire. These 'conditions' were used to adapt the questionnaire to different type of respondents. For instance, respondents who reported using KIBS received different questions at the end (evaluative of type) compared to those who did not used KIBS. In this way, respondents only received related questions which contributes to the rate of response and lowers the change of errors. The disadvantage of online questionnaires is that participants themselves still must show the initiative to begin with the questionnaire without intervention of a researcher. A feature similar to the use of an excel file above, was that the program allowed to keep track of the respondents' progress. Upon adding the enlisted respondents to the online program, their name and email address was included that the program used for automated emails. Because the response rate with emailing is much lower than calling (ibid.), the automated emails were used to send reminder emails each eighth day after not completing the questionnaire to provoke respondents until they completed the questionnaire or until they refrained from participation by email. In addition, since retaining a personal approach also increases response rates (ibid.), participants were addressed by their last name in all automatically send emails. A similar approach was also used during the enlisting of respondents, when called companies preferred an invitation by email rather than over the phone. Those emails were largely derived from same the protocol used for calling to avoid biased responses.

4.3 Questionnaire design

Extensive attention has been paid to the construction of the online questionnaire. Issues of self-administered data collections are that they need a careful design, that respondents require good reading skills and that it is difficult to control who answers the questions (ibid.). The questionnaire is subject to several conditions to tackle these potential issues.

Regarding the design, personal interviews were held until saturation was reached; this was achieved at the fifth interview. The enlisting of interviewees was done in the same way as explained above for the enlisting of respondents. After the second interview, similarities between both interviewees' comments were processed. After an additional interview the new comments were compared with previous ones to check for a majority in similarities. This ensured the questionnaire would be adapted to the general view of all interviewees, so that each question should mean the same to every respondent. Despite these adaptations, in some occasions questions still required additional clarification, which was done by adding separate help-parts to avoid them being too cumbersome. To prevent respondents from being distracted and overwhelmed by the amount of text, the help-part was displayed in a light gray tint, as can be seen from the written version of the online questionnaire in appendix 9.5.
An important part of the personal interviews included that interviewees started with the same amount of information as respondents of the online survey to ensure the participants' understanding would be on the same level. The interviewees were given the written version of the online questionnaire. They were asked to evaluate each question in respect to whether or not:

a. It is easy to read as worded;
b. Respondents understand the question in a consistent way;
c. Respondents can answer the question accurately (Fowler, 1995).

Interviewees were asked to think out loud, so that any thought that would come in mind during the evaluation of the questions could be noted. After the interviewees finished evaluating the questionnaire, additional questions were asked to clarify certain parts and to get them to elaborate more on critical questions.

Although the interviews already ensured that biased or vague questions were eliminated from the online version, an important finding was that the notion of KIBS needed further clarification. As Fowler (2009) notes, using a definition is useful to avoid poorly defined terms, as such, a definition was added for KIBS. However, a short example was also included to briefly explain in what situation KIBS can be used, since even literature is not perfectly clear on the definition of a KIBS (Toivonen, 2004), and on the advice of some interviewees.

Additionally, some interviewees advised to add one 'controlling' question for the pure purpose of emphasizing that the questionnaire concerns one specific project only. The question asks respondents for the name of the project and was included in the survey as optional, since some companies are not inclined to divulge that kind of information due to confidential reasons.

Most of the question in the survey contained closed questions, as to increase the ease of response to maximize returns (Fowler, 2009). For most of these questions, an ordinal 10-point Likert scale was used as can be seen from appendix 9.2. A Likert scale is used for measuring the perception of respondents towards the dimensions (Likert, 1932), because the perception needs to be converted into quantitative results for proper analyses. The type of questioning in this research is adopted from Song & Parry (1997). When respondents are asked to judge the execution of different activities, they should answer how well they think the firm undertook those activities, relatively to how they think it should have been done. In addition, regarding the different statements made, the respondents should indicate to what extent they agree or disagree. This is also known as attitude scales (Henn *et al*., 2006). The online survey only provided a choice between a 5- and 10-point scale, where the latter was selected to retain the option to manually reduce the point-scale that could prove helpful during data analyses. In addition, it provides a more accurate distinction for the respondents.

For the open numerical questions, an optional feature was used known as 'validations'. Those are expressions that prohibit respondents to give 'wrong' answers. This feature proved helpful to ensure typos are eliminated for numerical questions such as the age of the company or the complexity of the product. For instance, would someone accidentally rate 'complexity' with 12 when only numbers between one (1) and ten (10) are possible, they would not be able to proceed to the next set of questions. Instead, the page reloaded with a red warning to alter the incorrect answered question. Another feature within the program refers to the indication of optional and mandatory questions. Would the situation occur that someone accidentally skipped one mandatory question, the program automatically issued another warning. As such, the data does not contain any missing values. The written questionnaire in appendix 9.5 indicates mandatory questions with an asterisk (*).

Additional measures were taken to ensure a higher readability and reliability of the questionnaire. To avoid respondents from being distracted by secondary aspects, throughout the survey, several methods were used as underscore, **bold**, and grey shades. Although the online version is somewhat clearer than the written version in the paper, some of these aspects are clearly visible in appendix 9.5. Especially the ´help´-parts needed to be less visible to avoid the respondents of being overwhelmed by the amount of text.

Although complete control on the interviewees for the online survey (if it regards the right person) is somewhat limited, two measures were taken to retain some control of the process. First, the link of the questionnaire was send to a private email address of the enlisted respondents and additionally, respondents were asked about their function. The former a priori lowers the chance that other than members of the target population will fill in the questionnaire. The latter is used to check if members of the target population indeed were the ones that responded.

4.4 Data analysis

The program SPSS will be used for the statistical analyses. The main methods to be used will be cross-table analyses, bivariate analyses (correlations) to indicate possible relations, and the Mann-Whitney test[x] to test whether the means of a variable of two populations are equal to each other. Regarding the bivariate analyses, the correlation score denotes the coherence between different indicators, where 1 represents a perfect positive correlation (Baarda & de Goede, 2001). This is used in the research to indicate possible relations between indicators. Whenever significant results occur, in addition those variables are subjected to a Mann-Whitney test (or in a single case the Independent Samples T-test) to test whether there is a significant difference between the two indicators.

Two aspects need to be clarified before proceeding with the results; these are the calculation of the NPD performance and (the growth in) synergy. The score for the NPD performance will be calculated as follows. Figure 3 provides a schematic overview of the indicators. The NPD score is based on the cumulative score of all

[x] A non-parametric test whenever the conditions for the Independent Samples T-test do not satisfy (De Vocht, 2007).

NPD indicators together, namely Protocol, Proficiency of pre-development activities, Proficiency of technical activities, Proficiency of marketing activities, NPD-team, Technical synergy, Marketing synergy, and Communication (see appendix 9.2). Each indicator exists of several variables. The questions regarding the different variables are all scored from one (1) to ten (10). Taken all variable scores together provides a score per indicator, on its turn, taken all indicator scores together provides an overall score for NPD performance.

Looking at the synergy of the firms, respondents will be asked to rate the synergy before the start of the NPD development and after finishing it. This is displayed in Figure 3 with the Pro- and Post-synergy blocks. Similar to the variables above, the synergy variables score from one (1) to ten (10). Regarding the suggested relation R4, the range of Pro-synergy is divided into three parts giving a low (1-3), medium (4-7), and high (8-10) synergy score[xi]. By classifying Pro-synergy, it provides the possibility to check for differences between firms that rated their synergy overall low, medium or high. In addition, for each individual variable score (without use of the classification), the difference between the Post-variant and the Pro-variant can be calculated, resulting in a set of Post-Pro synergy variables. These variables are used for the growth in synergy regarding the suggested relation R5a.

It is important to note that regarding the score for NPD performance, only the Post-synergy variables are used. Post-synergy actually comprises technical and marketing synergy as components from NPD performance. The introduction of Pro-synergy was for the single purpose to check for the growth in synergy. However, to avoid confusion, 'Post' was added to the synergy that is part of the NPD process. As can be seen from appendix 9.5, questions related to Pro-synergy specifically ask respondents to rate the variables as if they were assessing them before starting with the NPD process. Regarding Post-synergy, respondents were asked to rate the variables regarding the NPD process, so it functions as '*Post*'-synergy in the way that it provides the growth in synergy when compared with Pro-synergy, as the latter is the perceived synergy before the start of the NPD and Post-synergy is the actual achieved level after fully completing the NPD process.

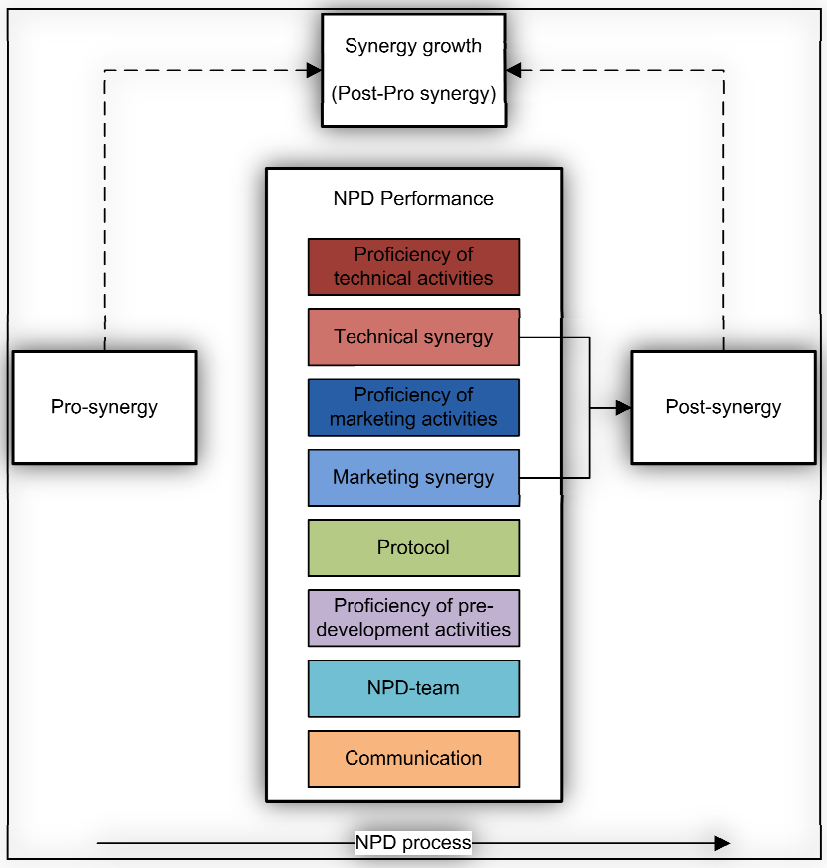

Figure 3 – Schematic overview of the indicators.

[xi] Whenever any indicator with a 10-point scale was classified into three parts, this classification was used.

Lastly, the total amount of employees is used as a separate indicator for the *size of the firm*. It is categorized in three parts where 5-49 employees is small, 50-249 is medium, and 250 and larger are large sized firms. The goal was to attain respondents that are responsible for their company's NPD program. Mostly, senior management will be chosen, since this improves data validity (Cooper & Kleinschmidt, 1995). This will be done by a screening test, where managers with three or more years of new product program involvement are regarded as senior (Ibid.).

4.5 Validity and reliability

During the whole process, several issues need to be dealt with. In general these are known as the validity and reliability of the research. It is important to maintain validity and reliability in the research since it improves the overall quality (Baarda *et al*., 2005; Henn *et al*., 2006; Hancké, 2009; Yin, 2009). Validity is divided in two parts. *Internal validity* means that the concepts as defined above are correctly expressed in the measurements that are used (Baarda *et al*., 2005; Yin, 2009). In other words, the researcher needs to measure what is intended to be measured. This is done with the operationalization of the indicators (appendix 9.2). *External validity* refers to the possibility to generalize the obtained results to a larger population (Baarda *et al*., 2005; Yin, 2009), that is maintained by following a strict survey design as dealt with in chapter 4.1. The last issue to be dealt with is *reliability*. Reliability means that the research is consistent and replicable (Henn *et al*., 2006; Hancké, 2009; Yin, 2009). The idea with reliability is that any researcher later on, when deciding to follow the same procedures as described here, is able to conduct the same case study and should arrive at the same findings and conclusion (Hancké, 2009; Yin, 2009). This is done by keeping the research as transparent as possible without elaborating too much on trifling aspects. In addition, important decisions are explicitly stated. This enables researchers to trace back any steps taken (Yin, 2009). A clear structured interview with defined indicators and the use of an interview protocol also add to research reliability (Ibid.).

It is preferable to combine multiple indicators when measuring the innovative performance of firms to increase the internal validity of the results, since each indicator has its own weaknesses (Lundvall, 1992; Carlsson *et al.*, 2002). The same is done regarding the NPD performance. Above, to increase the internal validity, every main concept is defined, as well as the used indicators, to avoid any ambiguous interpretation of (possibly vague) concepts or indicators. In the end, data is checked for consistency with insights from literature on intermediaries (KIBS) and NPD. If the results add up to the theory, this strengthens the results. Since survey research relies on statistical generalization (Baarda *et al*., 2005; Yin, 2009), a requisite for external validity is a large dataset. A too small dataset would be unusable for generalizing any results. For this research, 320 respondents were contacted of which 98 indicated to cooperate with the survey. Eventually, this resulted in 60 completed questionnaires.

5 Results

First, some basic results will be given of the respondents, companies, and KIBS general statistics of which summary tables will be excluded and displayed in appendix 9.4. For the main results, the most important tables and figures will be included. For matters of convenience, all tables or figures that are displayed between brackets () are displayed in the appendix. Bear in mind the type of measurement indicators for every variable to better understand the results. An overview of the measurement levels can be found in Table 17, appendix 9.2.

5.1 Respondent and company general statistics

Respondents' functions were classified into corresponding functions (Table 18). The years of experience related to these classified functions shows a distributed experience ranging from 4.29 to 14.65 years (Table 19), in contrast to the average of 9.43 years. A screening test shows that nine out of 60 respondents have less than three years experience. In addition, most of the respondents are highly involved or responsible for the new product development. Respectively one and three respondents indicated to be software or sales managers, other respondents noted to be CEO/Managing Director/Executive Director (17); Technical Director/Technical Manager (10); Product Manager/Project Manager (7) or Head R&D/Manager R&D (22). These results add to the validity of the research, since it regards mostly members of the target population; managers with an experience of at least three years that are heavily involved or responsible for the NPD within their firm.

All companies are classified into small (26), medium (27) or large (7) sized companies. For this, the amount of part-time and full-time employees was taken together. Companies with 0 to 49 employees are regarded as small, 50 to 249 are regarded as medium, and those with 250 or more are regarded as large (Table 20). Of all companies, slightly over 60% has a formal R&D department (Table 21). Regarding the number of formal R&D departments compared with the size of the company, results (Table 22) show that all seven large companies have a formal R&D, where medium and small companies attain roughly 70% and 40% respectively. This relation[xii] (Table 23) is moderately strong and positive (0.398), which states that larger companies have a formal R&D department more often as would be expected. However, although these results show there is a relation, the Chi-Square test (Table 24) indicates the relation is not significant, since it does not satisfy the Chi-Square conditions[xiii]. One way to satisfy the conditions is to combine categories so that the number of variable levels reduces (Ibid.). Since the amount of large companies is relatively low, another classification was made. This 'special' classification (Table 25) only makes a distinction between small (0 to 99 employees) and large (100 and more employees) companies. With this classification, just over 90% of the large companies use a formal R&D department against 46% of the small companies. Results (Table 26) still show a positive relation that is slightly stronger[xiv] (0.435), but one that satisfies the Chi-Square conditions (Table 27).
No difference was found regarding the average R&D expenditure in relation to sales when having a formal R&D department or compared for firm size. Firms with a formal R&D department did launch significantly more new products within the last five year. Since the variable is not normally distributed (Table 28), a Mann-Whitney-test[xv] (Table 29) is used that shows both distributions are not equal. On average, firms with a formal R&D department launched almost 16 new products within the last five years against 4.5 without a formal department (Table 30). Not surprisingly, the same holds for the special classified company size. On average large companies launched 21.5 new products in the last five years against 6 for smaller companies (see Table 31, Table 32 & Table 33).

5.2 KIBS general statistics

Of all 60 respondents, 26 noted they used KIBS, one used KIBS but terminated the relation, and 33 indicated they did not use KIBS. Twenty companies noted they used KIBS for product solution motives, one for cost reduction motives and five companies noted a different reason varying from design to competitive advantage motives (Table 34 & Table 35). The one company that terminated the relation indicated there were two reasons to do so, namely insufficient technological dialogue and technological uncertainty. For most of the remaining results, this company was omitted. In those situations the total number of cases equates to 59 instead of 60 and will be visible in most tables. From the 33 companies that did not use KIBS, 14 noted they did so for a reason: they already have the knowledge required (10); to prevent knowledge infringement (2); due to costs (1); or to stimulate internal knowledge development (1).

KIBS users were asked to indicate the use of KIBS along the seven phases of the Product Development Survey mentioned earlier (Table 36). KIBS were particularly used during prototype development (19), final product development (13), product testing (8), and product engineering (14) in contrast to identification of new products (4), market research (1), and marketing strategy (1). Note that the number of phases KIBS are used in varies per firm (see Table 37). In addition, the frequency in which KIBS were used reflects the use throughout the phases (Table 38); prototype development, final product development, product testing, and product engineering are the most KIBS intensive.

[xii] Kendall's tau-c = 0.398, with the 95% confidence interval being ± 0.22 (0.398 ± 1.96 * 0.113). Association measures as the Kendall's tau-c are used to show the strength and direction of a relation (De Vocht, 2007). For associations between ordinal variables and in case of rectangular cross-tables, the Kendall's tau-c is the most appropriate measure (Ibid.). For square cross-tables, the tau-b is used. Note that dichotomous variables (having a formal R&D department) can be treated as ordinal without affecting the analysis.

[xiii] The importance of the Chi-Square is that it indicates whether a relation between two variables in a cross-table is statistical significant. The conditions are that all expected frequencies must be larger or equal to 1 and that a maximum of 20% of the expected frequencies may be between 1 and 5 (De Vocht, 2007). The association measures based on the Chi-Square as the Pearson's Contingency coefficient C, Phi and Cramér's V (nominal variables) or the Gamma, Kendall's tau-b, tau-c and Somer's d (nominal variables) only indicate the strength and direction of the variable (De Vocht, 2007).

[xiv] Kendall's tau-b = 0.435, with the 95% confidence interval being ± 0.19 (0.435 ± 1.96 * 0.098).

[xv] If the conditions for the independent-samples t-test are not satisfied, the Mann-Whitney-test can be used as an alternative (Ibid.). The conditions require a sample distribution that is normally distributed, which occurs if the variable in the population is normally distributed and/or the sample size has a minimum of 30 cases (Ibid.). In both cases a parametric test will be used. If the variable does not satisfy the conditions, a non-parametric test like the Mann-Whitney-test can be used. If the two-tailed asymptotic significance is lower than 0.05, the H_0 can be rejected and can be concluded that the distribution of two groups is not equal.

Regarding the classified company size, 50% (small), 54% (medium) and 86% (large) of the companies used KIBS (Table 39). Results show no relation between the control variable 'size of the company' and the use of KIBS (Table 40).

5.3 New Product Development statistics

The results of this chapter will deal with the suggested relations give earlier. Other interesting aspects will be taken along though. Respondents were given the option to indicate the average R&D expenditure per year for the chosen project. Of all 60 respondents, 15 skipped this question and one was omitted from the results (the company that partly used KIBS, but terminated the relation was omitted). Tests of normality show that the variable is not normally distributed (Table 41). Therefore the Mann-Whitney test (Table 42) is used, that shows there is an unequal distribution in R&D expenditure for KIBS and non-KIBS users. Non-KIBS users spend on average around €78,000 per year, compared to €279,000 for KIBS users, displayed in Table 2.

Table 2 – The average R&D expenditure for the project (euro/yr.) for KIBS and non-KIBS users.

Report

Average R&D expenditure for the project (euro/yr.).*

Use of KIBS.	Mean	N
No	77825,48	21
Yes	278953,48	23
Total	182960,57	44

The first relations (R1) states using KIBS for product solution reasons involves KIBS in more stages and have a higher KIBS involvement (frequency) compared to companies that use KIBS for cost reduction reasons. From the results, the difference between product solution and cost reduction cannot be extracted, of the 26 companies that used KIBS, only one indicated to do so because of cost reduction motives. Nonetheless, although the motives for using KIBS cannot be tested in correspondence with the framework of Tran *et al*. (2011), not all is lost. The results above show that most of the companies noted to use KIBS for product solution motives. As of such, it is expected that the properties of its use correspond to those motives or in other words, its use corresponds to the phases where KIBS are mostly needed regarding product solution. In that case it is not surprising that the firms use KIBS the most during the phases prototype development, final product development, product testing, and product engineering. These results hold for both the number of involvement points (Table 36) and the frequency of its use (Table 38). So, although the initial relation cannot be tested, the previous results combined still point to the possibility that the theory holds. Either way, regarding sub-question IV, the results indicate that the motive for using KIBS could influence the property of KIBS use. For a full testing of sub-question IV though, more data is needed on other possible motives. However, there is a possibility that the use of KIBS throughout the phases is biased regarding marketing activities. This will be dealt with in the discussion.

Note that complexity relates to the same underlying idea. In the view of Tran *et al*. (2011), product solution and cost reduction are classifications of complexity. The reason for looking at complexity on the one hand and product solution & cost reduction on the other hand is that it would provide a more detailed understanding. Although the latter are classifications for complexity, it would still be possible to have a complex project were KIBS are used solely for cost reduction motives. The second type of relations (R2) states that the perceived complexity of a firms' product has a significant positive correlation with engaging in KIBS outsourcing, and with the frequency of KIBS outsourcing. Respondents were asked to rate the complexity of the project relative to their skills with a number between 1 and 10. For comparing results, two classifications were made. One is the 'classified complexity product' that divides complexity into low (1-3), medium (4-7) and, high (8-10). The second variable 'special classified complexity product' only divides between low (1-5) and high (6-10). When comparing the relative complexity of the product with the use of KIBS, results show a moderately strong positive relation 0.409[xvi], displayed in Table 3 and Table 4. This indicates that the relative complexity, the difficulty of the product in relation to the perceived dynamic capabilities of the firm, has a positive relation with the use of

[xvi] Kendall's tau-c = 0.409, with the 95% confidence interval being ± 0.23 (0.409 ± 1.96 * 0.117). Does not satisfy the Chi-Square conditions.

KIBS. In this case, the Chi-Square test does not satisfy the conditions, but when omitting the option 'low complexity' it does satisfy the conditions while the strength of the relation does not alter much[xvii]. Since the variable is not normally distributed (Table 43), the Mann-Whitney test (Table 44) is used that shows there is an unequal distribution in the rating of project complexity. On average, non-KIBS users rate the complexity of their project with 6.7 were KIBS users rate their project with 7.4. Regarding the frequency of KIBS use, for the number of stages KIBS are used in and the frequency of their use, results show no possible relation, neither with the 'classified complexity product' nor with the 'special classified complexity product' (Table 45). The strength of the given relations is too low to require any further investigation. When looking at the average number of phases where KIBS are used and the average frequency of their use, Table 6 shows that both hardly differ between medium and high complexity. The numbers reflect the 26 KIBS users, of which no one was divided into the lower complexity category. So, sub-question II is for the first part only answered regarding the complexity in relation to the use of KIBS, however the suggested relation R3 also refers to this sub-question.

Table 3 – The complexity of the product for KIBS and non-KIBS users.

Classified complexity product * Use of KIBS. Crosstabulation

			Use of KIBS.		
			No	Yes	Total
Classified complexity product	Low	Count	1	0	1
		% within Classified complexity product	100,0%	,0%	100,0%
	Medium	Count	25	10	35
		% within Classified complexity product	71,4%	28,6%	100,0%
	High	Count	7	16	23
		% within Classified complexity product	30,4%	69,6%	100,0%
Total		Count	33	26	59
		% within Classified complexity product	55,9%	44,1%	100,0%

Table 4 – Association measures regarding 'Classified complexity product' * 'Use of KIBS'.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	,414	,116	3,498	,000
	Kendall's tau-c	,409	,117	3,498	,000
	Spearman Correlation	,417	,117	3,464	,001[c]
Interval by Interval	Pearson's R	,416	,113	3,454	,001[c]
N of Valid Cases		59			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Table 5 – Rated complexity of the product for KIBS and non-KIBS users.

Report

Complexity of the product, relative to the competences of the firm.

Use of KIBS.	Mean	N
No	6,73	33
Yes	7,42	26
Total	7,03	59

[xvii] Kendall's tau-b = 0.403, with the 95% confidence interval being ± 0.24 (0.403 ± 1.96 * 0.121). Does satisfy the Chi-Square conditions.

Table 6 – Averages of KIBS involvement for medium and high complexity products.

Report

Mean

Classified complexity product	Nr of phases KIBS are used	Average frequency of KIBS use (contact moments/mo.)
Medium	2,30	18,70
High	2,31	15,37
Total	2,31	16,65

Before looking at the third relation, there is the possibility that project spending also depends on the complexity of the product, since complexity and the use of KIBS show a significant relation. Although it was not introduced during the theoretical framework, this variable is used as an optional control variable as indicated earlier. For comparing results, the classifications 'classified complexity product' and 'special classified complexity product' are used. Both variables are not normally distributed (Table 46 & Table 47), so the Mann-Whitney test is used. Results show no difference for the 'special classified complexity product' variable (Table 48) and for the comparison of the low and high classification of the 'classified complexity product' variable (Table 49). This is probably due to the low number of cases in both comparisons. Comparing the medium and high classification of the 'classified complexity product' variable shows that both groups are not equally distributed (Table 50). As seen in Table 7, respondents that rate their project as medium complex spend on average €99,000 per year, compared to €309,000 per year for respondents that rate their project as highly complex.

Table 7 – Average R&D expenditure for low, medium and high complexity products.

Report

Average R&D expenditure for the project (euro/yr.).*

Classified complexity product	Mean	N	Std. Deviation
Low	14000,00	1	.
Medium	99070,19	26	169403,427
High	308913,33	18	402525,560
Total	181117,00	45	300333,907

Other control variables like lead time, formal R&D, the number of new products launched, and firm age show no possible relation with KIBS usage or the complexity of the product (see Table 51). It can be seen though that complexity holds a relation with the use of KIBS and R&D expenditure, and that the use of KIBS and R&D expenditure are also related as is dealt with above.

The third relation (R3) states that the synergy of the firm before entering the NPD has a significant negative correlation with engaging in KIBS outsourcing. This means that the synergy values of KIBS users should be lower compared to those of non-KIBS users. Figure 4 and Figure 5 respectively give a visualization of the differences between KIBS usage regarding technical synergy and marketing synergy aspects. To avoid confusion with other activities, all activities that take place before entering the NPD are denoted with pro. The measurement level of the variables was done in the same way as with complexity, where respondents had the option to choose a number between one (1) and ten (10). When looking at the different figures, it immediately stands out that non-KIBS users rate pro-technical activities on average higher than KIBS users, although the differences regarding marketing synergy are less visible. When looking closer to the numbers (Table 52 & Table 53), we see the same findings for technical synergy and marketing synergy. All activities of non-KIBS users are rated higher, but the differences regarding marketing synergy are much smaller. These findings, at first sight, indicate the relation could be valid.

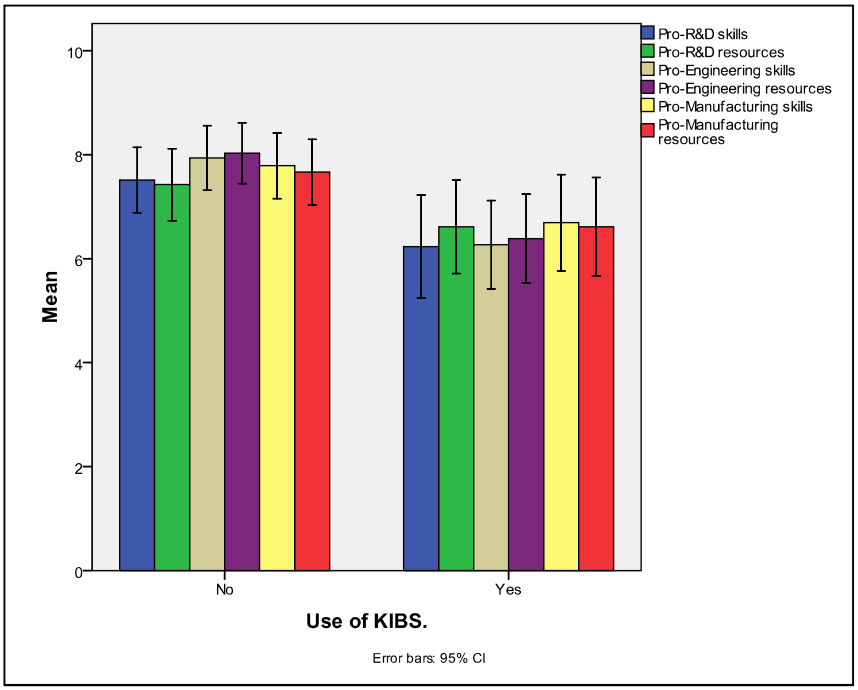

Figure 4 – Mean values of Pro-technical activities (technical synergy).

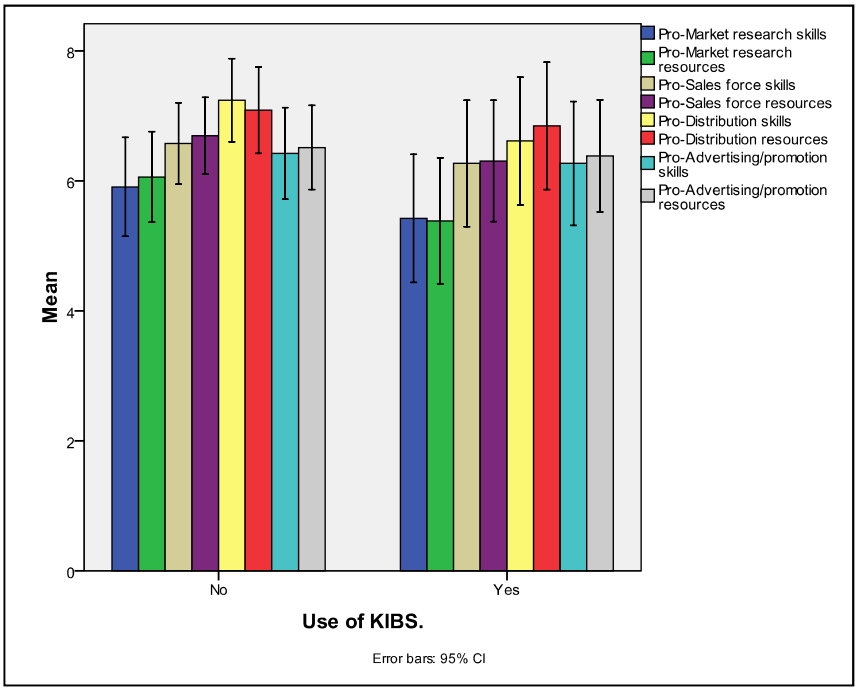

Figure 5 – Mean values of Pro-marketing activities (marketing synergy).

Table 8 provides a summary of each type of activity (for example all technical synergy aspects are now combined in one 'Pro-Technical synergy' variable[xviii]), alongside with the overall difference in pro-activities score (labeled 'Pro-Combination'). Compared with marketing synergy, technical synergy shows a larger difference; non-KIBS users score on average 46.4 against 38.8 for KIBS users, as expected from the figures above. When performing a correlation analysis (bivariate) to indicate possible relations, results show that all technical synergy aspects have a negative relation (Table 54), of which half are found significant, either at the 0.01 or 0.05 level. 'Pro-R&D skills' shows a weak correlation (-0.262), and 'Pro-engineering skills' and Pro-engineering resources' show a moderately strong negative relation (-0.412 and -0.405 respectively). The overall

[xviii] To keep a better overview of all the different variables, the difference between the collective variables and the individual variables can easily be spotted on the basis of their values. Average individual variables range between one (1) and ten (10), where collective variables are characterized by much larger numbers.

'Pro-technical synergy' also shows a weak negative correlation (-0.341). Regarding marketing synergy, seven out of eight activities show a negative relation (Table 55), although all are very weak and not significant, and only 'Pro-Market research resources' shows a weak negative relation (-0.147). The combined activities of each type reflect the same findings; Table 9 shows that only technical synergy has a significant negative relation with the use of KIBS. To control for the sensitivity of the correlation analyses in this case, example results are included for the three variables with the highest non significant found correlation; namely 'Pro-Manufacturing skills', 'Pro-Manufacturing resources', and 'Pro-Combination'. Results (Table 56, Table 57 & Table 58) indicate that all three variables are highly sensitive (sign. = 0.054, 0.090, and 0.060 respectively); H_0 is almost rejected, which occurs whenever the significance is equal or lower to 0.05. This indicates that an increase of data samples could only lead to more significant results, which add up to the validation of the suggested relation.

The last step is to check whether there is a real difference (read significant) between non-KIBS and KIBS users. For this, the significant collective variable 'Pro-technical synergy' is taken, along with the three significant found variables 'Pro-R&D skills', 'Pro-engineering skills' and 'Pro-engineering resources'. Since all variables are not normally distributed (Table 59), the Mann-Whitney test is used (Table 60). This test shows that for all three variables, the difference between the non-KIBS and KIBS users is found to be significant. The suggested relation thus holds for the pro-technical activities 'Pro-R&D skills', 'Pro-engineering skills' and 'Pro-engineering resources'. Although half of the pro-technical activities do not show a significant result, all together the relation also holds for the 'Pro-technical synergy' variable and this answers the second part regarding sub-question II. Table 10 shows the mean differences of KIBS users and non-KIBS users regarding the three variables and the collective variable. When taken into account that twenty out of 26 firms noted to use KIBS for production solution motives, it perhaps is not surprising that the very factors R&D skills, and engineering skills and resources are determinative in the decision for KIBS outsourcing.

So, regarding sub-question II, results show that both complexity and (part of) the technical synergy are indeed important for the choice of using KIBS. Not surprisingly, when comparing complexity with the same significant found variables of synergy, it shows (Table 61) that they hold a weak negative relation that in two out of four cases is found significant. This adds up to the theoretical framework, since the two aspects are related.

Table 8 – Mean values off all collective pro NPD activities.

Report

Mean

Use of KIBS.	Pro-Combination	Pro-Technical synergy	Pro-Marketing synergy
No	98,88	46,36	52,52
Yes	88,31	38,81	49,50
Total	94,22	43,03	51,19

Table 9 – Result of bivariate correlations between KIBS use and all collective pro NPD activities.

Correlations

			Use of KIBS.	Pro-Combination	Pro-Technical synergy	Pro-Marketing synergy
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	-,234	-,341**	-,050
		Sig. (2-tailed)	.	,075	,008	,706
		N	59	59	59	59
	Pro-Combination	Correlation Coefficient	-,234	1,000	,806**	,852**
		Sig. (2-tailed)	,075	.	,000	,000
		N	59	59	59	59
	Pro-Technical synergy	Correlation Coefficient	-,341**	,806**	1,000	,454**
		Sig. (2-tailed)	,008	,000	.	,000
		N	59	59	59	59
	Pro-Marketing synergy	Correlation Coefficient	-,050	,852**	,454**	1,000
		Sig. (2-tailed)	,706	,000	,000	.
		N	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10 – Mean values of all variables found to be of significant difference regarding non-KIBS users and KIBS users.

Report

Mean

Use of KIBS.	Pro-Technical synergy	Pro-R&D skills	Pro-Engineering skills	Pro-Engineering resources
No	46,36	7,52	7,94	8,03
Yes	38,81	6,23	6,27	6,38
Total	43,03	6,95	7,20	7,31

The fourth set of relations (R4) states that for firms engaged in KIBS outsourcing, firms with a medium synergy before entering the NPD show the lowest failure rate in terminating KIBS usage and, show a larger growth in synergy compared for firms with a low or high synergy. The data is insufficient to provide any results regarding the first relation (R4a). As dealt with above, only one company noted they terminated the relation with KIBS during the project. Regarding the second relation, Figure 6 and Figure 7 provide a visualization of the growth in synergy (Post-activities minus Pro-activities) for technical and marketing synergy respectively. Firms were asked to indicate the level of synergy before the NPD and after the project, as explained in chapter 4.4. Note that with the classification of complexity into 'classified complexity product', none of the 26 KIBS users are categorized into low product complexity (as can be seen in Table 3), therefore, the results only reflect differences between medium and high complexity. When following the suggested relation, we only see a large difference in the advantage of medium complexity regarding the 'Post-Pro Manufacturing' skills and resources variable. For all other variables, the differences are either minimal or in the advantage of high complexity. All the variables show a large confidence interval, so the results need to be further investigated. A possible explanation for a negative growth in synergy could be due to misalignment between the expected level of synergy before entering the NPD and the reflection upon the project when finished. This will be dealt with more extensively in the discussion.

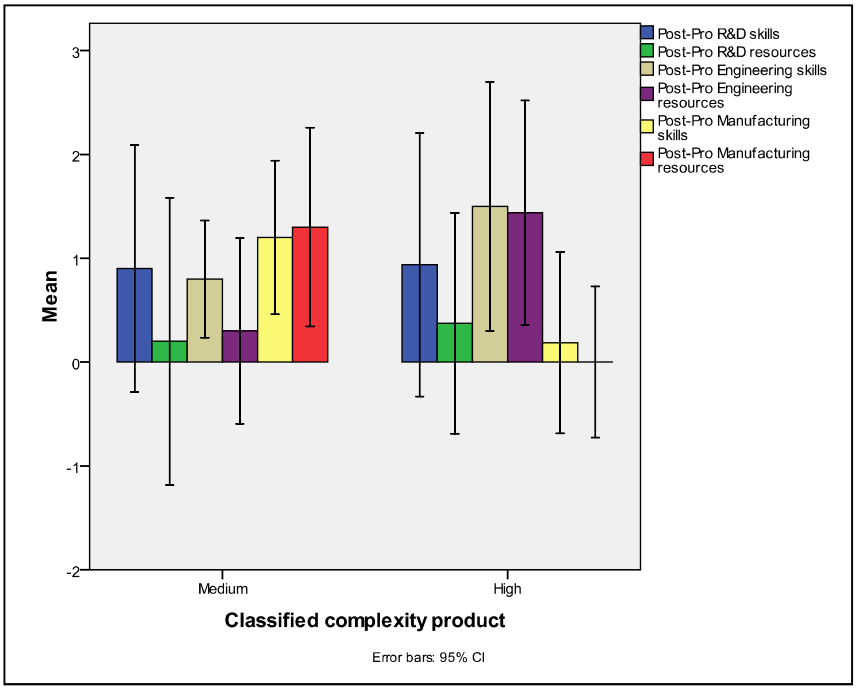

Figure 6 - Mean values of the growth in technical synergy aspects (Post minus Pro activities) for medium and high complexity products.

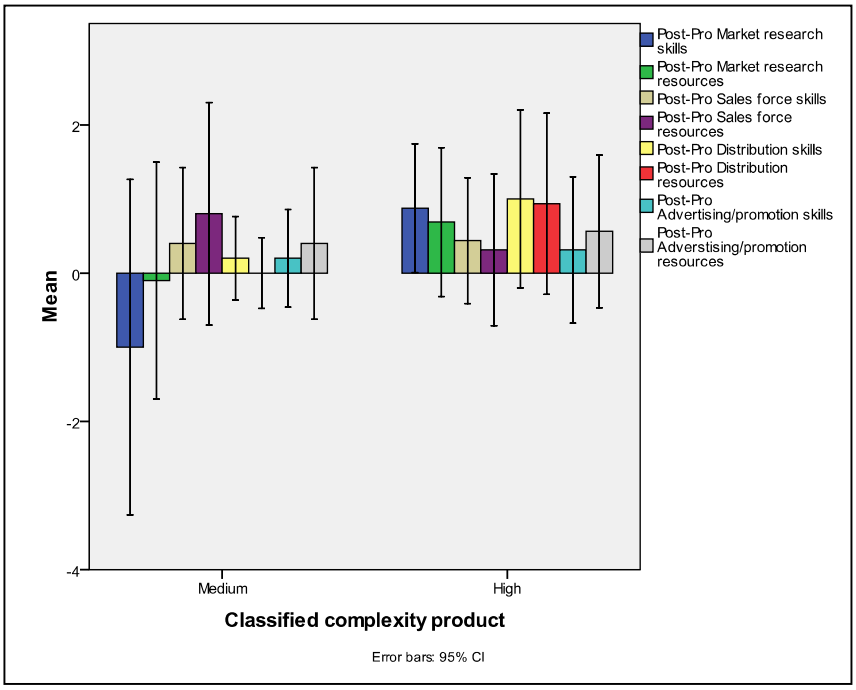

Figure 7 - Mean values of the growth in marketing synergy aspects (Post minus Pro activities) for medium and high complexity products.

Table 11 provides a summary of both collective Post-Pro activities for medium and high complexity products. Regarding technical synergy, medium complexity scores a fraction higher with 4.7 against 4.4 for high complexity. Regarding marketing synergy however, high complexity scores considerably higher with 5.1 against 0.9 for medium complexity. When performing a correlation analysis to indicate possible relations, results (Table 62) show that R&D resources and engineering skills and resources show a positive relation although insignificant, in which the latter shows a weak correlation (0.247). 'Post-Pro Technical synergy' shows a weak negative relation (-0.169), where 'Post-Pro Manufacturing skills' and 'Post-Pro Manufacturing resources' show a moderately strong negative relation (-0.456 and -0.452 respectively) that are both found significant at the 0.05 level. Regarding marketing synergy, results (Table 63) show no significant relation for any variables, remarkably not even for the collective variable that displays a large difference. Half of the variables are either show a positive or negative relation. Notably, 'Post-Pro Market skills' and 'Post-Pro Market resources' show a weak positive relation (0.345 and 0.243 respectively). A possible explanation for marketing synergy to be of none or very little influence is that companies attach less value to marketing related activities. This shares the same reason why the use of KIBS throughout the phases could be biased regarding marketing activities. As of such, compared to technical synergy, the activities could be seen as less formal and therefore be executed to a lesser extent. More on this will be dealt with in the discussion. To control for the sensitivity of the correlation analyses in this case, example results are included for the three variables with the highest non significant found correlation; namely 'Post-Pro Engineering resources', 'Post-Pro Market skills', and 'Post-Pro Market resources'. Results (Table 64, Table 65 & Table 66) show that only 'Post-Pro Market research skills' is sensitive since H_0 is almost rejected (sign. = 0.085). The other two are far less sensitive, since they show a significance of 0.216 and 0.344 respectively.

Only the significantly found variables 'Post-Pro Manufacturing skills' and Post-Pro Manufacturing resources' are taken along. The tests of normality show that both are not normally distributed (Table 67), therefore again the Mann-Whitney test is used. The test shows that the differences between the medium and high complexity groups are found significant (Table 68). The suggested relation (R4b) thus only holds for the variables 'Post-Pro Manufacturing skills' and Post-Pro Manufacturing resources'. Regarding sub-question VI, results thus show that firms with a medium synergy show the largest growth in synergy for the two significant found variables. In that way, synergy can be used as a measure for the effective and efficient use of KIBS among KIBS users. In Table 12, the significant found variables show the differences in synergy growth for respondents that, after classification, were divided into medium and high complexity products. It can be seen that the differences regarding the two variables is considerable.

Table 11 – Mean values off both collective Post-Pro-activities for medium and high complexity products.

Report

Mean

Classified complexity product	Post-Pro Technical synergy	Post-Pro Marketing synergy
Medium	4,70	,90
High	4,44	5,13
Total	4,54	3,50

Table 12 – Mean values of all variables found to be of significant difference regarding medium and high complexity products.

Report

Mean

Classified complexity product	Post-Pro Manufacturing skills	Post-Pro Manufacturing resources
Medium	1,20	1,30
High	,19	,00
Total	,58	,50

The last set of hypotheses (R5) states that firms that engaged in KIBS outsourcing show a larger growth in synergy compared to firms that did not used KIBS and that KIBS outsourcing has no correlation (neither negative nor positive) with the overall NPD performance of the firms. Figure 8 and Figure 9 provide a visualization of the growth in synergy for technical and marketing synergy respectively, compared for KIBS and non-KIBS users. The differences regarding technical synergy are fairly visible, for marketing synergy the differences are less visible, nonetheless still higher for KIBS users. Since both variables are characterized by rather large confidence intervals though, further investigation is necessary.

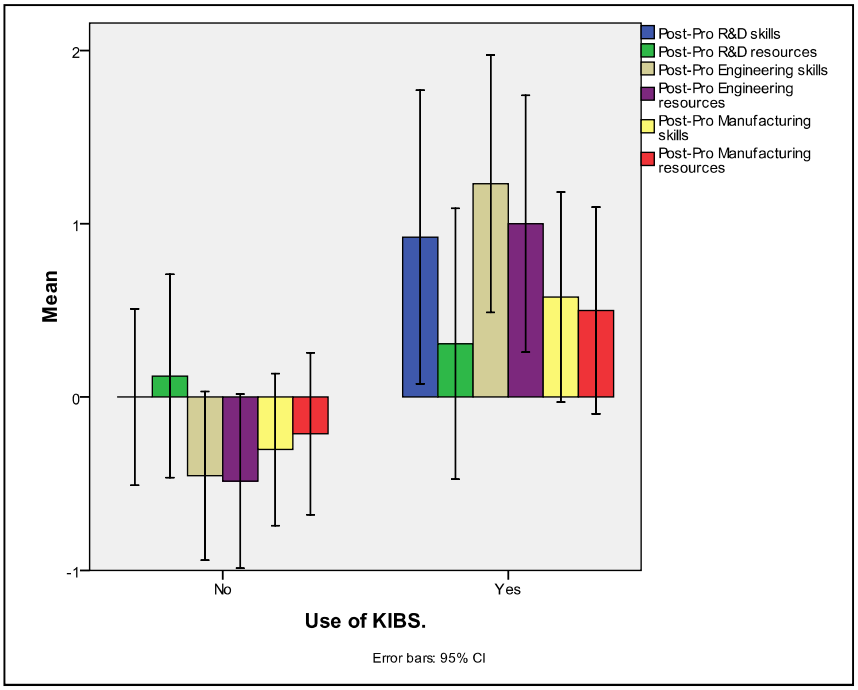

Figure 8 – Mean values of the growth in technical synergy aspects (Post minus Pro activities) for non-KIBS and KIBS users.

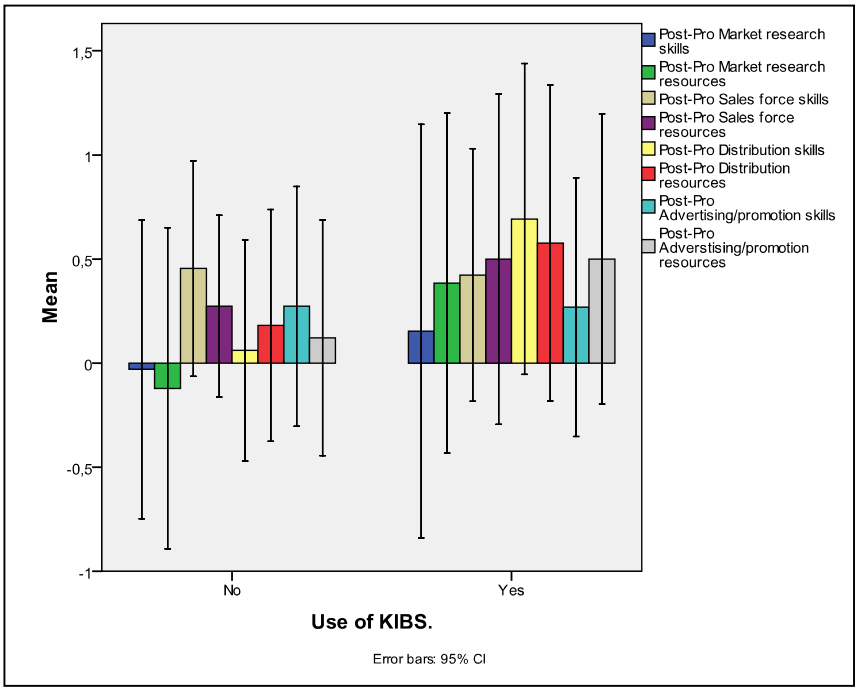

Figure 9 – Mean values of the growth in marketing synergy aspects (Post minus Pro activities) for non-KIBS and KIBS users.

Table 13 provides a summary of both collective Post-Pro activities for non-KIBS and KIBS users. It can be seen that the collective variables confirm the visualization of the figures above; the combined differences are much larger for technical synergy than for marketing synergy. Note that the values of the KIBS users correspond with the total values of the collective variables in Table 11. Results from the bivariate analysis (Table 69) show that regarding technical synergy all variables, except 'Post-Pro R&D resources' show a positive relation. From the six variables, four are found significant of which 'Post-Pro Engineering skills' and 'Post-Pro Engineering resources' show a moderately strong positive relation (0.512 and 0.411 respectively) that is significant at the 0.01 level, and 'Post-Pro Manufacturing skills' and 'Post-Pro Manufacturing resources' show a weak positive relation (0.320 and 0.272 respectively) that is significant at the 0.05 level. The collective variable 'Post-Pro Technical synergy' shows a weak positive relation (0.360) significant at the 0.01 level. Regarding marketing synergy all variables show a very weak relation; none is significant either. A possible explanation for this regards the same reason given above on why marketing synergy aspects appear to be of none or little influence for relation 4b.

The tests of normality (Table 71) show that all variables are not normally distributed. The Mann-Whitney test (Table 72) shows that for all variables, the differences between KIBS and non-KIBS users are significant. The suggested relation (R5a) thus holds for 'Post-Pro Engineering skills', 'Post-Pro Engineering resources', 'Post-Pro Manufacturing skills', 'Post-Pro Manufacturing resources', and for the overall variable 'Post-Pro Technical synergy'. In addition to (medium) synergy as a measure for the effective and efficient use of firms that use KIBS, results show for a part that the growth of synergy is a measure for the effective and efficient use of KIBS compared for non-KIBS and KIBS users. After all, knowing only the effect of KIBS among KIBS users does not answer the question whether they really add value. The comparison should cover both aspects. In Table 14, the significant found variables show the differences in synergy growth for KIBS and non-KIBS users. Although the absolute differences might indicate otherwise, the relation between the engineering activities and KIBS usage is the strongest.

Table 13 – Mean values off collective Post-Pro-activities for non-KIBS and KIBS users.

Report

Mean

Use of KIBS.	Post-Pro Technical synergy	Post-Pro Marketing synergy
No	-1,33	1,21
Yes	4,54	3,50
Total	1,25	2,22

Table 14 – Mean values of all variables found to be of significant difference regarding the use of KIBS.

Report

Mean

Use of KIBS.	Post-Pro Technical synergy	Post-Pro Engineering skills	Post-Pro Engineering resources	Post-Pro Manufacturing skills	Post-Pro Manufacturing resources
No	-1,33	-,45	-,48	-,30	-,21
Yes	4,54	1,23	1,00	,58	,50
Total	1,25	,29	,17	,08	,10

For the results regarding the last relation (R5b), recall that NPD is divided into eight different categories (see appendix 9.2), namely: Protocol, Proficiency of pre-development activities, Proficiency of technical activities, Proficiency of marketing activities, NPD-team, Technical synergy, Marketing synergy, and Communication. For the results, the indicator communication was omitted due to the issue of assigning values, which is dealt with in the discussion. Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, and Figure 15 respectively show the results of the values between non-KIBS users and KIBS users. Regarding the suggested relation, it is expected that the results between the two groups are sufficiently small so that they do not yield any significant differences. Most variables show hardly or small differences, but some differences appear considerable: 'Pro-Financial analyses' and 'Pro-Technical assessment' (Figure 10); 'Pilot production' and 'Start-up/launch' (Figure 11); 'Marketplace launching' and 'Marketing test' (Figure 12); 'NPD R&D and Marketing integration', 'NPD Marketing and production integration' and 'NPD Projectteam responsibility' (Figure 13); and 'Post-R&D resources' (Figure 14). Figure 16 and Table 15 provide an overview of all collective variables (the seven categories). It can be seen that for the sum of all categories, the differences remain small, although non-KIBS users score slightly better on each category. Note that some categories consist of more variables than others, so comparison between the categories may be biased. For example, the differences between non-KIBS and KIBS users for 'NPD team' and 'Post-Technical synergy' are 2.79 and 1.68 respectively, but the former consists of four variables against six for the latter. All small differences taken together could provide a sufficiently large difference to yield a significant result between non-KIBS and KIBS users.

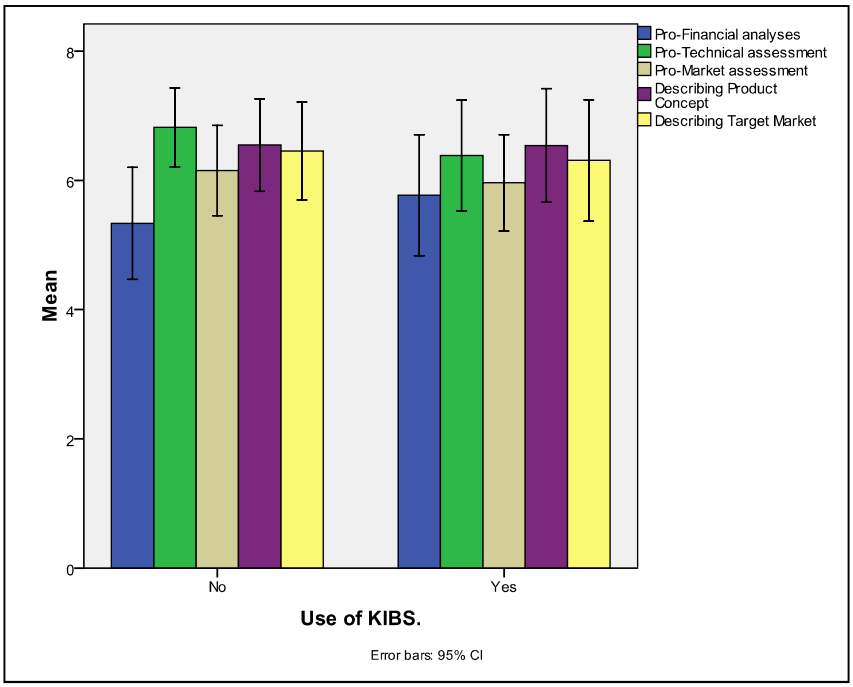

Figure 10 – Mean values of pre-development and protocol activities for non-KIBS and KIBS users.

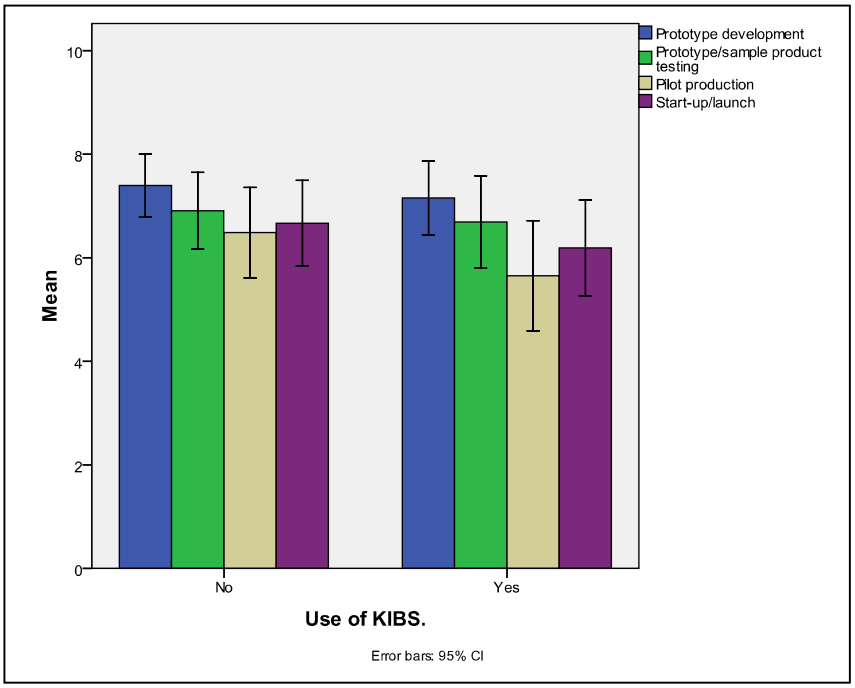

Figure 11 – Mean values of technical activities for non-KIBS and KIBS users.

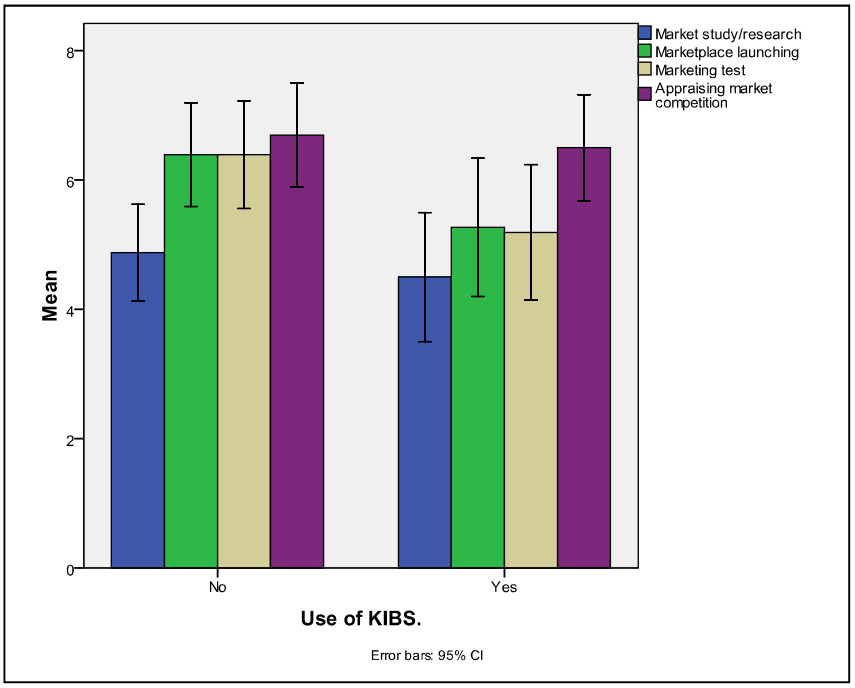

Figure 12 – Mean values of marketing activities for non-KIBS and KIBS users.

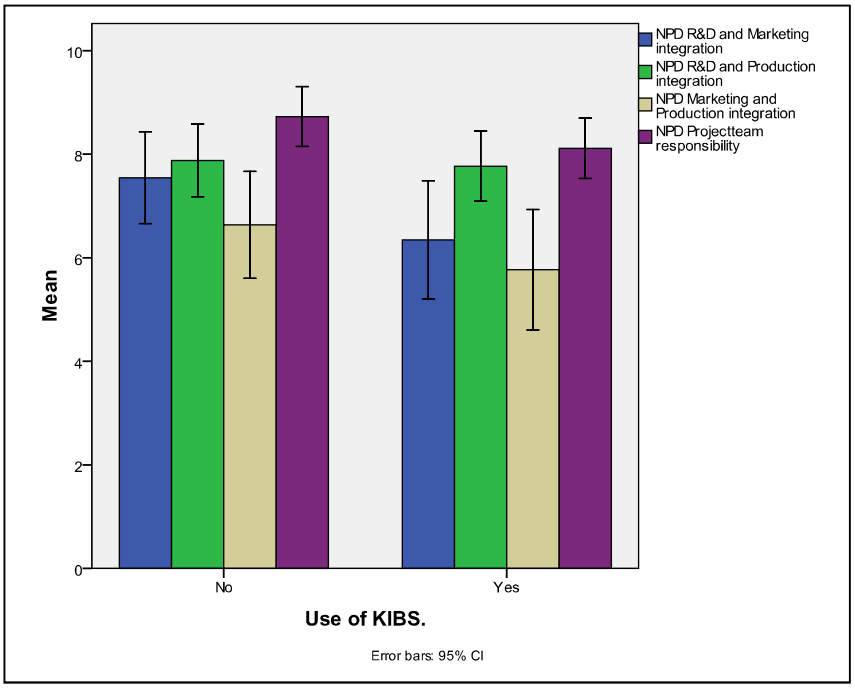

Figure 13 – Mean values of NPD team activities for non-KIBS and KIBS users.

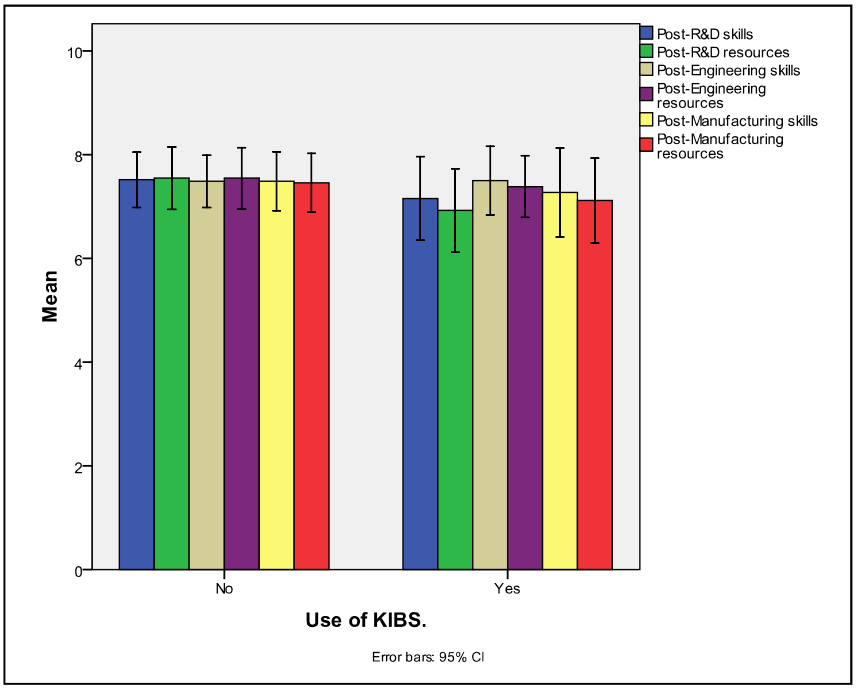

Figure 14 – Mean values of technical synergy aspects for non-KIBS and KIBS users.

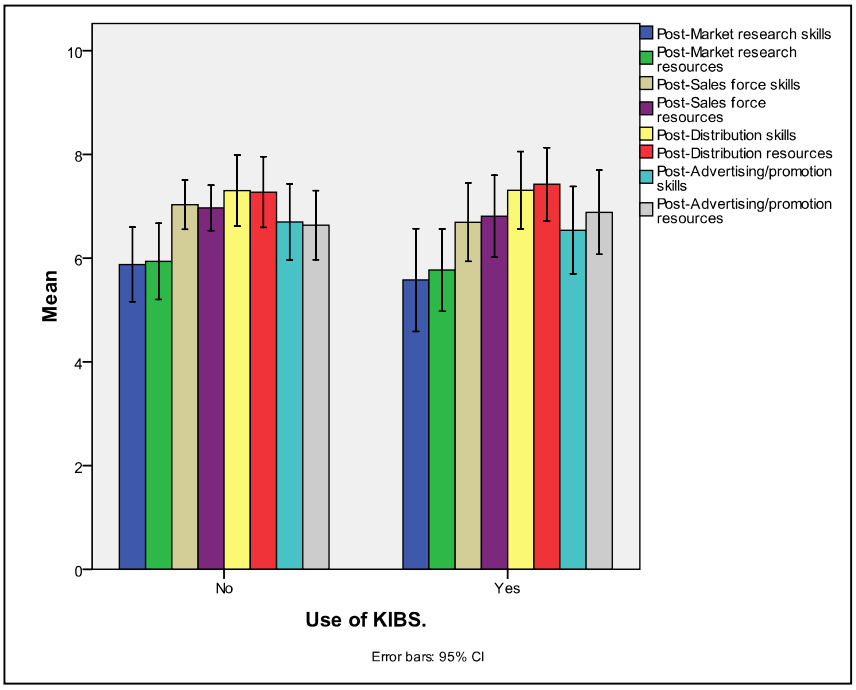

Figure 15 – Mean values of marketing synergy aspects for non-KIBS and KIBS users.

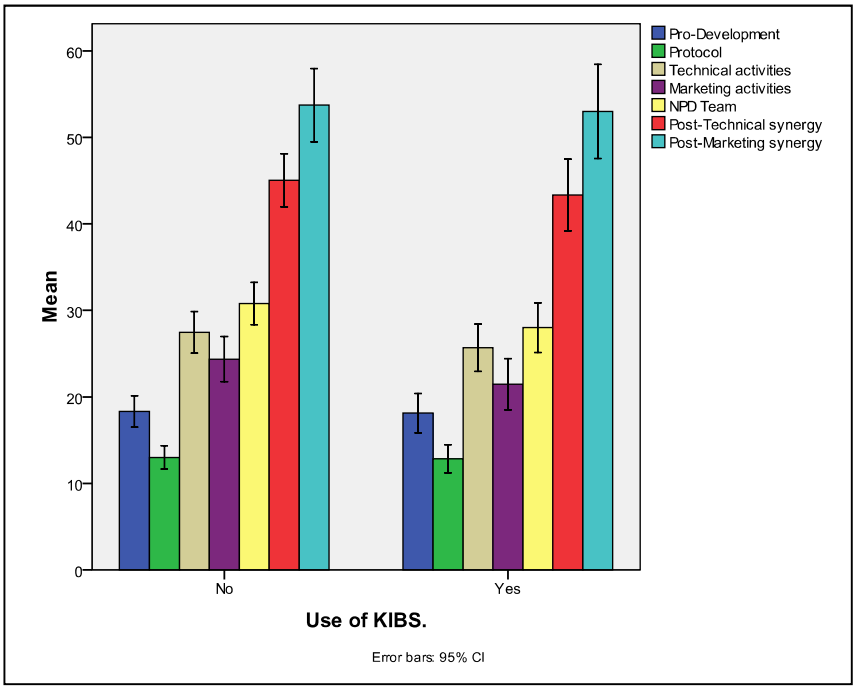

Figure 16 – Mean values of all collective NPD activities for non-KIBS and KIBS users.

Table 15 – Mean values off all collective NPD activities for non-KIBS and KIBS users

Report

Use of KIBS.		Pro-Development	Protocol	Technical activities	Marketing activities	NPD Team	Post-Technical synergy	Post-Marketing synergy
No	Mean	18,30	13,00	27,45	24,36	30,79	45,03	53,73
	N	33	33	33	33	33	33	33
	Std. Deviation	5,102	3,824	6,797	7,348	6,927	8,666	11,980
Yes	Mean	18,12	12,85	25,69	21,46	28,00	43,35	53,00
	N	26	26	26	26	26	26	26
	Std. Deviation	5,602	4,017	6,781	7,306	7,071	10,249	13,503
Total	Mean	18,22	12,93	26,68	23,08	29,56	44,29	53,41
	N	59	59	59	59	59	59	59
	Std. Deviation	5,282	3,877	6,789	7,410	7,069	9,350	12,566

Figure 17 and Table 16 provide the difference in the NPD performance score. As can be seen, when taken together, the differences between non-KIBS users and KIBS users yield a rather considerable difference; regarding the NPD performance, non-KIBS users score 212.7 against 202.5 for KIBS users. The correlation analyses could indicate possible significant relations. Where Figure 10 possibly indicated a significant difference, for Pro-Development and protocol, results (Table 73) show no significant relations. None of the correlation coefficients exceeds 0.1 that means there is no correlation found between the variables. Regarding technical and market activities, results (Table 74) also show no significant relation. The indication from Figure 11 and Figure 12 that 'Pilot production', 'Marketplace launching', and 'Marketing test' show a larger difference corresponds with these results. All three show a weak negative correlation (-0.143, -0.236, and -0.234 respectively), although not significant. The same effect is visible with the results of 'NPD team' (Table 75). Corresponding with the differences visible in Figure 13, 'NPD R&D and Marketing integration', 'NPD Marketing and production integration' and 'NPD Projectteam responsibility' all show a negative weak, but not significant relation (-0.225, -0.161, and -0.239 respectively). Note that correlation coefficients of this strength can be found significant; 'Post-Pro Manufacturing resources' was found significant regarding the suggested relation R5a with an initial correlation coefficient of 0.272 significant at the 0.05 level. To control for the sensitivity of the correlation analyses in this case, example results are included for the three variables with the highest non significant found correlation; namely 'Marketplace launching', 'Marketing test', and 'NPD Projectteam responsibility' with correlation coefficients of -0.236, -0.234 and -0.239 respectively. The results (Table 76 and Table 77) show no significant difference for non-KIBS and KIBS users, although as expected, the correlations are sensitive, since H_0 of the Mann-Whitney test is almost rejected. In this case the significance of the variables ranges from 0.069 to 0.075.
The results for technical and marketing synergy correspond with the findings. From Figure 14 and Figure 15 it appeared that only 'Post-R&D resources' showed a considerable difference. Results (Table 78 and Table 79) show that all variables are not significant, of which 'Post-R&D resources' indeed shows the largest correlation coefficient (-0.132). Of the collective variables, results show that none is significant, although 'Technical activities', 'Marketing activities', and 'NPD team' show the largest correlation coefficient (-0.236 and -0.205 respectively). When looking to Table 15, it can be seen that comparison between the variables indeed could be biased. The three collective variables consist each of four variables, but they show a difference to the same extent as 'Post-Technical synergy'. However, since the latter exists of six variables, the difference is mediated by more variables and that explains why its correlation coefficient is much smaller.

With each single and collective variable that indicated no significant difference, the last step is to look at the 'NPD performance'. Figure 17 and Table 16 show the final results for the NPD performance score between KIBS and non-KIBS users. As expected from the individual results above, non-KIBS users overall score higher on NPD performance. The correlation analyses (Table 80) shows a correlation coefficient of -0.128 that is not found significant. Since the variable is found normally distributed (Table 81), the Independent Samples Test is used. The test (Table 82 and Table 83) shows that with a 2-tailed significance of 0.282 that the difference between non-KIBS and KIBS users regarding NPD performance is not significant. In addition, in 95% of all cases, the difference lies between -8.6 and 29.0. Overall, the results are thus far less sensitive than compared to the example results above. All findings thus support the suggested relation (R5b), that KIBS outsourcing has no correlation (neither negative nor positive) with the overall NPD performance of the firms. So, regarding sub-question VII, this shows what kind of effect KIBS has on the NPD performance and with that it provides an additional measure for the effective and efficient use of KIBS, in addition to the two found above.

The attentive reader could have noticed that of the seven used categories, each is composed of a different set of indicators. However, the categories are not weighed, which in some situations regarding a set of categories with an unequal amount of indicators will be done. This is dealt in the discussion.

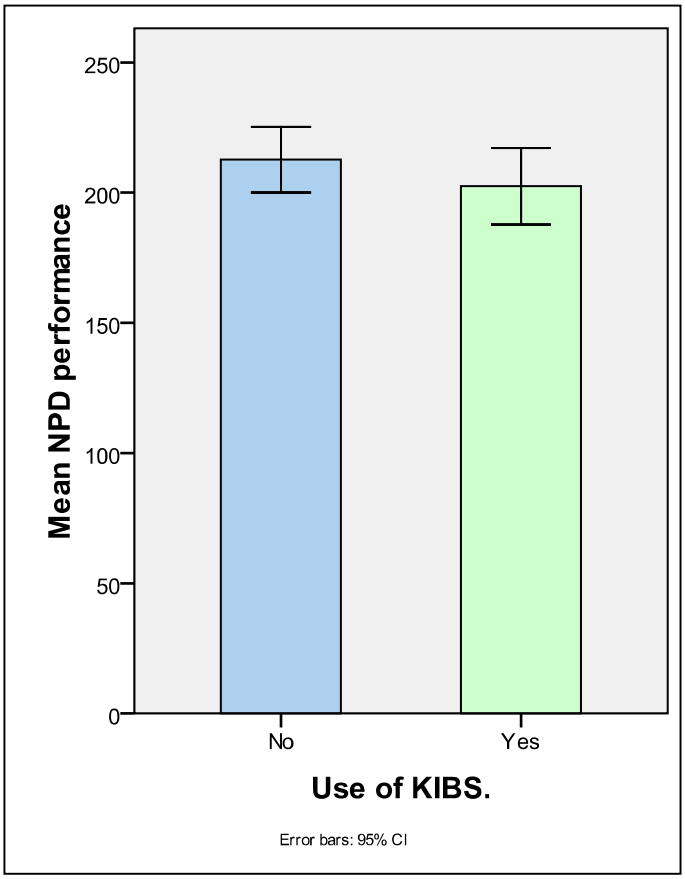

Figure 17 – Mean score for NPD performance for non-KIBS and KIBS users.

Table 16 – Mean score for NPD performance for non-KIBS and KIBS users.

Report

Mean

Use of KIBS.	NPD performance
No	212,67
Yes	202,46
Total	208,17

6 Discussion

A few issues need to be elucidated further. First, some methodological issues are dealt with, followed by the results.

Although it remains a limitation for all questionnaires, a common issue regards differences in interpretation among interviewees. This causes problems with construct validity because the answers are somewhat subject to subjectivity. This regards the type of questioning used in the research. For most indicators, a Likert scale was used, but the only assumptions that can be made when drawing conclusions that from that kind of data is that on average, differences occur. From the results it can be seen that this is taken into account. For all relations, initial correlations are sought at using bivariate anayleses. However, additional methods were used to look at the differences between the compared groups. Therefore, the mearument may contain unreliabilitiy, but it may still have meaning (Fowler, 2009). In addition, some researchers frequently criticized the use of several statistical methods as the ones that are used in this research. In recent work of Geoff (2010), he challenges several arguments that state using parametric methods is faulted due to a too small sample size; not normally distributed data; or the use of Likert scales. He concludes that parametric statistics can be used notwithstanding the occurrence of the three arguments and that 'coming to the wrong conclusion' is thus out

of the question. To prevent the possible differences in interpretation from becoming a large issue and causing biased result, much effort is put in the design of the survey and questionnaire as dealt with in the methodological section.

Regarding the comprehensiveness of this research as dealt in chapter 4.1, not all companies from the total population had a chance to be included in the sample. The sample obtained from the Dutch Chamber of Commerce was generated using several selection criteria as indicated in the methodology section. Therefore, the eventual sample was not completely representative for the actual population. One of the selection criteria was a minimum of five employees. As one could question this choice, it was mainly for practical reasons. Not omitting this criterion would result in a too large dataset, thereby raising costs, since access to the database is not free of charge. All criteria together resulted in a sample frame of 665 companies that was assumed sufficient to reach the desired sample size. In contrast to this issue, extra effort was made to ensure that the respondents were mostly members of the target population, which adds to the validity of the research. This was done by a screening test. The goal was to approach senior managers, responsible or highly involved with new product development. Nine out of 60 respondents have less than three years experience, where the average is 9.43 years. In addition, most of the respondents are indeed highly involved or responsible for the new product development as the results indicate (Table 18).

Also, several issues concern KIBS. First, a uniform definition of KIBS is still missing (Toivonen, 2004). So, to ensure respondents understand KIBS, this research provided them with one well known definition from Miles *et al*. (1995), along with a short elaboration on its function, accompanied with examples of KIBS use. Other issues rose from the personal interviews. One of the larger companies noted that they internalized a service division like KIBS. Due to its large size, it could meet its own demand. The respondent noted that in his view, this counted as a KIBS, though internalized. The research did not cover for this issue in the questionnaire, assuming it regarded an individual situation. Another aspect is that larger companies regularly make use of multiple KIBS, an effect that also is not taken into account in this study. Lastly, one interviewee noted they used KIBS to maintain a flexible workload. During times of high demand regarding a project the capacity could be increased using the KIBS and vice versa. In this way, they could enhance the pace of their project. All these issues point to a key aspect that is shared throughout the literature. Although much research is already done on KIBS (and intermediaries), there still remain lots of issues to be tackled.

The NPD literature provides an extensive list of indicators on determinants of NPD performance. Since the NPD indicators are a measure for the NPD performance of a firm, an important question is to ask why common performance indicators like profit, sales, turnover etc. are not used. The reason behind the choice for NPD indicators is that the list of indicators can point to differences between firms' processes in case of a different outcome. Or in other words, it can show where things go wrong. Indeed, common performance indicators give a clear view on the performance of a firm; they are better to comprehend, but do not provide an as comprehensive insight as using NPD indicators. Since the purpose of this research is to provide more insight regarding the particular use and performance of KIBS, the NPD indicators are used instead of the more common performance indicators.

From all KIBS users, it appeared the most common reason for engaging in a KIBS relation is for product solution motives. However, only six out of twenty-six KIBS users noted other motives, which may be a consequence of biased data. There is a possibility that using a specific sector, in this case the manufacturing and equipment sector, is a cause for the biased data. Current days, firms are forced to keep up with the vast pace of product development and require constant product improvement or introduction of new products. Since the sector is characterized by its diversity in machinery and equipment, it would be logical that KIBS are used mostly for product related issues, rather than for activities as cost reduction, design, or competitive advantage. On the other hand, the research did note to focus on T-KIBS only. This was also emphasized in the questionnaire that asked whether the company used KIBS or not, thereby explicitly indicating its use does not implicate activities other than technical related. When focusing on the rational for using KIBS, unlike the general approach in this study, it is thus important not to demarcate the notion of KIBS to a too small area, since this could impede the variation in results. A direct result of the lack of dispersion was noticeable, since the suggested relations R1 regarding firms' motives could not be answered due to insufficient data. As the theory suggests a relation between the motive and the properties of the use of KIBS, it perhaps is not surprising that with most companies using KIBS for product solution motives, results show that firms use KIBS the most during the phases prototype development, final product development, product testing, and product engineering, which hold for

both the number of involvement points (Table 36) and the frequency of its use (Table 38). However, despite the possible bias from using KIBS for product solution motives and its corresponding use throughout the phases, there is a possibility that its use is also biased regarding marketing activities. Seen all the results (Table 84, Table 85, and Table 86), companies in general score their marketing activities/synergy lower than technical activities/synergy. A possible explanation for marketing synergy or activities to be of less influence is that the manufacturing companies attach less value to marketing related activities compared to technical related issues. This could be a result of the focus on technical aspects due to their core activities being technical related, which draws attention away from marketing activities. Larger firms often have separate divisions for marketing, so this relates to a lesser extent to large firms. This is an aspect that also appeared during the personal interviews; smaller firms spend less time and effort on marketing activities, where large companies have separate divisions that focus on those activities. As of such, the results regarding KIBS use during the phases and the frequency of its use are possibly biased towards technical related aspects. In addition, it could explain that the market related results are found to be less significant and of less influence regarding the different suggested relations. Combining the notions of synergy and complexity regarding the relations R1 and R2 with the motives for using KIBS would add valuable insights, since it can be used to check if the intended use of KIBS (for instance product solution) and the properties of its use correspond with the property characteristics of that motive. Since the dispersion of the motive for using KIBS was too low, this poses an interesting starting point for further research. In addition, it would be preferable to test both aspects since the categorization of product solution and cost reduction into a complexity scale is not that clear-cut. As noted in the result chapter, it would still be possible to have a complex project were KIBS are used solely for cost reduction motives.

The data is insufficient to provide any results regarding the first relation (R4a). As dealt with earlier, only one company noted they terminated the relation with KIBS during the project. On the one hand this could simply be due to the aspect that there was indeed only one company that did so, but there is another possible situation that can lead to biased results. What the research did not incorporate was the situation where firms at first engaged in a KIBS relation, somewhere halfway during the NPD process terminated the relation, but then re-engaged in another KIBS relation instead of proceeding solely. Although this aspect was not taking along in the research, it was raised a possible issue during the personal interviews. Interviewees noted that it could be likely if the proposed situation occurred, companies would indicate they used KIBS during the NPD process since they re-engaged in a KIBS relation, rather than indicating they terminated the relation. Therefore, whenever further research is concerned with the same issue of terminating KIBS relation, this aspect should be kept in mind.

Regarding relation R4b, some variables showed a negative growth in synergy where a positive growth is expected. Recall the growth in synergy is captured by taking the difference between Post-synergy and Pro-synergy aspects. The latter explicitly asks respondents to indicate the level of synergy of various variables before the start of the NPD. Since synergy captures the gap that needs to be overcome by the firm to reach the required knowledge for the project, it is expected that the initial level of synergy will only increase. A possible explanation for the negative growth could be due to misalignment between the expected level of synergy before entering the NPD and the reflection upon the project when finished. Before engaging in NPD, firms need to assess their current level of skills and resources in order to find possible deficits regarding the development of the new product. This provides two pitfalls. On the one hand, assessing ones' own capabilities proves difficult, since knowledge can be either explicit (formal) or tacit (informal) (Nonaka, 1991; Miles *et al*., 1995), where tacit knowledge is more difficult to identify, since it partly encompasses technical skills and routines (Nonaka, 1991; Miles *et al*., 1995). Knowledge of that kind is thus highly personal, making it difficult to formalize and communicate (Nonaka, 1991; Miles *et al*., 1995). On the other hand, the assessment of the new product is done in relation to their current set of capabilities. This means companies need to assess the requirements of the new product in advance and compare those with their current set of capabilities. It is obvious this proves a difficult task. Chances are that firms either overestimate or underestimate their own capabilities instead of assessing them correctly. Both cases would lead to an inefficient and ineffective use of KIBS as argued in the theoretical framework (hence the inverted U-relation regarding R4). After finishing the NPD, assessing the level of synergy may thus result in lower (or higher) values than before. The negative growth of synergy in this research points to a self-assessment error, possibly begin an overestimation of the capabilities.

There are some issues that concern the suggested relation R5. First, it states that no correlation is to be found between the performance of non-KIBS and KIBS users. The ideal situation in which to investigate this relation would be to compare firms with the same features; ergo this would reveal differences among firms' features

that can point to possible deficits in a firms' new product development process. However, this goes beyond the scope of the research. Instead, this research focused on general properties of firms regarding KIBS. When comparing firms that share the same features, this gives a more accurate view on possible differences. Regarding the features, it does not concern typical features as firm size, but more importantly, it refers to aspects like the motive for using KIBS or the type of firm. Tordoir (1993) for instance, uses the organizational configurations framework of Mintzberg that describes several different structures of organizations. Results in this research already pointed to the interesting relation between the motives for KIBS use and properties of its use. Combining such aspects can provide a more comprehensive insight that may be interesting for further research.

A second issue concerns the calculation of NPD performance regarding relation R5b. In the end, communication was omitted from the results as one of the eight NPD performance indicators (see Figure 1). Before respondents could answer the question related to this indicator, they were asked if they had a project team for the NPD. For projects that did not have a project team, the assumption was that their level of communication would be 'perfect' since there was no basis on which communication could fail. Namely, during the personal interviews it appeared that for some companies, just one person was responsible for all NPD aspects (mostly small(er) firms). Therefore, this indicator initially was included in the survey. However, the absence of a project team yields missing values for communication, which means that comparison could only be performed when values were assigned for those missing values. One method for dealing with missing values is to assume 'perfect' communication for companies without a project team. However, the problem is that assigning values to 'perfect' communication is arbitrary when used for comparison with the values of companies that did have a project team. After all, to what extent is a certain amount of communication frequency seen as perfect. For this reason, this category was omitted from the results regarding NPD performance.

The last issue regards weighing of the different categories for NPD performance. Whenever a research has several categories to indicate possible relations with an overall concept, the situation often requires weighing of the categories when composed of an unequal amount of indicators. In those situations, the influence of each category on the concept needs to be equal, in order to compare the extent to which each indictor influences that concept. In that way, important categories for measuring the concept can be found. In this research, the categories for NPD performance are not weighed. First of all, regarding the innovative performance of the firm, studies indicate that multiple indicators combined increase the validity of the results, since each indicator has its own weakness (Lundvall, 1992; Carlsson *et al.*, 2002). In addition, Cooper and Kleinschmidt (1995) note that regarding the NPD, multiple performance measures are better than a single one. This indicates using multiple indicators is an important aspect. But above all, although an extensive list of literature exists on drivers of new product performance, this research made a selection of only the most common and significantly found drivers of new product performance. These indicators combined provide an accurate view on the performance of the NPD, but by weighing the different categories, some of these variables would obtain a too large influence. For example, protocol consists of two variables, but when all other categories would be recalculated as to weigh the same, the protocol category would bias the NPD performance heavily. The categories are thus of a lesser importance than the indicators. In cases of weighing the categories, most often research starts off with a set of categories for which a set of indicators needs to be found that can be used as category measures. In this research, the method was used differently. It only looked at the significant found variables among the extensive literature list which combined, cover the NPD performance. In addition, the categories are recurrent throughout the literature, but the list of indicators they consist of varies according to Montoya-Weiss and Calantone (1994), and Ernst (2002). As of such, all indicators should weigh the same and therefore it is important for this research not to weigh the different categories of NPD performance to prevent any biased results.

7 Conclusion

The findings have several implications for management and research on KIBS use and NPD performance. As Tran *et al.* (2011) notes, little knowledge exists regarding the role of intermediaries in the NPD processes. Complexity (R2a) and synergy (R3) both are shown to be of importance for the choice of using KIBS (sub-question I). No relation was found though between complexity and the frequency of KIBS use (R2b). Relative complexity, or the difficulty of the product in relation to the perceived dynamic capabilities of the firm, is determinative for the choice of KIBS as it has a significant positive relation with the use of KIBS (sub-question II). On average, non-KIBS users rate the complexity of their project with 6.7 where KIBS users rate their project with 7.4. Respondents that rate their project as medium complex spend on average €99,000 per year on

project R&D, compared to €309,000 per year for respondents that rate their project as highly complex. In addition, non-KIBS users spend on average around €78,000 per year on total R&D, compared to €279,000 for KIBS users. For synergy, the pro-technical activities 'Pro-R&D skills' and 'Pro-engineering skills' show a moderately strong negative relation and 'Pro-engineering resources' shows a weak negative relation with the use of KIBS. In addition, the overall 'Pro-technical synergy' variable also shows a weak negative relation (sub-question II). When taken into account that twenty out of 26 firms noted to use KIBS for production solution motives, it perhaps is not surprising that the very factors R&D skills, and engineering skills and resources are determinative in the decision for KIBS outsourcing. Keeping this and the possible biased results regarding marketing aspects as dealt with above in mind, both complexity and (part of) technical synergy show to be important for the choice of using KIBS. It is therefore not surprising that results show that both concepts – the four significant found variables of synergy and complexity – have a weak negative relation that in two out of four cases is found significant. This adds up to the theoretical framework, since it indicates that the two aspects are related. It is stated that synergy captures the gap that needs to be overcome by the firm to reach the required knowledge for the project and the level of complexity determines the difficulty to overcome that gap, or how much effort is needed to bridge that gap. In that sense they relate. For instance, a high complexity can coexist with a high level of synergy, however this is unlikely. It could only occur when it regards a company that has highly skilled employees with knowledge of the forefront of the technology. Most likely though is the situation where an increase in complexity leads to a lower level of synergy. The results substantiate this as it shows a negative relation between the two. For firms that want to decide on whether or not they should use KIBS, both aspects thus need to be taken into account regarding their decision. First, the company needs to assess the requirements of the new product in advance and compare those with their current set of capabilities. Considering this gap, the company can decide whether or not to use KIBS when they also assign a certain complexity level to the project. Does the firm have the capacity to overcome the gap? Namely, the complexity determines the pace in which the firm is able to overcome the gap. This should not be considered an easy task. More likely, this research advocates that this part is the most difficult aspect and therefore the most important determinant for the relation with KIBS to result in a success.

After the choice for using KIBS, firms need to determine the extent of its use, which relates to sub-questions III and IV. The theory suggests that the motives KIBS are used for should correspond with the properties of its use. Although the relations R1 could not be answered due to insufficient dispersion of the rationale for the use of KIBS, relation R2a offered additional insight since complexity and synergy are related. In addition, results show that most of the companies noted to use KIBS for product solution motives. In that case it is not surprising that the firms in the research use KIBS the most during the phases prototype development, final product development, product testing, and product engineering, which holds for both the number of involvement points (Table 36) and the frequency of its use (Table 38). So, despite that the relations cannot be tested, the combined results still point to the possibility that the theory holds. Regarding sub-questions III and IV, the rationale for using KIBS thus seems to be of importance for the property of KIBS use. Different motives should induce the company to adapt the property of KIBS use to the extent that they correspond. After all, engaging in a KIBS relation for cost reduction motives while using it throughout all phases seems excessive. However, for a full testing of sub-question IV though, more data is needed on other possible motives besides product solution.

When the choice for using KIBS and the properties of its use are known, the next logical step is to see whether the use of KIBS is justified; does it add value to the NPD process of a firm? However, before answering this question, there are other methods besides using NPD performance that can be used as a measure for the effective and efficient use of KIBS (sub-question V). First, a comparison can be made among KIBS users (R4). As synergy measures the degree to which the firms' capabilities match the required capabilities necessary for the NPD, outsourcing could result in a failure due to a too low or high synergy. In both cases, the use of KIBS is less effective and efficient. This is best explained using the notion of cognitive distance of Nooteboom (1999). If the distance between the firms' capabilities and the required capabilities necessary for the NPD is too large, engaging in a KIBS relation could lead to a failure due the fact that the firm is not able to efficiently and effectively exploit the knowledge of the intermediary. In case the distance is too high, the knowledge of the intermediary would be of a too low novelty value. Therefore, firms benefit the most of using KIBS when having a medium synergy, and are expected to show the largest growth in synergy. 'Post-Pro Manufacturing skills' and Post-Pro Manufacturing resources' show a significant moderately strong negative relation with growth in synergy. Thus firms with a medium synergy show the largest growth in synergy for the two variables and this substantiates the theory (R4a). No results can be extracted for relation R4b though, since only one company noted to terminate the KIBS relation. Second, and to complete the answer for sub-question VI, synergy can also

be used to compare between non-KIBS and KIBS users (R5a). When assuming that the firm who chooses to externalize did so because it is not able to overcome the knowledge gap required for the project due to certain constraints[xix], the KIBS function would then be to contribute to the firms' knowledge base to the extent that the firm can compete on a same level with the firm that did not used KIBS. The value contribution of KIBS would only be to the extent that it helps firms who are less able to acquire the required knowledge base, to reach that level. In addition, if the synergy indeed shows a negative relation with the use of KIBS as appeared above, it is expected that KIBS users show a larger growth in synergy, as their initial synergy level (before starting the NPD) is lower compared to non-KIBS users. 'Post-Pro Engineering skills', 'Post-Pro Engineering resources', 'Post-Pro Manufacturing skills', 'Post-Pro Manufacturing resources', and the overall variable 'Post-Pro Technical synergy' respectively show a significant moderately strong positive (former two), and a weak positive relation (latter three) with synergy, which substantiates the theory. These results thus show that KIBS indeed contribute to the capabilities of the firm in respect to the new product. This also emphasizes the importance for the necessary match between the rationale for using KIBS and the properties of its use. Only when these match, will the function of KIBS be exploited to the fullest. In case there is a mismatch, the use of KIBS is expected to become increasingly more ineffective and inefficient.
The last and more obvious measure for the efficiency and effectiveness of KIBS is the concept NPD performance. The literature provides an extensive list of indicators that can be categorized into eight aspects; namely Protocol, Proficiency of pre-development activities, Proficiency of technical activities, Proficiency of marketing activities, NPD-team, Technical synergy, Marketing synergy, and Communication, of which the latter is omitted from the results as discussed above. Following the same rationale regarding synergy, KIBS would appear to contribute when the new product development performance of KIBS and non-KIBS users is found to be the same. After all, would this not be the case, either KIBS would not function as expected, or non-KIBS users would be no match for KIBS users. None of the single indicators or the collective variables shows a significant difference for KIBS and non-KIBS users. Also the 'NPD performance' variable does not show any differences between the two groups. The results for sub-question VII thus substantiate the theory that the KIBS function is to the extent that it contributes to the firms' knowledge base to acquire the required knowledge base, eventually leading to the same NPD performance as non-KIBS users. Thus, the NPD performance and the growth in synergy are two aspects that can be used to measure the effective and efficient use of KIBS (sub-question V).

With these findings, the main research question is answered. Note that the question is twofold. The key words in the question regard the 'use' and the 'contribution' of KIBS which both are answered above. The first part is the particular use of KIBS that is dealt with by research questions I till VI. The second part regards the KIBS contribution towards the new product development of a firm within the machine industry in the Netherlands and is dealt by research question VII.

To what extent does the <u>use</u> of KIBS <u>contribute</u> to the new product development performance of a firm within the machine industry in the Netherlands?

So KIBS contribute to the lack of dynamic capabilities in relation to the product, to ensure that the firm reaches the required dynamic capabilities necessary for the project. However, the effectiveness and efficiency of this process is dependent upon the level of correspondence between synergy and complexity regarding the product and the dynamic capabilities of the firm, and the motive for using KIBS. In turn, the effectiveness and efficiency of using KIBS can be investigated by looking at the growth in synergy and the NPD performance, where both regard differences between non-KIBS and KIBS users and where additionally, the former can be used for comparison between KIBS users mutually. Combined with the results of the phases, the use of KIBS specifically adds value during the phases 'prototype development', 'final product development', 'product testing', and 'product engineering'.

Concluding by following the logic of Karl Popper of his theory on falsifiability with the well-known example that all swans are white, the results in this research do not prove the constructed theory is correct, they substantiate it. Further research on the issue should further substantiate the findings or prove that the findings are false.

[xix] Whether it regards time or costs constraints does not matter for the rationale.

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9 Appendix

9.1 Sector classification

The SBI 2008 (translated, Standard Industrial Classification) is a Dutch hierarchical classification of economic activities based on the international NACE Rev 2[xx] and ISIC Rev 4[xxi] (CBS, 2011). The classification of the machine industry is given below. Some data on this industry (in older articles) refers to an older version of SBI. In that case similar classifications can be found using the conversion scheme of the CBS (the Dutch Central Statistics Office).

28 Manufacture of machinery and equipment n.e.c.
281 Manufacture of engines, turbines, pumps, compressors, taps, valves and driving elements
2811 Manufacture of engines and turbines, not for aircraft, vehicles and cycles
2812 Manufacture of fluid power equipment
2813 Manufacture of non-hydraulic pumps and compressors
2814 Manufacture of other taps and valves
2815 Manufacture of gears, bearings and other driving elements

282 Manufacture of other general-purpose machinery
2821 Manufacture of industrial ovens and furnace burners
2822 Manufacture of lifting and handling equipment
2823 Manufacture of office machinery and equipment (except computers and peripheral equipment)
2824 Manufacture of pneumatic and electrical hand tools
2825 Manufacture of non-domestic cooling and ventilation equipment
2829 Manufacture of other general-purpose machinery and equipment n.e.c.

283 Manufacture of agricultural and forestry machinery
2830 Manufacture of agricultural and forestry machinery

284 Manufacture of machine tools
2841 Manufacture of metal forming machine tools
2849 Manufacture of machine tools not for metal forming

289 Manufacture of other special-purpose machinery
2891 Manufacture of machinery for metallurgy
2892 Manufacture of machinery for construction and mining
2893 Manufacture of machinery for food and beverage processing
2894 Manufacture of machinery for textile, apparel and leather production
2895 Manufacture of machinery for paper and paperboard production
2896 Manufacture of plastics and rubber machinery
2899 Manufacture of other special-purpose machinery and equipment n.e.c.

[xx] The *Nomenclature statistique des Activités économiques dans la Communauté Européenne* (NACE) is the industry standard classification system of the European Union.
[xxi] The *International Standard Industrial Classification of All Economic Activities* (ISIC) is the industry standard classification system of the United Nations.

9.2 NPD indicators

Table 17 – Operationalization of the conceptual model.

Concept	Dimension	Category	Indicator	Measurement
Use of KIBS	General use	Use of KIBS	Used KIBS for new product development *´Use of a Knowledge Intensive Business Service for the New Product Development (Not for activities other than technical related)´*	Nominal 0= no 1= Partly, but terminated the relation 2= yes
	Incentive	Not using KIBS	Reason for not using KIBS *´Having a reason for not engaging a KIBS relation for the project´*	Nominal 0= no 1= yes If yes, followed by an open answer.
		Terminating KIBS relation	Reason for terminating KIBS relation *´Reason(s) for terminating the KIBS relation´* (Monteverde & Teece, 1995; Lane and Lubatkin, 1998; Gopal *et al*., 2002; Sahay *et al*., 2003; Cusumano, 2006; Mahnke *et al*., 2008; Lichtenthaler & Ernst, 2009)	Nominal 1= competency gaps 2= poor relational capabilities 3= cultural distance 4= lack of experience in using exchange platforms 5= insufficient technological dialogue 6= technological uncertainty 7= other, namely
		Using KIBS	Motive for using KIBS *´Primary reason for engaging in the KIBS relation´* (Tordoir, 1993; Mahnke *et al*., 2008)	Nominal 0= cost reduction 1= product solution 2= other, namely
	Involvement	Phases	Use of KIBS in different development phases *'In what phase(s) of the project the firm engaged in the KIBS relation?'* (Love & Roper, 1999)	Nominal 1= identification of new or improved products 2= prototype development 3= final product development 4= product testing 5= production engineering 6= market research 7= marketing strategy
		Frequency	Frequency of use in different development phases *´The frequency of contact moments per month between the KIBS and (part of) the project team in each phase(s)´*	Scale, open answer per phase.
Product	Characteristic	Complexity	Firms' perceived complexity *'The complexity of the product relative to the competencies of the firm'*	Scale, open answer with validation (Only possible in the range of 1-10, where one (1) is not complex and ten (10) complex).

New Product Development	Process *'The NPD process and the specific activities within this process'*	Proficiency of technical activities (Cooper, 1979a; Cooper & Brentani, 1991; Parry & Song, 1994; Calantone *et al.*, 1997; Song & Parry, 1997; Souder *et al.*, 1997)	Prototype development *'Executing prototype development (Expanding the idea into a full product concept)'* (Cooper, 1979a; Parry & Song, 1994; Calantone *et al.*, 1997; Souder *et al.*, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Prototype testing *'Executing prototype or "in-house" sample product testing'* (Cooper, 1979a; Cooper & Brentani, 1991; Parry & Song, 1994; Calantone *et al.*, 1997; Song & Parry, 1997; Souder *et al.*, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Pilot production *'Executing pilot production'* (Cooper, 1979a; Parry & Song, 1994; Calantone *et al.*, 1997; Souder *et al.*, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Production start-up/launch *'Executing production start-up/launch'* (Cooper, 1979a; Parry & Song, 1994; Calantone *et al.*, 1997; Souder *et al.*, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
		Technical synergy '*The degree of technical aspects that meet the requirements needed for the development of the product*' (Cooper, 1979a; Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Cooper & Kleinschmidt, 1995; Song & Parry 1997; Souder *et al.*, 1997)	R&D skills '*The company's R&D skills were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			R&D resources '*The company's R&D resources were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Engineering skills '*The company's engineering skills were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Cooper, 1979a; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Engineering resources '*The company's engineering resources were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Manufacturing skills '*The company's manufacturing skills were more than adequate for the project*'	Ordinal 10-point 1= strongly disagree 10= strongly agree

			(Cooper & Kleinschmidt, 1987; Song & Parry 1997; Souder *et al.*, 1997)	
			Manufacturing resources '*The company's manufacturing resources were more than adequate for the project*' (Cooper, 1979a; Cooper & Kleinschmidt, 1987; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
		Proficiency of marketing activities (Rothwell *et al*., 1974; Cooper, 1979a; Cooper & Brentani, 1991; Parry & Song, 1994; Calantone *et al*., 1997; Song & Parry 1997; Souder *et al.*, 1997)	Market study/research/potential *'Proficiency of conducting a market study or research'* (Rothwell *et al*., 1974; Cooper, 1979a; Cooper & Brentani, 1991; Parry & Song, 1994; Calantone *et al*., 1997; Song & Parry; 1997; Souder *et al.*, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Market launch *'Proficiency of launching the product in the marketplace (selling, promoting and distributing)'* (Cooper, 1979a; Cooper & Brentani, 1991; Parry & Song, 1994; Souder *et al.*, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Test marketing/ trail selling *'Proficiency of executing marketing test'* (Cooper, 1979a; Parry & Song, 1994; Calantone *et al*., 1997; Song & Parry 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Market competition *'Proficiency of appraising market competition'* (Cooper, 1979a; Cooper & Brentani, 1991)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
		Marketing synergy '*The degree of market aspects that meet the requirements needed for the development of the product*' (Cooper & Kleinschmidt, 1987; Cooper, 1979a; Parry & Song, 1994; Cooper & Kleinschmidt, 1995; Song & Parry 1997)	Market research skills '*The company's market research skills were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997: Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Market research resources '*The company's market research resources were more than adequate for the project*' (Cooper, 1979a; Cooper 1982; Cooper 1984; Maidique & Zirger 1984; Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997; Balbontin et al 1999)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Sales force skills '*The company's sales force skills were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Sales force resources	Ordinal 10-point

			'*The company's sales force resources were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Cooper, 1979a; Parry & Song, 1994; Song & Parry 1997)	1= strongly disagree 10= strongly agree
			Distribution skills '*The company's distribution skills were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Distribution resources '*The company's distribution resources were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Cooper, 1979a; Parry & Song, 1994; Song & Parry 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Advertising/promotion skills '*The company's advertising/promotion skills were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Cooper, 1979a; Parry & Song, 1994; Song & Parry 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Advertising/promotion resources '*The company's advertising/promotion resources were more than adequate for the project*' (Cooper & Kleinschmidt, 1987; Parry & Song, 1994; Song & Parry 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
		Protocol (Cooper & Brentani, 1991; Cooper & Kleinschmidt, 1995)	Product concept definition *'Proficiency of describing a product concept before entering the development phase'* (Cooper & Brentani, 1991; Cooper & Kleinschmidt, 1995)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Target market definition *'Proficiency of describing a target market before entering the development phase'* (Cooper & Brentani, 1991; Cooper & Kleinschmidt, 1995)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
		Proficiency of pre-development activities (Cooper & Brentani, 1991; Parry & Song, 1994; Cooper & Kleinschmidt,	Preliminary financial analyses '*Proficiency of executing a financial analyses before entering the development phase*' (Cooper, 1979; Cooper & Brentani, 1991; Parry & Song, 1994; Calantone *et al*., 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
			Preliminary technical assessment '*Proficiency of executing a technical*	Ordinal 10-point 1 = done very poorly

		1995; Calantone *et al.*, 1997; Souder *et al.*, 1997)	*assessment before entering the development phase*' (Cooper, 1979; Parry & Song, 1994; Calantone *et al.*, 1997; Souder *et al.*, 1997)	or omitted altogether 10 = done excellently
			Preliminary market assessment '*Proficiency of executing a market assessment before entering the development phase*' (Cooper, 1979; Parry & Song, 1994; Cooper & Brentani, 1991; Song & Parry, 1997)	Ordinal 10-point 1 = done very poorly or omitted altogether 10 = done excellently
	Organization *'The way the firm is organized'*	NPD-team (Cooper & Kleinschmidt, 1995; Song & Parry 1997; Souder *et al.*, 1997)	Cross functional I *'The degree of integration between R& and marketing was high during the entire development process*' (Cooper & Kleinschmidt, 1995; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Cross functional II *'The degree of integration between R&D and manufacturing was high during the entire development process*' (Cooper & Kleinschmidt, 1995; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Cross functional III *'The degree of integration between marketing and manufacturing was high during the entire development process*' (Cooper & Kleinschmidt, 1995; Song & Parry 1997; Souder *et al.*, 1997)	Ordinal 10-point 1= strongly disagree 10= strongly agree
			Team responsibility *'The project team was held accountable for all facets of the project*' (Cooper & Kleinschmidt, 1995)	Ordinal 10-point 1= strongly disagree 10= strongly agree
		Communication (Rothwell *et al.*, 1974; Cooper & Kleinschmidt, 1995; Souder *et al.*, 1997)	Communication intensity *'The average frequency of the number of contact moments of the project team in meetings per phase'* (Rothwell *et al.*, 1974; Cooper & Kleinschmidt, 1995; Souder *et al.*, 1997)	Scale, open answer per phase.
Control variables		Firm specific	Formal R&D *'Having a formal R&D department'*	Nominal 0= no 1= yes
			R&D expenditure *'The average percentage of R&D expenditure for the periods 2009, 2010 and 2011 of the entire company in relation to sales'*	Nominal 1= 1-2% 2= 3-4% 3= 5-7% 4= 7-10% 5= 10% or more 6= Do not know
			New products launched	Scale, open answer.

			'The number of new products launched during the last five years'	
			Firm size I *'The current number of full-time (FTE's) employees (from 36 hours)'*	Scale, open answer.
			Firm size II *'The current number of part-time employees (under 36 hours)'*	Scale, open answer.
			Firm age *'Age of the firm in years'*	Scale, open answer.
		Project specific	Lead-time *'The lead-time of the project in months'*	Scale, open answer.

9.3 Calling protocol

Below is the calling protocol used for contacting the required respondent. It is used to avoid biased response and maintain a professional approach towards the companies. The protocol is carefully translated from Dutch. Note that the protocol is used as a guideline and does not refer to the actual conversations. In addition, it is spoken language to retain a personal approach; it differs from formal written text. Main lines are indicated within brackets (“), other text is optional and could be used when additional information was requested.

First contact:
“Good day, with Tomas van Woerkom.

I am a Master student of the program Innovation Management at the Utrecht University. Currently, I am working on a research on the development of new products. For the research, I am looking for the person that is responsible or heavily involved in the development of new products within your company.”

Optional:
This may be a:
- Head of new product development
- Senior manager involved in new product development, or possibly
- Head of Research & Development (R & D)
- Senior manager involved in Research & Development (R & D)

Only if one of the above is not present within the company, one of the options below would suffice. So, in case of absence of one of the above functions, the companies were contacted again later.
- General manager
- Human Resource Manager
- Marketing manager.

Designated person:
“Good day, with Tomas van Woerkom.

I am a Master student of the program Innovation Management at the Utrecht University. Currently, I am working on a research on the development of new products.* Therefore, I was looking for the person responsible or heavily involved in the development of new products within your company and that is the reason why I was referred to you, is that correct? (In case of yes, proceeding with the rest) For the study, I am conducting online surveys. The survey is expected to take between fifteen to twenty minutes of your time. The survey is online, that means you get an email containing a link to the online version, so you can complete and fill it in your own time. The company and you will remain anonymous. At the end of the survey, you will be given the option to indicate whether you want to receive the final report. Are you interested for participation?

* If asked about the specific sector, I referred to the enlisting of the company in the database of the Chamber of Commerce with SBI code 28; manufacture of other machinery and equipment."

Yes:
"That is good. May I note your name and email address?"

No, I have no time for that:
"Is it possibly to approach you any other time that is more convenient for you?"

Optional (additional information regarding the research):
For the research, I investigate the differences between companies in the use of a special type of consultancy company for the development of new products. It is not clear how and under what circumstances those companies contribute to the development of new products. I'll be honest by saying that your participation may yield little for you. However, when the investigation is completed I can send you the final report with all findings. Possibly, there can be some points of value for you and your company with respect to the use of consultancies.

9.4 Results

9.4.1 Respondent and company general statistics

Table 18 – Respondents' function.

Classified function

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CEO/Managing Director/Executive Director	17	28,3	28,3	28,3
	Technical Director/Technical Manager	10	16,7	16,7	45,0
	Product Manager/Project Manager	7	11,7	11,7	56,7
	Head R&D/Manager R&D	22	36,7	36,7	93,3
	Sales Manager	3	5,0	5,0	98,3
	Software Manager	1	1,7	1,7	100,0
	Total	60	100,0	100,0	

Table 19 – Respondents' experience with their current function (yr.).

Report

Respondents' function experience (yr.).

Classified function	Mean	N	Std. Deviation
CEO/Managing Director/Executive Director	14,65	17	9,110
Technical Director/Technical Manager	9,90	10	8,937
Product Manager/Project Manager	4,29	7	,951
Head R&D/Manager R&D	6,95	22	5,394
Sales Manager	9,67	3	7,506
Software Manager	6,00	1	.
Total	9,43	60	7,782

Table 20 – The distribution in size of the companies.

Classified company size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Small	26	43,3	43,3	43,3
	Medium	27	45,0	45,0	88,3
	Large	7	11,7	11,7	100,0
	Total	60	100,0	100,0	

Table 21 – Presence of a formal R&D department for the companies in general.

Formal R&D department.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	37	61,7	61,7	61,7
	No	23	38,3	38,3	100,0
	Total	60	100,0	100,0	

Table 22 – Presence of a formal R&D department for small, medium, and large companies.

Formal R&D department. * Classified company size Crosstabulation

			Classified company size			
			Small	Medium	Large	Total
Formal R&D department.	No	Count	15	8	0	23
		% within Classified company size	57,7%	29,6%	,0%	38,3%
	Yes	Count	11	19	7	37
		% within Classified company size	42,3%	70,4%	100,0%	61,7%
Total		Count	26	27	7	60
		% within Classified company size	100,0%	100,0%	100,0%	100,0%

Table 23 – Association measures regarding 'Formal R&D department' * 'Classified company size'.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	,375	,102	3,510	,000
	Kendall's tau-c	,398	,113	3,510	,000
	Gamma	,670	,145	3,510	,000
N of Valid Cases		60			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 24 – Chi-Square test of 'Formal R&D department' * 'Classified company size'.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9,339[a]	2	,009
Likelihood Ratio	11,639	2	,003
Linear-by-Linear Association	9,180	1	,002
N of Valid Cases	60		

a. 2 cells (33,3%) have expected count less than 5. The minimum expected count is 2,68.

Table 25 - Presence of a formal R&D department for small and large companies.

Formal R&D department. * Special classified company size Crosstabulation

			Special classified company size		
			Small	Large	Total
Formal R&D department.	No	Count	21	2	23
		% within Special classified company size	53,8%	9,5%	38,3%
	Yes	Count	18	19	37
		% within Special classified company size	46,2%	90,5%	61,7%
Total		Count	39	21	60
		% within Special classified company size	100,0%	100,0%	100,0%

Table 26 – Association measures regarding 'Formal R&D department' * 'Special classified company size'.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	,435	,098	4,085	,000
	Kendall's tau-c	,403	,099	4,085	,000
	Gamma	,834	,123	4,085	,000
N of Valid Cases		60			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 27 – Chi-Square test of 'Formal R&D department' * 'Special classified company size'.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11,344[a]	1	,001		
Continuity Correction[b]	9,546	1	,002		
Likelihood Ratio	12,838	1	,000		
Fisher's Exact Test				,001	,001
Linear-by-Linear Association	11,155	1	,001		
N of Valid Cases	60				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 8,05.

b. Computed only for a 2x2 table

Table 28 – Tests of normality for the 'Number of new products launched in the last five years' grouped by having a 'Formal R&D department'.

Tests of Normality

	Formal R&D department.	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Number of new products launched in the last five years.	No	,211	23	,009	,870	23	,006
	Yes	,366	37	,000	,486	37	,000

a. Lilliefors Significance Correction

The tests of normality show whether the distribution of the tested variable differs significantly from a normal distribution. Both the Kolmogorov-Smirnov and Shapiro-Wilk test show this, where the latter has the preference for smaller samples (De Vocht, 2007). Both tests have a significance lower or equal to 0.05, this means the H_0 can be rejected, thus the variable 'number of new products launched in the last five years' is not normally distributed.

Table 29 – Non-parametric test for the 'Number of new products launched in the last five years' grouped by having a 'Formal R&D department'.

Test Statistics[a]

	Number of new products launched in the last five years.
Mann-Whitney U	227,000
Wilcoxon W	503,000
Z	-3,035
Asymp. Sig. (2-tailed)	,002

a. Grouping Variable: Formal R&D department.

The Mann-Whitney test above shows with a two-sided significance level that the H_0 hypothesis can be rejected (sig. = 0.002 < 0.05), in other words, the distribution of the number of new products launched in the last five years for firms with and without a formal R&D department are not equal.

Table 30 – The mean 'Number of new products launched in the last five years' for companies with and without a 'Formal R&D department'.

Number of new products launched in the last five years. * Formal R&D department.

Number of new products launched in the last five years.

Formal R&D department.	Mean	N	Std. Deviation
No	4,43	23	3,824
Yes	15,95	37	28,256
Total	11,53	60	22,901

Table 31 - Tests of normality for the 'Number of new products launched in the last five years' grouped by 'Special classified company size'.

Tests of Normality

	Special classified company size	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Number of new products launched in the last five years.	Small	,236	39	,000	,528	39	,000
	Large	,375	21	,000	,551	21	,000

a. Lilliefors Significance Correction

Table 32 - Non-parametric test for the 'Number of new products launched in the last five years' grouped by 'Special classified company size'.

Test Statistics[a]

	Number of new products launched in the last five years.
Mann-Whitney U	216,500
Wilcoxon W	996,500
Z	-3,008
Asymp. Sig. (2-tailed)	,003

a. Grouping Variable: Special classified company size

Table 33 – The mean number of 'New products launched in the last five years' for small and large companies.

Number of new products launched in the last five years. * Special classified company size

Number of new products launched in the last five years.

Special classified company size	Mean	N	Std. Deviation
Small	6,13	39	8,053
Large	21,57	21	35,513
Total	11,53	60	22,901

9.4.2 KIBS general statistics

Table 34 – Main reasons using KIBS.

Main reason using KIBS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cost reduction	1	3,8	3,8	3,8
	Product solution	20	76,9	76,9	80,8
	Other	5	19,2	19,2	100,0
	Total	26	100,0	100,0	

Table 35 – Other reasons using KIBS.

Main reason using KIBS (others)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		21	80,8	80,8	80,8
	Competitive advantage	1	3,8	3,8	84,6
	Design	1	3,8	3,8	88,5
	Different perspective on things	1	3,8	3,8	92,3
	Executing Computational Fluid Dynamics simulation	1	3,8	3,8	96,2
	Special departments in the coorporate group for gear calculation, test center	1	3,8	3,8	100,0
	Total	26	100,0	100,0	,0

Table 36 – Distribution of KIBS use along seven phases.

Statistics

		1 Identification of new products	2 Prototype development	3 Final product development	4 Product testing	5 Product Engineering	6 Market research	7 Marketing strategy
N	Valid	26	26	26	26	26	26	26
	Missing	0	0	0	0	0	0	0
Sum		4	19	13	8	14	1	1

The table above shows the cumulative score for each phase KIBS could be used in. For example, four companies noted to use KIBS in the first phase, where 19 companies used KIBS in the second phase.

Table 37 – Number of phases companies used KIBS.

Nr of phases KIBS are used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	23,1	23,1	23,1
	2	10	38,5	38,5	61,5
	3	6	23,1	23,1	84,6
	4	4	15,4	15,4	100,0
	Total	26	100,0	100,0	

The way the table above should be read is that four out of the 26 companies that used KIBS, used them throughout four phases. Six companies used KIBS in three phases and respectively ten and six companies used them for two and one phase.

Table 38 – Frequency of KIBS use along seven phases (contact moments/mo.).

Statistics

		1 Identification of new products	2 Prototype development	3 Final product development	4 Product testing	5 Product Engineering	6 Market research	7 Marketing strategy
N	Valid	26	26	26	26	26	26	26
	Missing	0	0	0	0	0	0	0
Mean		,81	4,58	3,19	3,69	3,69	,35	,35
Sum		21	119	83	96	96	9	9

Table 39 – The use of KIBS for small, medium, and large companies.[xxii]

Classified company size * Use of KIBS. Crosstabulation

			Use of KIBS.		
			No	Yes	Total
Classified company size	Small	Count	13	13	26
		% within Classified company size	50,0%	50,0%	100,0%
	Medium	Count	14	12	26
		% within Classified company size	53,8%	46,2%	100,0%
	Large	Count	6	1	7
		% within Classified company size	85,7%	14,3%	100,0%
Total		Count	33	26	59
		% within Classified company size	55,9%	44,1%	100,0%

[xxii] Note the amount of companies N=59. The company that used KIBS, but terminated the relation was omitted from these results.

Table 40 – Association measures regarding 'Classified company size' * 'Use of KIBS'.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-,158	,119	-1,308	,191
	Kendall's tau-c	-,171	,131	-1,308	,191
	Spearman Correlation	-,164	,125	-1,257	,214[c]
Interval by Interval	Pearson's R	-,183	,120	-1,409	,164[c]
N of Valid Cases		59			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

9.4.3 New Product Development statistics

Table 41 - Tests of normality for the 'Average R&D expenditure for the project' grouped by the 'Use of KIBS'.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Use of KIBS.	Statistic	df	Sig.	Statistic	df	Sig.
Average R&D expenditure for the project (euro/yr.).*	No	,355	21	,000	,519	21	,000
	Yes	,226	23	,004	,753	23	,000

a. Lilliefors Significance Correction

Table 42 - Non-parametric test for the 'Average R&D expenditure for the project' grouped by the 'Use of KIBS'.

Test Statistics[a]

	Average R&D expenditure for the project (euro/yr.).*
Mann-Whitney U	142,500
Wilcoxon W	373,500
Z	-2,329
Asymp. Sig. (2-tailed)	,020

a. Grouping Variable: Use of KIBS.

Table 43 - Tests of normality for the 'Complexity of the product' grouped by the 'Use of KIBS'.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Use of KIBS.	Statistic	df	Sig.	Statistic	df	Sig.
Complexity of the product, relative to the competences of the firm.	No	,217	33	,000	,938	33	,060
	Yes	,309	26	,000	,802	26	,000

a. Lilliefors Significance Correction

Table 44 - Non-parametric test for the 'Complexity of the product' grouped by the 'Use of KIBS'.

Test Statistics[a]

	Complexity of the product, relative to the competences of the firm.
Mann-Whitney U	271,500
Wilcoxon W	832,500
Z	-2,482
Asymp. Sig. (2-tailed)	,013

a. Grouping Variable: Use of KIBS.

Table 45 - Result of bivariate correlations between complexity and KIBS involvement.

Correlations

			Classified complexity product	Special classified complexity product	Nr of phases KIBS are used	Average frequency of KIBS use (contact moments/mo.)
Spearman's rho	Classified complexity product	Correlation Coefficient	1,000	,365	-,011	-,048
		Sig. (2-tailed)	.	,067	,957	,817
		N	26	26	26	26
	Special classified complexity product	Correlation Coefficient	,365	1,000	,080	-,087
		Sig. (2-tailed)	,067	.	,696	,673
		N	26	26	26	26
	Nr of phases KIBS are used	Correlation Coefficient	-,011	,080	1,000	,177
		Sig. (2-tailed)	,957	,696	.	,387
		N	26	26	26	26
	Average frequency of KIBS use (contact moments/mo.)	Correlation Coefficient	-,048	-,087	,177	1,000
		Sig. (2-tailed)	,817	,673	,387	.
		N	26	26	26	26

Table 46 - Tests of normality for the 'Average R&D expenditure for the project' grouped by the 'Special classified complexity product'.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Special classified complexity product	Statistic	df	Sig.	Statistic	df	Sig.
Average R&D expenditure for the project (euro/yr.).*	Low	,332	5	,075	,764	5	,040
	High	,271	40	,000	,653	40	,000

a. Lilliefors Significance Correction

In the above situation, only one of the two tests is significant below 0.05. In case of doubt, the Shapiro-Wilk test has the preference above the Kolmogorov-Smirnov test in case of smaller samples. The former thus will be used here.

Table 47 - Tests of normality for the 'Average R&D expenditure for the project' grouped by the 'Classified complexity product'.

Tests of Normality[b]

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Classified complexity product	Statistic	df	Sig.	Statistic	df	Sig.
Average R&D expenditure for the project (euro/yr.).*	Medium	,360	26	,000	,627	26	,000
	High	,280	18	,001	,749	18	,000

a. Lilliefors Significance Correction

b. Average R&D expenditure for the project (euro/yr.).* is constant when Classified complexity product = Low. It has been omitted.

Table 48 - Non-parametric test for the 'Average R&D expenditure for the project' grouped by the 'Special classified complexity product'.

Test Statistics[b]

	Average R&D expenditure for the project (euro/yr.).*
Mann-Whitney U	92,500
Wilcoxon W	107,500
Z	-,271
Asymp. Sig. (2-tailed)	,786
Exact Sig. [2*(1-tailed Sig.)]	,793[a]

a. Not corrected for ties.

b. Grouping Variable: Special classified complexity product

The variable 'special classified complexity product' classified complexity into low (1-5) and high (6-10).

Table 49 - Non-parametric test for the 'Average R&D expenditure for the project' grouped by the 'Classified complexity product'.

Test Statistics[b]

	Average R&D expenditure for the project (euro/yr.).*
Mann-Whitney U	3,000
Wilcoxon W	4,000
Z	-1,097
Asymp. Sig. (2-tailed)	,273
Exact Sig. [2*(1-tailed Sig.)]	,421[a]

a. Not corrected for ties.

b. Grouping Variable: Classified complexity product

In the table above, the test compares the categories low (1-3) and high (8-10) of the 'classified complexity product' variable. The medium (numbers 4-7) category is not tested.

Table 50 - Non-parametric test for the 'Average R&D expenditure for the project' grouped by the 'Classified complexity product'.

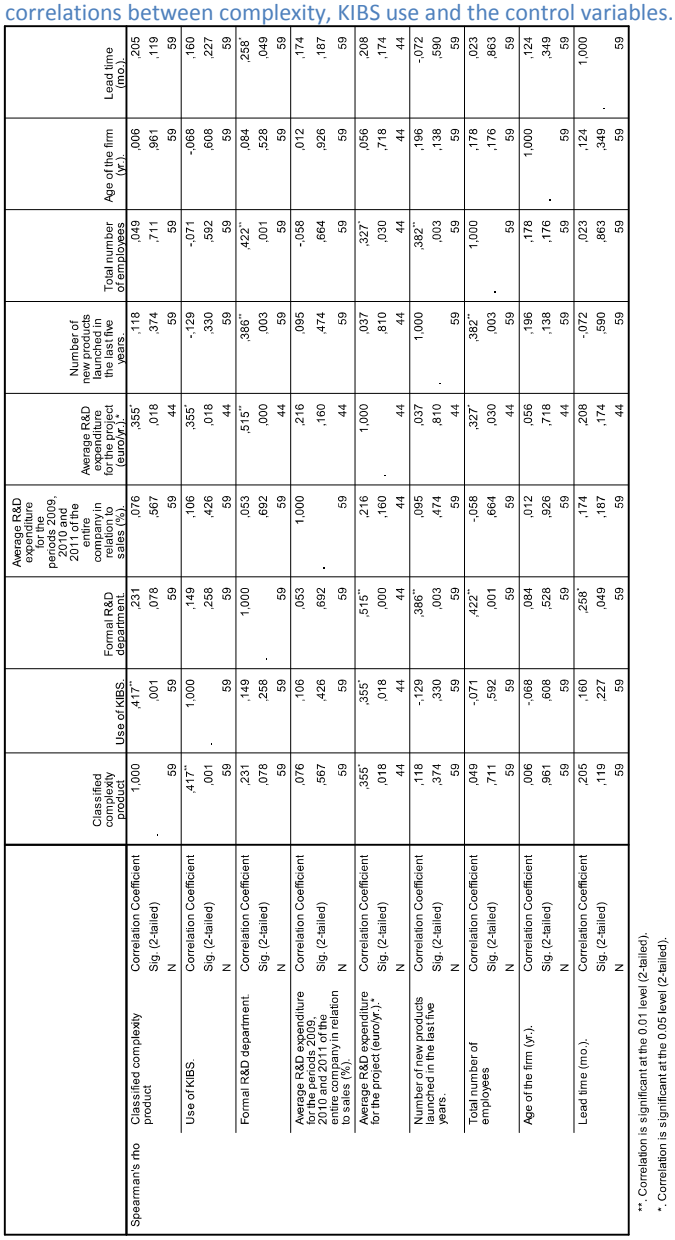
Test Statistics[a]

	Average R&D expenditure for the project (euro/yr.).*
Mann-Whitney U	137,500
Wilcoxon W	488,500
Z	-2,306
Asymp. Sig. (2-tailed)	,021

a. Grouping Variable: Classified complexity product

The test above compares the categories medium (4-7) and high (8-10) of the 'classified complexity product' variable. With a significance of 0.021 that is lower than 0.05, H_0 (the distribution of expenditure for medium and high rated projects is equal) can be rejected. So, it can be concluded that there is a difference in spending between medium and high rated projects.

Table 51 - Result of bivariate correlations between complexity, KIBS use and the control variables.



Correlations

			Classified complexity product	Use of KIBS.	Formal R&D department.	Average R&D expenditure for the periods 2009, 2010 and 2011 of the entire company in relation to sales (%).	Average R&D expenditure for the project (euro/yr.).*	Number of new products launched in the last five years.	Total number of employees	Age of the firm (yr.).	Lead time (mo.).
Spearman's rho	Classified complexity product	Correlation Coefficient	1,000	,417**	,231	,076	,355*	,118	,049	,006	,205
		Sig. (2-tailed)	.	,001	,078	,567	,018	,374	,711	,961	,119
		N	59	59	59	59	44	59	59	59	59
	Use of KIBS.	Correlation Coefficient	,417**	1,000	,149	,106	,355*	-,129	-,071	-,068	,160
		Sig. (2-tailed)	,001	.	,258	,426	,018	,330	,592	,608	,227
		N	59	59	59	59	44	59	59	59	59
	Formal R&D department.	Correlation Coefficient	,231	,149	1,000	,053	,515**	,386**	,422**	,084	,258*
		Sig. (2-tailed)	,078	,258	.	,692	,000	,003	,001	,528	,049
		N	59	59	59	59	44	59	59	59	59
	Average R&D expenditure for the periods 2009, 2010 and 2011 of the entire company in relation to sales (%).	Correlation Coefficient	,076	,106	,053	1,000	,216	,095	-,058	,012	,174
		Sig. (2-tailed)	,567	,426	,692	.	,160	,474	,664	,926	,187
		N	59	59	59	59	44	59	59	59	59
	Average R&D expenditure for the project (euro/yr.).*	Correlation Coefficient	,355*	,355*	,515**	,216	1,000	,037	,327*	,056	,208
		Sig. (2-tailed)	,018	,018	,000	,160	.	,810	,030	,718	,174
		N	44	44	44	44	44	44	44	44	44
	Number of new products launched in the last five years.	Correlation Coefficient	,118	-,129	,386**	,095	,037	1,000	,382**	,196	-,072
		Sig. (2-tailed)	,374	,330	,003	,474	,810	.	,003	,138	,590
		N	59	59	59	59	44	59	59	59	59
	Total number of employees	Correlation Coefficient	,049	-,071	,422**	-,058	,327*	,382**	1,000	,178	,023
		Sig. (2-tailed)	,711	,592	,001	,664	,030	,003	.	,176	,863
		N	59	59	59	59	44	59	59	59	59
	Age of the firm (yr.).	Correlation Coefficient	,006	-,068	,084	,012	,056	,196	,178	1,000	,124
		Sig. (2-tailed)	,961	,608	,528	,926	,718	,138	,176	.	,349
		N	59	59	59	59	44	59	59	59	59
	Lead time (mo.).	Correlation Coefficient	,205	,160	,258*	,174	,208	-,072	,023	,124	1,000
		Sig. (2-tailed)	,119	,227	,049	,187	,174	,590	,863	,349	.
		N	59	59	59	59	44	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 52 – Mean values of pro-technical activities (technical synergy).

Report

Use of KIBS.		Pro-Technical synergy	Pro-R&D skills	Pro-R&D resources	Pro-Engineering skills	Pro-Engineering resources	Pro-Manufacturing skills	Pro-Manufacturing resources
No	Mean	46,36	7,52	7,42	7,94	8,03	7,79	7,67
	Std. Deviation	9,154	1,770	1,953	1,749	1,649	1,781	1,780
	N	33	33	33	33	33	33	33
Yes	Mean	38,81	6,23	6,62	6,27	6,38	6,69	6,62
	Std. Deviation	11,335	2,455	2,228	2,108	2,118	2,294	2,351
	N	26	26	26	26	26	26	26
Total	Mean	43,03	6,95	7,07	7,20	7,31	7,31	7,20
	Std. Deviation	10,767	2,177	2,100	2,074	2,028	2,078	2,099
	N	59	59	59	59	59	59	59

Table 53 – Mean values of pro-marketing activities (marketing synergy).

Report

Use of KIBS.		Pro-Marketing synergy	Pro-Market research skills	Pro-Market research resources	Pro-Sales force skills	Pro-Sales force resources	Pro-Distribution skills	Pro-Distribution resources	Pro-Advertising/promotion skills	Pro-Advertising/promotion resources
No	Mean	52,52	5,91	6,06	6,58	6,70	7,24	7,09	6,42	6,52
	Std. Deviation	11,838	2,141	1,968	1,768	1,667	1,803	1,877	1,985	1,822
	N	33	33	33	33	33	33	33	33	33
Yes	Mean	49,50	5,42	5,38	6,27	6,31	6,62	6,85	6,27	6,38
	Std. Deviation	16,662	2,436	2,401	2,409	2,311	2,434	2,428	2,359	2,137
	N	26	26	26	26	26	26	26	26	26
Total	Mean	51,19	5,69	5,76	6,44	6,53	6,97	6,98	6,36	6,46
	Std. Deviation	14,116	2,269	2,176	2,062	1,968	2,109	2,121	2,140	1,950
	N	59	59	59	59	59	59	59	59	59

Table 54 – Results of bivariate correlations between KIBS use and pro-technical activities (technical synergy).

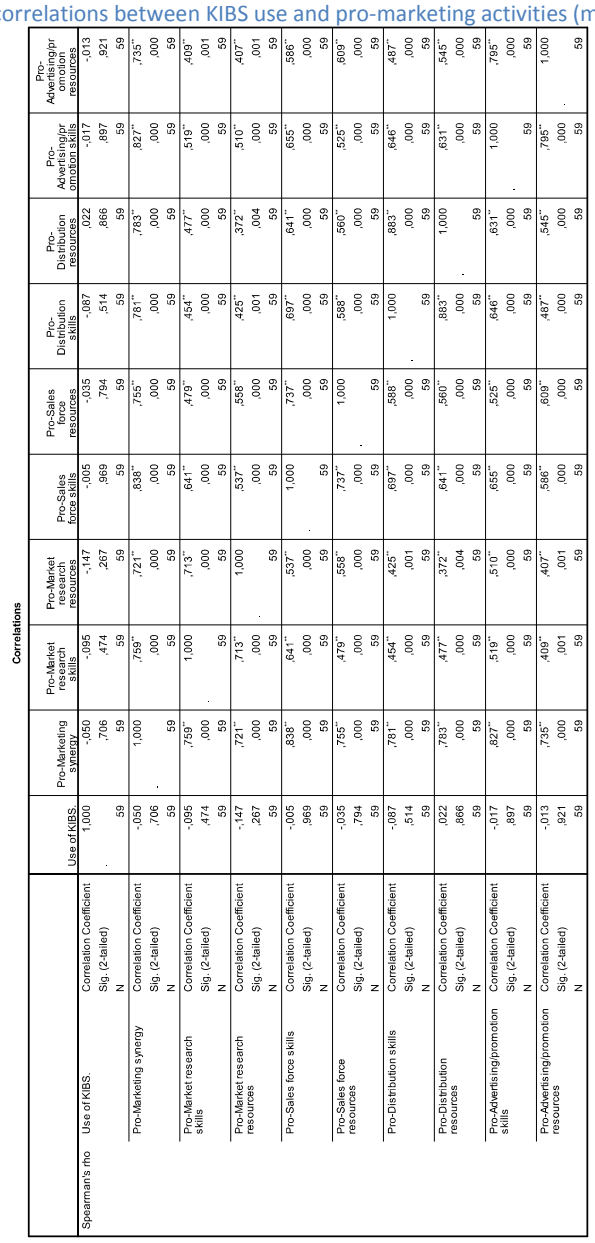
Correlations

			Use of KIBS.	Pro-Technical synergy	Pro-R&D skills	Pro-R&D resources	Pro-Engineering skills	Pro-Engineering resources	Pro-Manufacturing skills	Pro-Manufacturing resources
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	-,341**	-,262*	-,187	-,412**	-,405**	-,253	-,223
		Sig. (2-tailed)	.	,008	,045	,157	,001	,001	,053	,090
		N	59	59	59	59	59	59	59	59
	Pro-Technical synergy	Correlation Coefficient	-,341**	1,000	,835**	,858**	,888**	,911**	,826**	,795**
		Sig. (2-tailed)	,008	.	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-R&D skills	Correlation Coefficient	-,262*	,835**	1,000	,709**	,863**	,762**	,551**	,476**
		Sig. (2-tailed)	,045	,000	.	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-R&D resources	Correlation Coefficient	-,187	,858**	,709**	1,000	,738**	,749**	,571**	,559**
		Sig. (2-tailed)	,157	,000	,000	.	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-Engineering skills	Correlation Coefficient	-,412**	,888**	,863**	,738**	1,000	,860**	,591**	,537**
		Sig. (2-tailed)	,001	,000	,000	,000	.	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-Engineering resources	Correlation Coefficient	-,405**	,911**	,762**	,749**	,860**	1,000	,713**	,672**
		Sig. (2-tailed)	,001	,000	,000	,000	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-Manufacturing skills	Correlation Coefficient	-,253	,826**	,551**	,571**	,591**	,713**	1,000	,894**
		Sig. (2-tailed)	,053	,000	,000	,000	,000	,000	.	,000
		N	59	59	59	59	59	59	59	59
	Pro-Manufacturing resources	Correlation Coefficient	-,223	,795**	,476**	,559**	,537**	,672**	,894**	1,000
		Sig. (2-tailed)	,090	,000	,000	,000	,000	,000	,000	.
		N	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 55 – Result of bivariate correlations between KIBS use and pro-marketing activities (marketing synergy)



Correlations

			Use of KIBS.	Pro-Marketing synergy	Pro-Market research skills	Pro-Market research resources	Pro-Sales force skills	Pro-Sales force resources	Pro-Distribution skills	Pro-Distribution resources	Pro-Advertising/promotion skills	Pro-Advertising/promotion resources
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	,050	-,095	-,147	-,005	-,035	-,087	,022	-,017	,013
		Sig. (2-tailed)	.	,706	,474	,267	,969	,794	,514	,866	,897	,921
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Marketing synergy	Correlation Coefficient	-,050	1,000	,759**	,721**	,838**	,755**	,781**	,783**	,827**	,735**
		Sig. (2-tailed)	,706	.	,000	,000	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Market research skills	Correlation Coefficient	-,095	,759**	1,000	,713**	,641**	,479**	,454**	,477**	,519**	,409**
		Sig. (2-tailed)	,474	,000	.	,000	,000	,000	,000	,000	,000	,001
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Market research resources	Correlation Coefficient	-,147	,721**	,713**	1,000	,537**	,558**	,425**	,372**	,510**	,407**
		Sig. (2-tailed)	,267	,000	,000	.	,000	,000	,001	,004	,000	,001
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Sales force skills	Correlation Coefficient	-,005	,838**	,641**	,537**	1,000	,737**	,697**	,641**	,655**	,586**
		Sig. (2-tailed)	,969	,000	,000	,000	.	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Sales force resources	Correlation Coefficient	-,035	,755**	,479**	,558**	,737**	1,000	,588**	,560**	,525**	,609**
		Sig. (2-tailed)	,794	,000	,000	,000	,000	.	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Distribution skills	Correlation Coefficient	-,087	,781**	,454**	,425**	,697**	,588**	1,000	,883**	,646**	,487**
		Sig. (2-tailed)	,514	,000	,000	,001	,000	,000	.	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Distribution resources	Correlation Coefficient	,022	,783**	,477**	,372**	,641**	,560**	,883**	1,000	,631**	,545**
		Sig. (2-tailed)	,866	,000	,000	,004	,000	,000	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Advertising/promotion skills	Correlation Coefficient	-,017	,827**	,519**	,510**	,655**	,525**	,646**	,631**	1,000	,795**
		Sig. (2-tailed)	,897	,000	,000	,000	,000	,000	,000	,000	.	,000
		N	59	59	59	59	59	59	59	59	59	59
	Pro-Advertising/promotion resources	Correlation Coefficient	-,013	,735**	,409**	,407**	,586**	,609**	,487**	,545**	,795**	1,000
		Sig. (2-tailed)	,921	,000	,001	,001	,000	,000	,000	,000	,000	.
		N	59	59	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 56 – Tests of normality for example variables (sensitivity test).

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pro-Combination	,099	59	,200*	,965	59	,087
Pro-Manufacturing skills	,190	59	,000	,909	59	,000
Pro-Manufacturing resources	,173	59	,000	,917	59	,001

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Table 57 – Independent Samples Test for example variable and 'Use of KIBS' (sensitivity test).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pro-Combination	Equal variances assumed	1,568	,216	1,916	57	,060	10,571	5,518	-,479	21,621
	Equal variances not assumed			1,845	44,020	,072	10,571	5,731	-,979	22,121

Table 58 – Non-parametric test for two example variables grouped by 'Use of KIBS'(sensitivity test).

Test Statistics[a]

	Pro-Manufacturing skills	Pro-Manufacturing resources
Mann-Whitney U	304,500	319,500
Wilcoxon W	655,500	670,500
Z	-1,930	-1,695
Asymp. Sig. (2-tailed)	,054	,090

a. Grouping Variable: Use of KIBS.

Table 59 – Tests of normality for three pro-technical activities and the overall technical synergy.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pro-Technical synergy	,101	59	,200*	,957	59	,038
Pro-R&D skills	,153	59	,001	,930	59	,002
Pro-Engineering skills	,173	59	,000	,925	59	,001
Pro-Engineering resources	,193	59	,000	,921	59	,001

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

The tests of normality show whether the distribution of the tested variable differs significantly from a normal distribution. Both the Kolmogorov-Smirnov and Shapiro-Wilk test show this, where the latter has the preference for smaller samples and thus will be used in case of doubt (De Vocht, 2007). Since all four variables have a significance lower or equal to 0.05 (Shapiro-Wilk), the H_0 can be rejected, thus the variables are not normally distributed.

Table 60 – Non-parametric test for three pro-technical activities and the overall technical synergy, grouped by the 'Use of KIBS'.

Test Statistics[a]

	Pro-Technical synergy	Pro-R&D skills	Pro-Engineering skills	Pro-Engineering resources
Mann-Whitney U	259,000	300,000	226,500	230,000
Wilcoxon W	610,000	651,000	577,500	581,000
Z	-2,598	-1,993	-3,134	-3,083
Asymp. Sig. (2-tailed)	,009	,046	,002	,002

a. Grouping Variable: Use of KIBS.

The Mann-Whitney test above shows with a two-sided significance level that the H_0 hypotheses can be rejected (sig. < 0.05).

Table 61 – Results of bivariate correlations between complexity and the four significant found pro technical synergy aspects

Correlations

			Classified complexity product	Pro-Technical synergy	Pro-R&D skills	Pro-Engineering skills	Pro-Engineering resources
Spearman's rho	Classified complexity product	Correlation Coefficient	1,000	-,179	-,262*	-,276*	-,205
		Sig. (2-tailed)	.	,171	,044	,033	,116
		N	60	60	60	60	60
	Pro-Technical synergy	Correlation Coefficient	-,179	1,000	,834**	,879**	,902**
		Sig. (2-tailed)	,171	.	,000	,000	,000
		N	60	60	60	60	60
	Pro-R&D skills	Correlation Coefficient	-,262*	,834**	1,000	,838**	,742**
		Sig. (2-tailed)	,044	,000	.	,000	,000
		N	60	60	60	60	60
	Pro-Engineering skills	Correlation Coefficient	-,276*	,879**	,838**	1,000	,859**
		Sig. (2-tailed)	,033	,000	,000	.	,000
		N	60	60	60	60	60
	Pro-Engineering resources	Correlation Coefficient	-,205	,902**	,742**	,859**	1,000
		Sig. (2-tailed)	,116	,000	,000	,000	.
		N	60	60	60	60	60

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 62 – Results of bivariate correlations between complexity and post-pro technical synergy aspects.

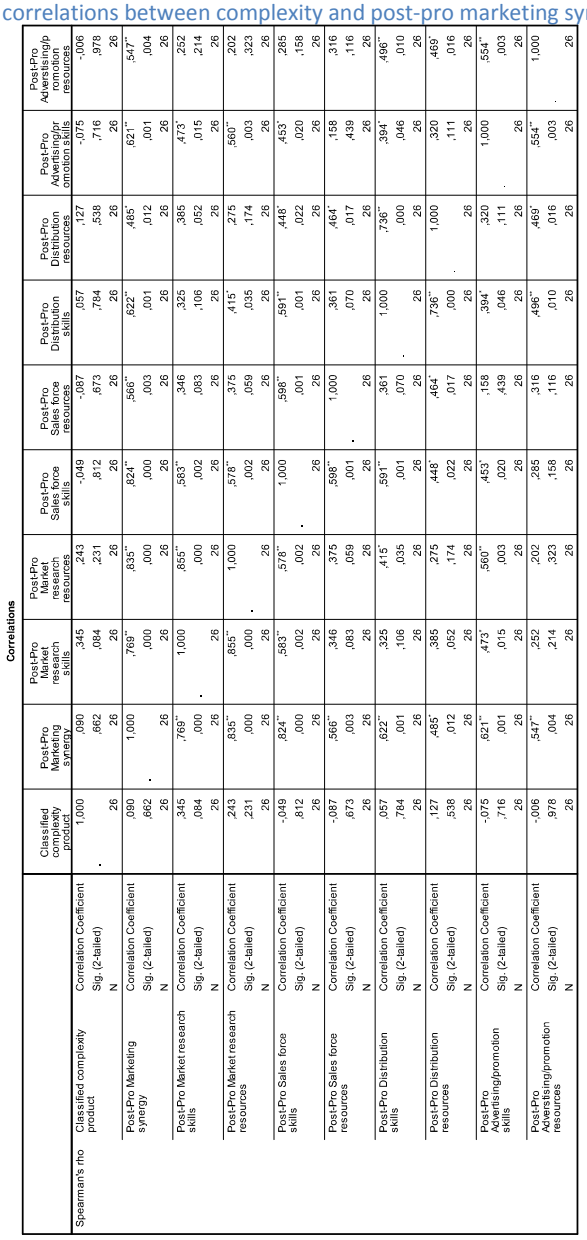
Correlations

			Classified complexity product	Post-Pro Technical synergy	Post-Pro R&D skills	Post-Pro R&D resources	Post-Pro Engineering skills	Post-Pro Engineering resources	Post-Pro Manufacturing skills	Post-Pro Manufacturing resources
Spearman's rho	Classified complexity product	Correlation Coefficient	1,000	-,169	-,077	,087	,044	,247	-,456*	-,452*
		Sig. (2-tailed)	.	,408	,709	,672	,832	,223	,019	,020
		N	26	26	26	26	26	26	26	26
	Post-Pro Technical synergy	Correlation Coefficient	-,169	1,000	,577**	,548**	,829**	,783**	,635**	,595**
		Sig. (2-tailed)	,408	.	,002	,004	,000	,000	,000	,001
		N	26	26	26	26	26	26	26	26
	Post-Pro R&D skills	Correlation Coefficient	-,077	,577**	1,000	,123	,564**	,566**	,273	,067
		Sig. (2-tailed)	,709	,002	.	,549	,003	,003	,177	,744
		N	26	26	26	26	26	26	26	26
	Post-Pro R&D resources	Correlation Coefficient	,087	,548**	,123	1,000	,317	,478*	,231	,219
		Sig. (2-tailed)	,672	,004	,549	.	,115	,014	,255	,282
		N	26	26	26	26	26	26	26	26
	Post-Pro Engineering skills	Correlation Coefficient	,044	,829**	,564**	,317	1,000	,670**	,423*	,348
		Sig. (2-tailed)	,832	,000	,003	,115	.	,000	,031	,081
		N	26	26	26	26	26	26	26	26
	Post-Pro Engineering resources	Correlation Coefficient	,247	,783**	,566**	,478*	,670**	1,000	,174	,230
		Sig. (2-tailed)	,223	,000	,003	,014	,000	.	,394	,259
		N	26	26	26	26	26	26	26	26
	Post-Pro Manufacturing skills	Correlation Coefficient	-,456*	,635**	,273	,231	,423*	,174	1,000	,737**
		Sig. (2-tailed)	,019	,000	,177	,255	,031	,394	.	,000
		N	26	26	26	26	26	26	26	26
	Post-Pro Manufacturing resources	Correlation Coefficient	-,452*	,595**	,067	,219	,348	,230	,737**	1,000
		Sig. (2-tailed)	,020	,001	,744	,282	,081	,259	,000	.
		N	26	26	26	26	26	26	26	26

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 63 – Results of bivariate correlations between complexity and post-pro marketing synergy aspects.



Correlations

			Classified complexity product	Post-Pro Marketing synergy	Post-Pro Market research skills	Post-Pro Market research resources	Post-Pro Sales force skills	Post-Pro Sales force resources	Post-Pro Distribution skills	Post-Pro Distribution resources	Post-Pro Advertising/promotion skills	Post-Pro Advertising/promotion resources
Spearman's rho	Classified complexity product	Correlation Coefficient	1,000	,090	,345	,243	-,049	-,087	,057	,127	-,075	-,006
		Sig. (2-tailed)	.	,662	,084	,231	,812	,673	,784	,538	,716	,978
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Marketing synergy	Correlation Coefficient	,090	1,000	,769**	,835**	,824**	,566**	,622**	,485*	,621**	,547**
		Sig. (2-tailed)	,662	.	,000	,000	,000	,003	,001	,012	,001	,004
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Market research skills	Correlation Coefficient	,345	,769**	1,000	,855**	,583**	,346	,325	,385	,473*	,252
		Sig. (2-tailed)	,084	,000	.	,000	,002	,083	,106	,052	,015	,214
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Market research resources	Correlation Coefficient	,243	,835**	,855**	1,000	,578**	,375	,415*	,275	,560**	,202
		Sig. (2-tailed)	,231	,000	,000	.	,002	,059	,035	,174	,003	,323
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Sales force skills	Correlation Coefficient	-,049	,824**	,583**	,578**	1,000	,598**	,591**	,448*	,453*	,285
		Sig. (2-tailed)	,812	,000	,002	,002	.	,001	,001	,022	,020	,158
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Sales force resources	Correlation Coefficient	-,087	,566**	,346	,375	,598**	1,000	,361	,464*	,439*	,316
		Sig. (2-tailed)	,673	,003	,083	,059	,001	.	,070	,017	,116	,116
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Distribution skills	Correlation Coefficient	,057	,622**	,325	,415*	,591**	,361	1,000	,736**	,394*	,496**
		Sig. (2-tailed)	,784	,001	,106	,035	,001	,070	.	,000	,046	,010
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Distribution resources	Correlation Coefficient	,127	,485*	,385	,275	,448*	,464*	,736**	1,000	,320	,469*
		Sig. (2-tailed)	,538	,012	,052	,174	,022	,017	,000	.	,111	,016
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Advertising/promotion skills	Correlation Coefficient	-,075	,621**	,473*	,560**	,453*	,158	,394*	,320	1,000	,554**
		Sig. (2-tailed)	,716	,001	,015	,003	,020	,439	,046	,111	.	,003
		N	26	26	26	26	26	26	26	26	26	26
	Post-Pro Advertising/promotion resources	Correlation Coefficient	-,006	,547**	,252	,202	,285	,316	,496**	,469*	,554**	1,000
		Sig. (2-tailed)	,978	,004	,214	,323	,158	,116	,010	,016	,003	.
		N	26	26	26	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 64 – Tests of normality for example variables (sensitivity test).

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Post-Pro Engineering resources	,192	26	,014	,916	26	,037
Post-Pro Market research skills	,283	26	,000	,837	26	,001
Post-Pro Market research resources	,191	26	,016	,928	26	,070

a. Lilliefors Significance Correction

Table 65 - Non-parametric test for two example variables grouped by 'Classified complexity product' (sensitivity test).

Test Statistics[b]

	Post-Pro Engineering resources	Post-Pro Market research skills
Mann-Whitney U	57,000	49,000
Wilcoxon W	112,000	104,000
Z	-1,236	-1,724
Asymp. Sig. (2-tailed)	,216	,085
Exact Sig. [2*(1-tailed Sig.)]	,241[a]	,109[a]

a. Not corrected for ties.

b. Grouping Variable: Classified complexity product

Table 66 - Independent Samples Test for example variable and 'Classified complexity product' (sensitivity test).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post-Pro Market research resources	Equal variances assumed	,352	,558	-,965	24	,344	-,788	,816	-2,472	,897
	Equal variances not assumed			-,927	16,816	,367	-,788	,849	-2,581	1,006

Table 67 – Tests of normality for 'Post-Pro Manufacturing skills' and 'Post-Pro Manufacturing resources'.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Post-Pro Manufacturing skills	,197	26	,011	,903	26	,018
Post-Pro Manufacturing resources	,214	26	,004	,918	26	,041

a. Lilliefors Significance Correction

Both variables have a significance lower or equal to 0.05 (Shapiro-Wilk), therefore H_0 can be rejected, which means that the variables are not normally distributed. In that case the variables do not satisfy the conditions needed for the Independent-Samples T-test, therefore the Mann-Whitney test can be used (De Vocht, 2007).

Table 68 – Non-parametric test for 'Post-Pro Manufacturing skills' and 'Post-Pro Manufacturing resources', grouped by the 'Classified complexity product'.

Test Statistics[b]

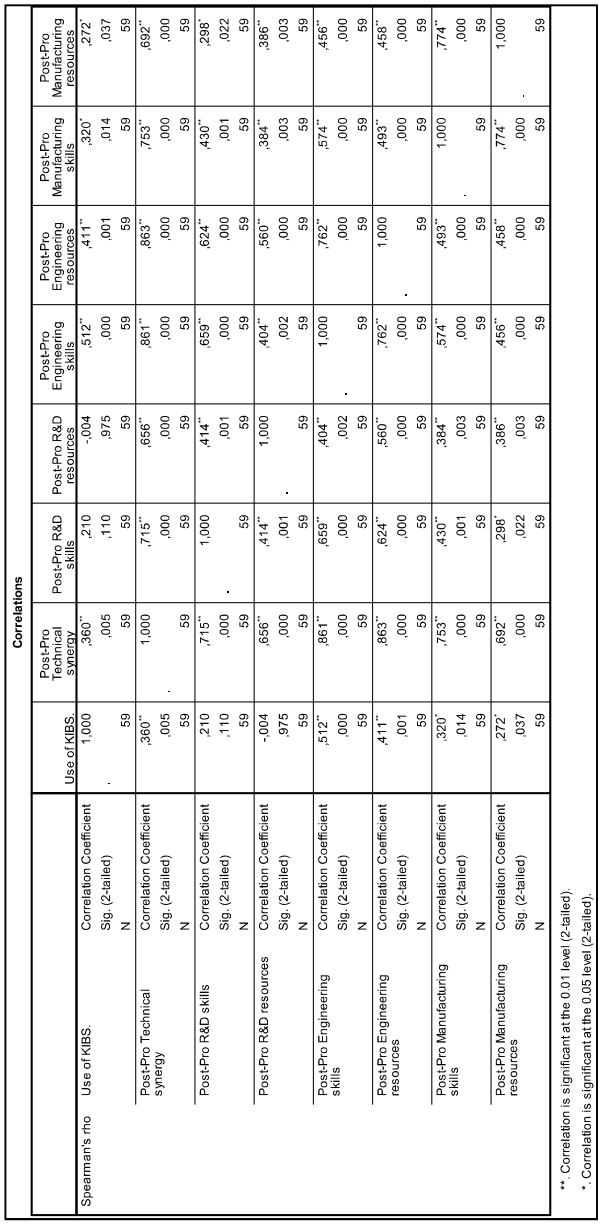
	Post-Pro Manufacturing skills	Post-Pro Manufacturing resources
Mann-Whitney U	38,500	39,000
Wilcoxon W	174,500	175,000
Z	-2,278	-2,260
Asymp. Sig. (2-tailed)	,023	,024
Exact Sig. [2*(1-tailed Sig.)]	,027[a]	,031[a]

a. Not corrected for ties.

b. Grouping Variable: Classified complexity product

The Mann-Whitney test above shows with a two-sided significance level that the H_0 hypotheses can be rejected (sig. < 0.05).

Table 69 – Results of bivariate correlations between 'Use of KIBS' and post-pro technical synergy aspects.



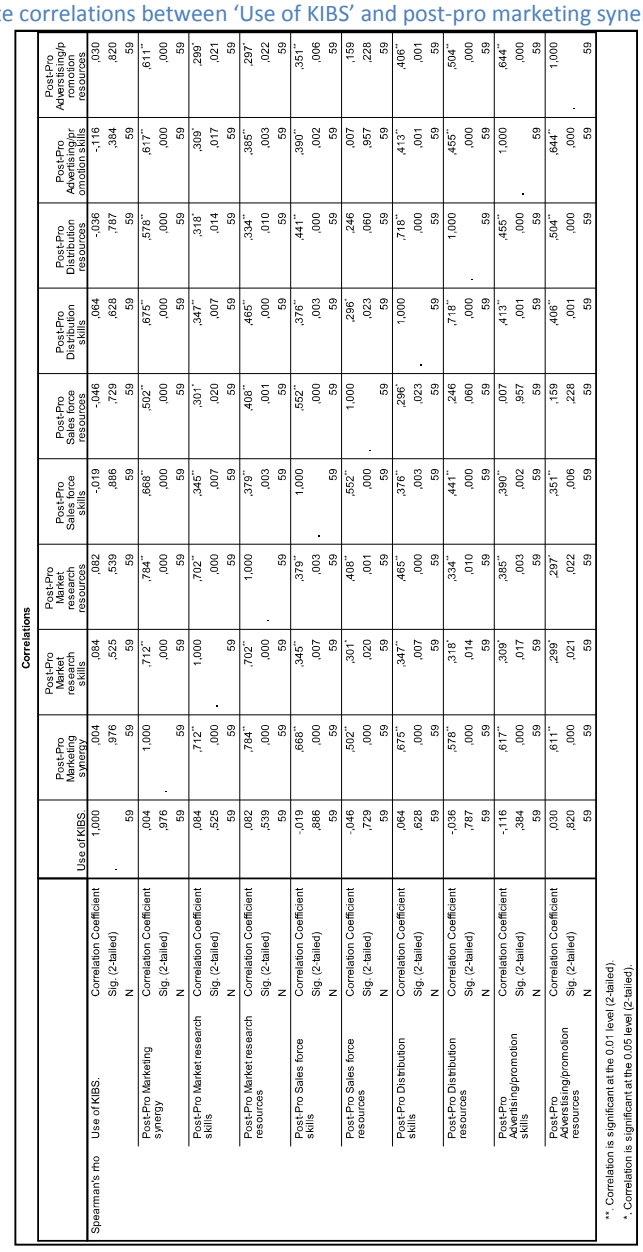
Correlations

			Use of KIBS	Post-Pro Technical synergy	Post-Pro R&D skills	Post-Pro R&D resources	Post-Pro Engineering skills	Post-Pro Engineering resources	Post-Pro Manufacturing skills	Post-Pro Manufacturing resources
Spearman's rho	Use of KIBS	Correlation Coefficient	1,000	,360**	,210	-,004	,512**	,411**	,320*	,272*
		Sig. (2-tailed)	.	,005	,110	,975	,000	,001	,014	,037
		N	59	59	59	59	59	59	59	59
	Post-Pro Technical synergy	Correlation Coefficient	,360**	1,000	,715**	,656**	,861**	,863**	,753**	,692**
		Sig. (2-tailed)	,005	.	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-Pro R&D skills	Correlation Coefficient	,210	,715**	1,000	,414**	,659**	,624**	,430**	,298*
		Sig. (2-tailed)	,110	,000	.	,001	,000	,000	,001	,022
		N	59	59	59	59	59	59	59	59
	Post-Pro R&D resources	Correlation Coefficient	-,004	,656**	,414**	1,000	,404**	,560**	,384**	,386**
		Sig. (2-tailed)	,975	,000	,001	.	,002	,000	,003	,003
		N	59	59	59	59	59	59	59	59
	Post-Pro Engineering skills	Correlation Coefficient	,512**	,861**	,659**	,404**	1,000	,762**	,574**	,456**
		Sig. (2-tailed)	,000	,000	,000	,002	.	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-Pro Engineering resources	Correlation Coefficient	,411**	,863**	,624**	,560**	,762**	1,000	,493**	,458**
		Sig. (2-tailed)	,001	,000	,000	,000	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-Pro Manufacturing skills	Correlation Coefficient	,320*	,753**	,430**	,384**	,574**	,493**	1,000	,774**
		Sig. (2-tailed)	,014	,000	,001	,003	,000	,000	.	,000
		N	59	59	59	59	59	59	59	59
	Post-Pro Manufacturing resources	Correlation Coefficient	,272*	,692**	,298*	,386**	,456**	,458**	,774**	1,000
		Sig. (2-tailed)	,037	,000	,022	,003	,000	,000	,000	.
		N	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 70 – Results of bivariate correlations between 'Use of KIBS' and post-pro marketing synergy aspects.



Correlations

			Use of KIBS.	Post-Pro Marketing synergy	Post-Pro Market research skills	Post-Pro Market research resources	Post-Pro Sales force skills	Post-Pro Sales force resources	Post-Pro Distribution skills	Post-Pro Distribution resources	Post-Pro Advertising/promotion skills	Post-Pro Advertising/promotion resources
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	,004	,084	,082	-,019	-,046	,064	-,036	-,116	,030
		Sig. (2-tailed)	.	,976	,525	,539	,886	,729	,628	,787	,384	,820
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Marketing synergy	Correlation Coefficient	,004	1,000	,712**	,784**	,668**	,502**	,675**	,578**	,617**	,611**
		Sig. (2-tailed)	,976	.	,000	,000	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Market research skills	Correlation Coefficient	,084	,712**	1,000	,702**	,345**	,301*	,347**	,318*	,309*	,299*
		Sig. (2-tailed)	,525	,000	.	,000	,007	,020	,007	,014	,017	,021
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Market research resources	Correlation Coefficient	,082	,784**	,702**	1,000	,379**	,408**	,465**	,334**	,385**	,297*
		Sig. (2-tailed)	,539	,000	,000	.	,003	,001	,000	,010	,003	,022
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Sales force skills	Correlation Coefficient	-,019	,668**	,345**	,379**	1,000	,552**	,376**	,441**	,390**	,351**
		Sig. (2-tailed)	,886	,000	,007	,003	.	,000	,003	,000	,002	,006
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Sales force resources	Correlation Coefficient	-,046	,502**	,301*	,408**	,552**	1,000	,296*	,246	,007	,159
		Sig. (2-tailed)	,729	,000	,020	,001	,000	.	,023	,060	,957	,228
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Distribution skills	Correlation Coefficient	,064	,675**	,347**	,465**	,376**	,296*	1,000	,718**	,413**	,406**
		Sig. (2-tailed)	,628	,000	,007	,000	,003	,023	.	,000	,001	,001
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Distribution resources	Correlation Coefficient	-,036	,578**	,318*	,334**	,441**	,246	,718**	1,000	,455**	,504**
		Sig. (2-tailed)	,787	,000	,014	,010	,000	,060	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Advertising/promotion skills	Correlation Coefficient	-,116	,617**	,309*	,385**	,390**	,007	,413**	,455**	1,000	,644**
		Sig. (2-tailed)	,384	,000	,017	,003	,002	,957	,001	,000	.	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Pro Advertising/promotion resources	Correlation Coefficient	,030	,611**	,299*	,297*	,351**	,159	,406**	,504**	,644**	1,000
		Sig. (2-tailed)	,820	,000	,021	,022	,006	,228	,001	,000	,000	.
		N	59	59	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 71 – Tests of normality for four post-pro technical activities and the overall technical synergy.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Post-Pro Technical synergy	,107	59	,088	,944	59	,009
Post-Pro Engineering skills	,225	59	,000	,885	59	,000
Post-Pro Engineering resources	,166	59	,000	,935	59	,004
Post-Pro Manufacturing skills	,202	59	,000	,909	59	,000
Post-Pro Manufacturing resources	,206	59	,000	,930	59	,002

a. Lilliefors Significance Correction

All four variables have a significance lower or equal to 0.05 (Shapiro-Wilk), therefore H_0 can be rejected, which means that the variables are not normally distributed.

Table 72 – Non-parametric test for four post-pro technical activities and the overall technical synergy, grouped by the 'Use of KIBS'.

Test Statistics[a]

	Post-Pro Technical synergy	Post-Pro Engineering skills	Post-Pro Engineering resources	Post-Pro Manufacturing skills	Post-Pro Manufacturing resources
Mann-Whitney U	250,000	180,000	229,000	276,000	299,000
Wilcoxon W	811,000	741,000	790,000	837,000	860,000
Z	-2,740	-3,897	-3,127	-2,434	-2,070
Asymp. Sig. (2-tailed)	,006	,000	,002	,015	,038

a. Grouping Variable: Use of KIBS.

The Mann-Whitney test above shows with a two-sided significance level that the H_0 hypotheses can be rejected (sig. < 0.05) four all five variables. This indicates the differences found between KIBS and non-KIBS users are significant.

Table 73 – Results of bivariate correlations between 'Use of KIBS' and pro-development & protocol activities.

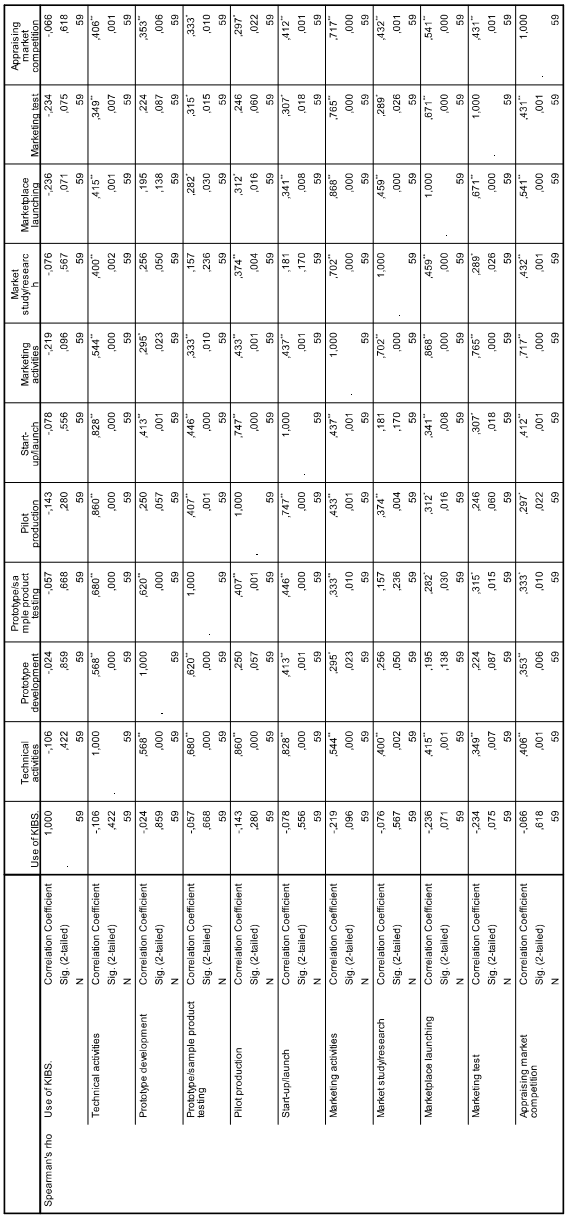
Correlations

			Use of KIBS.	Pro-Development	Pro-Financial analyses	Pro-Technical assessment	Pro-Market assessment	Protocol	Describing Product Concept	Describing Target Market
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	,024	,091	-,058	-,050	,017	,032	-,016
		Sig. (2-tailed)	.	,856	,493	,660	,706	,897	,812	,902
		N	59	59	59	59	59	59	59	59
	Pro-Development	Correlation Coefficient	,024	1,000	,916**	,817**	,806**	,576**	,554**	,509**
		Sig. (2-tailed)	,856	.	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-Financial analyses	Correlation Coefficient	,091	,916**	1,000	,644**	,595**	,605**	,542**	,569**
		Sig. (2-tailed)	,493	,000	.	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Pro-Technical assessment	Correlation Coefficient	-,058	,817**	,644**	1,000	,583**	,426**	,500**	,299*
		Sig. (2-tailed)	,660	,000	,000	.	,000	,001	,000	,021
		N	59	59	59	59	59	59	59	59
	Pro-Market assessment	Correlation Coefficient	-,050	,806**	,595**	,583**	1,000	,436**	,410**	,424**
		Sig. (2-tailed)	,706	,000	,000	,000	.	,001	,001	,001
		N	59	59	59	59	59	59	59	59
	Protocol	Correlation Coefficient	,017	,576**	,605**	,426**	,436**	1,000	,868**	,904**
		Sig. (2-tailed)	,897	,000	,000	,001	,001	.	,000	,000
		N	59	59	59	59	59	59	59	59
	Describing Product Concept	Correlation Coefficient	,032	,554**	,542**	,500**	,410**	,868**	1,000	,619**
		Sig. (2-tailed)	,812	,000	,000	,000	,001	,000	.	,000
		N	59	59	59	59	59	59	59	59
	Describing Target Market	Correlation Coefficient	-,016	,509**	,569**	,299*	,424**	,904**	,619**	1,000
		Sig. (2-tailed)	,902	,000	,000	,021	,001	,000	,000	.
		N	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 74 – Results of bivariate correlations between 'Use of KIBS' and technical & marketing activities.



Correlations

			Use of KIBS	Technical activities	Prototype development	Prototype/sample product testing	Pilot production	Start-up/launch	Marketing activities	Market study/research	Marketplace launching	Marketing test	Appraising market competition
Spearman's rho	Use of KIBS	Correlation Coefficient	1,000	-,106	-,024	-,057	-,143	-,078	-,219	-,076	-,236	-,234	-,066
		Sig. (2-tailed)	.	,422	,859	,668	,280	,556	,096	,567	,071	,075	,618
		N	59	59	59	59	59	59	59	59	59	59	59
	Technical activities	Correlation Coefficient	-,106	1,000	,568**	,680**	,860**	,828**	,544**	,400**	,415**	,349**	,406**
		Sig. (2-tailed)	,422	.	,000	,000	,000	,000	,000	,002	,001	,007	,001
		N	59	59	59	59	59	59	59	59	59	59	59
	Prototype development	Correlation Coefficient	-,024	,568**	1,000	,620**	,250	,413**	,295*	,256	,195	,224	,353**
		Sig. (2-tailed)	,859	,000	.	,000	,057	,001	,023	,050	,138	,087	,006
		N	59	59	59	59	59	59	59	59	59	59	59
	Prototype/sample product testing	Correlation Coefficient	-,057	,680**	,620**	1,000	,407**	,446**	,333**	,157	,282*	,315*	,333**
		Sig. (2-tailed)	,668	,000	,000	.	,001	,000	,010	,236	,030	,015	,010
		N	59	59	59	59	59	59	59	59	59	59	59
	Pilot production	Correlation Coefficient	-,143	,860**	,250	,407**	1,000	,747**	,433**	,374**	,312*	,245	,297*
		Sig. (2-tailed)	,280	,000	,057	,001	.	,000	,001	,004	,016	,060	,022
		N	59	59	59	59	59	59	59	59	59	59	59
	Start-up/launch	Correlation Coefficient	-,078	,828**	,413**	,446**	,747**	1,000	,437**	,181	,341**	,307*	,412**
		Sig. (2-tailed)	,556	,000	,001	,000	,000	.	,001	,170	,008	,018	,001
		N	59	59	59	59	59	59	59	59	59	59	59
	Marketing activities	Correlation Coefficient	-,219	,544**	,295*	,333**	,433**	,437**	1,000	,702**	,868**	,765**	,717**
		Sig. (2-tailed)	,096	,000	,023	,010	,001	,001	.	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59	59
	Market study/research	Correlation Coefficient	-,076	,400**	,256	,157	,374**	,181	,702**	1,000	,459**	,289*	,432**
		Sig. (2-tailed)	,567	,002	,050	,236	,004	,170	,000	.	,000	,026	,001
		N	59	59	59	59	59	59	59	59	59	59	59
	Marketplace launching	Correlation Coefficient	-,236	,415**	,195	,282*	,312*	,341**	,868**	,459**	1,000	,671**	,541**
		Sig. (2-tailed)	,071	,001	,138	,030	,016	,008	,000	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59	59	59	59
	Marketing test	Correlation Coefficient	-,234	,349**	,224	,315*	,245	,307*	,765**	,289*	,671**	1,000	,431**
		Sig. (2-tailed)	,075	,007	,087	,015	,060	,018	,000	,026	,000	.	,001
		N	59	59	59	59	59	59	59	59	59	59	59
	Appraising market competition	Correlation Coefficient	-,066	,406**	,353**	,333**	,297*	,412**	,717**	,432**	,541**	,431**	1,000
		Sig. (2-tailed)	,618	,001	,006	,010	,022	,001	,000	,001	,000	,001	.
		N	59	59	59	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 75 - Results of bivariate correlations between 'Use of KIBS' and NPD team activities.

Correlations

			Use of KIBS.	NPD Team	NPD R&D and Marketing integration	NPD R&D and Production integration	NPD Marketing and Production integration	NPD Projectteam responsibility
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	-,205	-,225	-,059	-,161	-,239
		Sig. (2-tailed)	.	,119	,086	,657	,224	,069
		N	59	59	59	59	59	59
	NPD Team	Correlation Coefficient	-,205	1,000	,892**	,819**	,924**	,418**
		Sig. (2-tailed)	,119	.	,000	,000	,000	,001
		N	59	59	59	59	59	59
	NPD R&D and Marketing integration	Correlation Coefficient	-,225	,892**	1,000	,631**	,830**	,227
		Sig. (2-tailed)	,086	,000	.	,000	,000	,084
		N	59	59	59	59	59	59
	NPD R&D and Production integration	Correlation Coefficient	-,059	,819**	,631**	1,000	,719**	,392**
		Sig. (2-tailed)	,657	,000	,000	.	,000	,002
		N	59	59	59	59	59	59
	NPD Marketing and Production integration	Correlation Coefficient	-,161	,924**	,830**	,719**	1,000	,138
		Sig. (2-tailed)	,224	,000	,000	,000	.	,298
		N	59	59	59	59	59	59
	NPD Projectteam responsibility	Correlation Coefficient	-,239	,418**	,227	,392**	,138	1,000
		Sig. (2-tailed)	,069	,001	,084	,002	,298	.
		N	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 76 – Tests of normality for example variables (sensitivity test).

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Use of KIBS.	Statistic	df	Sig.	Statistic	df	Sig.
Marketplace launching	No	,212	33	,001	,886	33	,002
	Yes	,224	26	,002	,848	26	,001
Marketing test	No	,221	33	,000	,885	33	,002
	Yes	,163	26	,075	,887	26	,008
NPD Projectteam responsibility	No	,298	33	,000	,779	33	,000
	Yes	,161	26	,083	,915	26	,034

a. Lilliefors Significance Correction

All three example variables have a significance lower or equal to 0.05 (Shapiro-Wilk), therefore H_0 can be rejected, which means that the variables are not normally distributed.

Table 77 – Non-parametric test for three example variables grouped by 'Use of KIBS' (sensitivity test).

Test Statistics[a]

	Marketplace launching	Marketing test	NPD Projectteam responsibility
Mann-Whitney U	313,000	314,000	314,000
Wilcoxon W	664,000	665,000	665,000
Z	-1,801	-1,781	-1,819
Asymp. Sig. (2-tailed)	,072	,075	,069

a. Grouping Variable: Use of KIBS.

The Mann-Whitney test above shows with a two-sided significance level that the H_0 hypotheses cannot be rejected (sig. > 0.05) for the three examples. This indicates the differences found between KIBS and non-KIBS users are not significant.

Table 78 – Results of bivariate correlations between 'Use of KIBS' and technical synergy aspects.

Correlations

			Use of KIBS	Post-Technical synergy	Post-R&D skills	Post-R&D resources	Post-Engineering skills	Post-Engineering resources	Post-Manufacturing skills	Post-Manufacturing resources
Spearman's rho	Use of KIBS	Correlation Coefficient	1,000	-,052	-,053	-,132	,044	-,063	,009	-,037
		Sig. (2-tailed)	.	,694	,689	,320	,740	,638	,945	,782
		N	59	59	59	59	59	59	59	59
	Post-Technical synergy	Correlation Coefficient	-,052	1,000	,836**	,913**	,892**	,942**	,919**	,896**
		Sig. (2-tailed)	,694	.	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-R&D skills	Correlation Coefficient	-,053	,836**	1,000	,752**	,866**	,898**	,712**	,610**
		Sig. (2-tailed)	,689	,000	.	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-R&D resources	Correlation Coefficient	-,132	,913**	,752**	1,000	,712**	,906**	,758**	,753**
		Sig. (2-tailed)	,320	,000	,000	.	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-Engineering skills	Correlation Coefficient	,044	,892**	,866**	,712**	1,000	,819**	,839**	,763**
		Sig. (2-tailed)	,740	,000	,000	,000	.	,000	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-Engineering resources	Correlation Coefficient	-,063	,942**	,698**	,906**	,819**	1,000	,865**	,855**
		Sig. (2-tailed)	,638	,000	,000	,000	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59
	Post-Manufacturing skills	Correlation Coefficient	,009	,919**	,712**	,758**	,839**	,865**	1,000	,897**
		Sig. (2-tailed)	,945	,000	,000	,000	,000	,000	.	,000
		N	59	59	59	59	59	59	59	59
	Post-Manufacturing resources	Correlation Coefficient	-,037	,896**	,610**	,753**	,763**	,855**	,897**	1,000
		Sig. (2-tailed)	,782	,000	,000	,000	,000	,000	,000	.
		N	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 79 – Results of bivariate correlations between 'Use of KIBS' and marketing synergy aspects.

Correlations

			Use of KIBS.	Post-Marketing synergy	Post-Market research skills	Post-Market research resources	Post-Sales force skills	Post-Sales force resources	Post-Distribution skills	Post-Distribution resources	Post-Advertising/promotion skills	Post-Advertising/promotion resources
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	,027	-,043	-,036	-,062	,036	,018	,059	-,045	,086
		Sig. (2-tailed)	.	,838	,748	,788	,639	,785	,890	,655	,736	,519
		N	59	59	59	59	59	59	59	59	59	59
	Post-Marketing synergy	Correlation Coefficient	-,027	1,000	,765**	,779**	,671**	,721**	,840**	,807**	,829**	,821**
		Sig. (2-tailed)	,838	.	,000	,000	,000	,000	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Market research skills	Correlation Coefficient	-,043	,765**	1,000	,814**	,529**	,388**	,529**	,427**	,544**	,493**
		Sig. (2-tailed)	,748	,000	.	,000	,000	,002	,000	,001	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Market research resources	Correlation Coefficient	-,036	,779**	,814**	1,000	,435**	,556**	,435**	,484**	,496**	,524**
		Sig. (2-tailed)	,788	,000	,000	.	,001	,000	,001	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Sales force skills	Correlation Coefficient	-,062	,671**	,529**	,435**	1,000	,703**	,618**	,570**	,481**	,401**
		Sig. (2-tailed)	,639	,000	,000	,001	.	,000	,000	,000	,000	,002
		N	59	59	59	59	59	59	59	59	59	59
	Post-Sales force resources	Correlation Coefficient	,036	,721**	,388**	,556**	,703**	1,000	,644**	,658**	,447**	,497**
		Sig. (2-tailed)	,785	,000	,002	,000	,000	.	,000	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Distribution skills	Correlation Coefficient	,018	,840**	,529**	,488**	,618**	,644**	1,000	,939**	,679**	,659**
		Sig. (2-tailed)	,890	,000	,000	,000	,000	,000	.	,000	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Distribution resources	Correlation Coefficient	,059	,807**	,427**	,484**	,570**	,658**	,939**	1,000	,621**	,665**
		Sig. (2-tailed)	,655	,000	,001	,000	,000	,000	,000	.	,000	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Advertising/promotion skills	Correlation Coefficient	-,045	,829**	,544**	,496**	,481**	,447**	,679**	,621**	1,000	,933**
		Sig. (2-tailed)	,736	,000	,000	,000	,000	,000	,000	,000	.	,000
		N	59	59	59	59	59	59	59	59	59	59
	Post-Advertising/promotion resources	Correlation Coefficient	,086	,821**	,493**	,524**	,401**	,497**	,659**	,665**	,933**	1,000
		Sig. (2-tailed)	,519	,000	,000	,000	,002	,000	,000	,000	,000	.
		N	59	59	59	59	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 80 – Results of bivariate correlations between 'Use of KIBS' and 'NPD performance'.

Correlations

			Use of KIBS.	NPD performance
Spearman's rho	Use of KIBS.	Correlation Coefficient	1,000	-,128
		Sig. (2-tailed)	.	,333
		N	59	59
	NPD performance	Correlation Coefficient	-,128	1,000
		Sig. (2-tailed)	,333	.
		N	59	59

Table 81 – Tests of normality for 'Use of KIBS' and 'NPD performance'.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Use of KIBS.	Statistic	df	Sig.	Statistic	df	Sig.
NPD performance	No	,075	33	,200*	,983	33	,869
	Yes	,114	26	,200*	,933	26	,094

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

The 'NPD performance' has a significance higher than 0.05 (Shapiro-Wilk), therefore H_0 cannot be rejected, which means that the variables are normally distributed.

Table 82 – Group statistics of the Independent Samples Test for 'Use of KIBS' and 'NPD performance'.

Group Statistics

	Use of KIBS.	N	Mean	Std. Deviation	Std. Error Mean
NPD performance	No	33	212,67	35,443	6,170
	Yes	26	202,46	36,295	7,118

Table 83 – Independent Samples Test for 'Use of KIBS' and 'NPD performance'.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NPD performance	Equal variances assumed	,009	,924	1,086	57	,282	10,205	9,393	-8,604	29,014
	Equal variances not assumed			1,083	53,212	,284	10,205	9,420	-8,687	29,097

The results from the Independent Samples Test show that there is no significant difference between NPD performance between KIBS and non-KIBS users. The Levene's test is with 0.924 not significant (sig. > 0.05), that means H_0 cannot be rejected, therefore 'Equal variances assumed' is used. The H_0 cannot be rejected since the 2-tailed significance is 0.282, therefore the differences between non-KIBS and KIBS users are not significant. The 95% confidence interval corresponds to the conclusion. When both the lower and upper bound are either positive or negative, they indicate a difference, but when one is positive and the other one negative or vice versa, a difference can occur. The results show that the difference between non-KIBS and KIBS users in 95% of all cases lies between -8.6 and 29.0.

Table 84 – Differences between pro-technical and pro-marketing synergy variables (descending).

Descriptive Statistics

	N	Mean	Std. Deviation
Pro-Engineering resources	60	7,32	2,013
Pro-Manufacturing skills	60	7,27	2,082
Pro-Engineering skills	60	7,22	2,059
Pro-Manufacturing resources	60	7,17	2,101
Pro-R&D resources	60	7,10	2,097
Pro-R&D skills	60	6,88	2,218
Valid N (listwise)	60		

Descriptive Statistics

	N	Mean	Std. Deviation
Pro-Distribution resources	60	6,97	2,107
Pro-Distribution skills	60	6,95	2,095
Pro-Sales force resources	60	6,52	1,953
Pro-Sales force skills	60	6,43	2,045
Pro-Advertising/promotion resources	60	6,42	1,960
Pro-Advertising/promotion skills	60	6,32	2,143
Pro-Market research resources	60	5,70	2,212
Pro-Market research skills	60	5,65	2,276
Valid N (listwise)	60		

Table 85 – Differences between technical and marketing activities variables (descending).

Descriptive Statistics

	N	Mean	Std. Deviation
Prototype development	60	7,28	1,708
Prototype/sample product testing	60	6,82	2,111
Start-up/launch	60	6,43	2,302
Pilot production	60	6,10	2,536
Valid N (listwise)	60		

Descriptive Statistics

	N	Mean	Std. Deviation
Appraising market competition	60	6,52	2,251
Marketplace launching	60	5,85	2,489
Marketing test	60	5,82	2,514
Market study/research	60	4,67	2,267
Valid N (listwise)	60		

Table 86 – Differences between post-technical and post-marketing synergy variables (descending).

Descriptive Statistics

	N	Mean	Std. Deviation
Post-Engineering resources	60	7,48	1,557
Post-Engineering skills	60	7,48	1,490
Post-Manufacturing skills	60	7,40	1,825
Post-R&D skills	60	7,35	1,716
Post-R&D resources	60	7,28	1,833
Post-Manufacturing resources	60	7,25	1,828
Valid N (listwise)	60		

Descriptive Statistics

	N	Mean	Std. Deviation
Post-Distribution resources	60	7,32	1,827
Post-Distribution skills	60	7,30	1,862
Post-Sales force resources	60	6,85	1,614
Post-Sales force skills	60	6,85	1,593
Post-Advertising/promotion resources	60	6,68	1,970
Post-Advertising/promotion skills	60	6,58	2,069
Post-Market research resources	60	5,78	2,092
Post-Market research skills	60	5,68	2,244
Valid N (listwise)	60		

9.5 Written questionnaire

Questions marked with an asterisk (*) are mandatory, others are optional. The text "**Answer this question only if the following conditions are met:**" alongside the conditions below it did not appeared to the respondents, but it indicates that the relevant question only appeared to the respondent if the specific condition was met. For instance, question 15 only appeared to those respondents who answered question 14 with 'Yes'. Below is the questionnaire that is carefully translated from Dutch. For some questions it was necessary to add an extra help section for clarification. As in the online questionnaire, these sections are displayed below the question in a gray tint.

New Product Development

Dear managers,

This research is part of my Master thesis of the Science and Innovation Management program at the Utrecht University. The research focuses on the use of consultancy services during the development of new products. In particular, the research focuses on Knowledge Intensive Business Services (KIBS). The definition of KIBS in this study: "Private companies or organizations; relying heavily on professional knowledge, i.e. Knowledge or expertise related to a specific (technical) discipline or (technical) functional domain: and, supplying intermediate products and services that are knowledge based."

This questionnaire is set up to gather information about various aspects of concerning this subject, for which you were approached. All information of the questionnaire will remain confidential and will be dealt with care. Above, anonymity is assured for both the firm and respondent. Only the aggregate results of the survey will be publicly accessible in the final report, from which separate data of respondents and companies cannot be traced. The questionnaire consists of five parts and will take approximately 15 a 20 minutes.

There are 48 questions in this questionnaire.

A Introduction I/II

Personal questions

1 What is your current function within the company? *

Enter your answer here:

2 How many years of experience do you have with your current function within the company?*

Enter your answer here:

Prolonged absence through illness, but while remaining employed, is not seen as building up experience and should therefore not be included in the number of years. Round to the nearest decimal.

A Introduction II/II

Firm specific questions

3 What is the current number of full-time (FTE's) employees? (from 36 hours)*

Enter your answer here:

4 What is the current number of part-time employees? (under 36)*

Enter your answer here:

5 What is the age of the firm in years? *

Enter your answer here:

Any restart, takeover or other form of continuation of the original company is hereby excluded.

6 Does the firm have a formal R&D department? *

Please select from the following options:

- ○ Yes
- ○ No

7 Regardless of having a formal R&D department. What is the average percentage of R&D expenditure for the periods 2009, 2010 and 2011 of the entire company in relation to sales? *

Please select from the following options:

- ○ 1-2%
- ○ 3-4%
- ○ 5-7%
- ○ 7-10%
- ○ 10% or more
- ○ Do not know

8 What is the number of new products launched during the last five years? *

Enter your answer here:

Products considered new to the firm do not necessarily need to be new to the market or new globally.

B Knowledge Intensive Business Services (KIBS) involvement

Instruction:

Choose the most recently completed product that the firm markets/sells and what the firm considered new. This may be new to the firm, new to the market or new globally.

9 What is the name of the project? (optional)

Enter your answer here:

10 Throughout the survey, we will evaluate this project. Note that it is not relevant whether the product is succesful or not succesful. Think back over the process of developing the new product. For each of the following questions, please give the answer that best represents your judgment about each aspect.

11 What is the average R&D expenditure for the chosen project per year in euro? (optional)

Enter your answer here:

Answer without the use of commas, dots or other symbols. Round to the nearest decimal.

12 If you could give a grade to the complexity of the product relative to the competencies of your firm, what would you give? Where one (1) is not complex and ten (10) complex. *

Enter your answer here:

Answer without the use of commas, dots or other symbols. Round to the nearest decimal.

13 What was the lead-time of the project in months? *

Enter your answer here:

Answer without the use of commas, dots or other symbols. Round to the nearest decimal.

14 Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related) *

Please select from the following options:

- ○ Yes
- ○ Partly, but terminated the relation
- ○ No

More information about a 'Knowledge Intensive Business Service':

Definition used in this study: "Private companies or organizations; relying heavily on professional knowledge, i.e. Knowledge or expertise related to a specific (technical) discipline or (technical) functional domain: and, supplying intermediate products and services that are knowledge based."

A term which may be more appealing is that KIBS in this study can be seen as a technical consultant. In this sense they are organizations with professionals that rely heavily on technical expertise. When technical expertise for the product is not available within your firm, a KIBS can be enabled. In that case, a knowledge service is purchased. Together with the KIBS, the required knowledge can be developed. Please note that this not concerns a ready made package of information that is purchased.

Examples of KIBS:

- Training in new technologies
- Design involving new technologies
- Technical engineering

R&D consultancy

15 What was the primary reason for engaging in the KIBS relation? *

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Please select from the following options:

- ○ Cost reduction
- ○ Product solution
- ○ Other, namely

16 For what phase(s) of the project did you engaged in the KIBS relation? *

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Select those that satisfy
- ☐ 1 Identification of new products
- ☐ 2 Prototype development
- ☐ 3 Final product development
- ☐ 4 Product testing
- ☐ 5 Product engineering
- ☐ 6 Market research
- ☐ 7 Marketing strategy

If in your opinion there is a phase not available, check the answer that best represents yur judgement. The order of the phases may vary by firm. There are multiple answers possible.

17 What was the frequency of contact moments per month between the KIBS and (part of) the project team in each of the following phases? *

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Fill in your answer(s) here

1 Identification of new products	
2 Prototype development	
3 Final product development	
4 Product testing	
5 Product engineering	
6 Market research	
7 Marketing strategy	

The order of the phases may vary by firm. If you did not check a phase in the previous question, please enter zero (0)).

18 What was/were the reason(s) for terminating the KIBS relation?*

Answer this question only if the following conditions are met:
° If 'Partly, but terminated the relation' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Select those that satisfy
- ☐ Competency gaps
- ☐ Poor relational capabilities
- ☐ Cultural distance
- ☐ Lack of experience in using exchange platforms
- ☐ Insufficient technological dialogue
- ☐ Technological uncertainty
- ☐ Other, namely..:

There are multiple answers possible.

19 Did (do) you have a reason for not engaging a KIBS relation for that project?*

Answer this question only if the following conditions are met:
° If 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Please select from the following options:

- ○ Yes
- ○ No

20 What is/are your motive(s) for not using KIBS?*

Answer this question only if the following conditions are met:
° If 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related)) and If 'Yes' to question '19' (Did (do) you have a reason for not engaging a KIBS relation for that project?)

Enter your answer here:

C Prior to the development of the new product

Instruction:

In this study, the evaluation of the project is dealt with in three parts. The parts relate to the time of the study; prior to the development, during the development and after the development of the product.

This part explicitly deals with aspects **prior** to the start of the project. For example, aspects will receive a lower score when knowledge or resources are, prior to the project, insufficient or not available at all compared to the situation where it is (sufficiently) available.

To what extent does each statement listed below correctly describe the situation? Please indicate your level of agreement or disagreement by circling a number from one (1) to ten (10) on the scale right of each statement.

1 = strongly disagree, 10 = strongly agree

21 Technical synergy *

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The company's R&D skills were more than adequate for the start of the project.	○○○○○○○○○○
The company's R&D resources were more than adequate for the start of the project.	○○○○○○○○○○
The company's engineering skills were more than adequate for the start of the project.	○○○○○○○○○○
The company's engineering resources were more than adequate for the start of the project.	○○○○○○○○○○
The company's manufacturing skills more than adequate for the start of the project.	○○○○○○○○○○
The company's manufacturing resources more than adequate for the start of the project.	○○○○○○○○○○

This question consists of three parts; R&D, engineering and manufacturing aspects. For each of these, the skills and resources are asked for. Skills are personal and resources refers to things like equipment, available software , materials, etc. …

22 Marketing synergy*

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The company's market research skills were more than adequate for the start of the project.	○○○○○○○○○○
The company's market research resources were more than adequate for the start of the project.	○○○○○○○○○○
The company's sales force skills were more than adequate for the start of the project.	○○○○○○○○○○
The company's sales force resources were more than adequate for the start of the project.	○○○○○○○○○○
The company's distribution skills were more than adequate for the start of the project.	○○○○○○○○○○
The company's distribution resources were more than adequate for the start of the project.	○○○○○○○○○○
The company's advertising/promotion skills were more than adequate for the start of the project.	○○○○○○○○○○
The company's advertising/promotion resources were more than adequate for the start of the project.	○○○○○○○○○○

This question consists of four parts; market research, sales force, distribution and advertising/promotion. For each of these, the skills and resources are asked for.

23 How well were each of the following activities undertaken prior to the start of the project? Please indicate how well or adequately your firm undertook each activity before the start of the process, relative to how you think it should have been done-by circling a number from 1 to 10 on the scale right of each statement.

1 = done very poorly or omitted altogether, 10 = done excellently

24 Pre-development activities *

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
Executing a financial analyses before entering the development phase.	○○○○○○○○○○
Executing a technical assessment before entering the development phase.	○○○○○○○○○○
Executing a market assessment before entering the development phase.	○○○○○○○○○○

25 Protocol *

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
Describing a product concept before entering the development phase.	○○○○○○○○○○
Describing a target market before entering the development phase.	○○○○○○○○○○

D During the development of the new product

Instruction:

This part explicitly deals with aspects during the development of the project.

How well was each of the following activities undertaken **during** the development of this project,? Please indicate how well or adequately your firm undertook each activity in this product development process-relative to how you think it should have been done-by circling a number from 1 to 10 on the scale right of each statement.

1 = done very poorly or omitted altogether, 10 = done excellently

26 You indicated that your firm has used Knowledge Intensive Business Services (KIBS) for the project. Therefore, answer the following questions including KIBS where applicable.

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

27 Technical activities *

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
Executing prototype development (Expanding the idea into a full product concept).	○○○○○○○○○○
Executing prototype or "in-house" sample product testing.	○○○○○○○○○○
Executing pilot production	○○○○○○○○○○
Executing start-up/launch	○○○○○○○○○○

28 Marketing activities *

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
Conducting a market study or research *	○○○○○○○○○○
Launching the product in the marketplace (selling, promoting, and distributing)	○○○○○○○○○○
Executing a marketing test	○○○○○○○○○○
Appraising market competition	○○○○○○○○○○

* A detailed study of market potential, customer preferences, purchase process, etc.

29 Does your firm make a distinction between the R&D, marketing and production department? *

Please select from the following options:

- ○ Yes
- ○ No

30 Was there a project team? *

Please select from the following options:

- ○ Yes
- ○ No

In the case of a SME, it may be that one person only executed the project.

31 To what extent does each statement listed below correctly describe the situation? Please indicate your level of agreement or disagreement by checking a number from one (1) to ten (10) on the scale right of each statement.

1 = strongly disagree, 10 = strongly agree

Answer this question only if the following conditions are met:

-------- Scenario 1 --------
If 'Yes' to question '29' (Does your firm make a distinction between the R&D, marketing and production department?)

-------- or Scenario 2 --------
If 'Yes' to question '30' (Was there a project team?)

32 New Product Development team.*

Answer this question only if the following conditions are met:
° If 'Yes' to question '29' (Does your firm make a distinction between the R&D, marketing and production department?) *and* If 'Yes' to question '30' (Was there a project team?)

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The degree of integration* between R&D and marketing was high during the entire development process.	○○○○○○○○○○
The degree of integration* between R&D and manufacturing was high during the entire development process.	○○○○○○○○○○
The degree of integration* between marketing and manufacturing was high during the entire development.	○○○○○○○○○○
The project team was held accountable for all facets of the project.	○○○○○○○○○○

* Integration refers to the collaboration (communication) between different departements within the company.

33 New Product Development team.*

Answer this question only if the following conditions are met:
° If 'Yes' to question '29' (Does your firm make a distinction between the R&D, marketing and production department?) *and* If 'No' to question '30' (Was there a project team?)

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The degree of integration* between R&D and marketing was high during the entire development process.	○○○○○○○○○○
The degree of integration* between R&D and manufacturing was high during the entire development process.	○○○○○○○○○○
The degree of integration* between marketing and manufacturing was high during the entire development.	○○○○○○○○○○

* Integration refers to the collaboration (communication) between different departements within the company.

34 New Product Development team.*

Answer this question only if the following conditions are met:
° If 'No' to question '29' (Does your firm make a distinction between the R&D, marketing and production department?) *and* If 'Yes' to question '30' (Was there a project team?)

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The project team was held accountable for all facets of the project.	○○○○○○○○○○

35 What was the average frequency of the number of contact moments of the project team in meetings per phase? *

Answer this question only if the following conditions are met:
° If 'Yes' to question '30' (Was there a project team?)

Enter your answer(s) here:

1 Indentification of new products	
2 Prototype development	
3 Final product development	
4 Product testing	
5 Product engineering	
6 Market research	
7 Marketing strategy	

The order of the phases may vary by firm. When in a phase no contact moments occurred, please enter zero (0).

E After the development of the new product

Instruction:

This part explicitly deals with aspects after the development of the project.

To what extent does each statement listed below correctly describe the situation? Please indicate your level of agreement or disagreement by circling a number from one (1) to ten (10) on the scale right of each statement.

1 = strongly disagree, 10 = strongly agree

36 Technical synergy *

Choose the appropriate answer for each item:

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

	1 2 3 4 5 6 7 8 9 10
The company's R&D skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's R&D resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's engineering skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's engineering resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's manufacturing skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's manufacturing resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○

37 Marketing synergy*

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The company's market research skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's market research resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's sales force skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's sales force resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's distribution skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's distribution resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's advertising/promotion skills (including KIBS) were more than adequate for this project.	○○○○○○○○○○
The company's advertising/promotion resources (including KIBS) were more than adequate for this project.	○○○○○○○○○○

38 Technical synergy *

Choose the appropriate answer for each item:

Answer this question only if the following conditions are met:
°If 'Partly, but terminated the relation' or 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

	1 2 3 4 5 6 7 8 9 10
The company's R&D skills were more than adequate for this project.	○○○○○○○○○○
The company's R&D resources were more than adequate for this project.	○○○○○○○○○○
The company's engineering skills were more than adequate for this project.	○○○○○○○○○○
The company's engineering resources were more than adequate for this project.	○○○○○○○○○○
The company's manufacturing skills were more than adequate for this project.	○○○○○○○○○○
The company's manufacturing resources were more than adequate for this project.	○○○○○○○○○○

39 Marketing synergy*

Answer this question only if the following conditions are met:
°If 'Partly, but terminated the relation' or 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Choose the appropriate answer for each item:

	1 2 3 4 5 6 7 8 9 10
The company's market research skills were more than adequate for this project.	○○○○○○○○○○
The company's market research resources were more than adequate for this project.	○○○○○○○○○○
The company's sales force skills were more than adequate for this project.	○○○○○○○○○○
The company's sales force resources were more than adequate for this project.	○○○○○○○○○○
The company's distribution skills were more than adequate for this project.	○○○○○○○○○○
The company's distribution resources were more than adequate for this project.	○○○○○○○○○○
The company's advertising/promotion skills were more than adequate for this project.	○○○○○○○○○○
The company's advertising/promotion resources were more than adequate for this project.	○○○○○○○○○○

40 Upon reflecting on the project, do you have the idea that you could do without the use of a KIBS?*

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Please select from the following options:

- ○ Yes
- ○ Partly
- ○ No

41 Why do you have that idea?*

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related)) *and* If 'Yes' or 'Partly' to question '40' (Upon reflecting on the project, do you have the idea that you could do without the use of a KIBS?)

Enter your answer here:

42 Do you consider the KIBS contribution in each phase of equal importance?*

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Please select from the following options:

- ○ Yes
- ○ No

43 In which phase(s) do you consider KIBS to be of more importance? *

Answer this question only if the following conditions are met:
°If 'Yes' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related)) *and* If 'No' to question '42' (Do you consider the KIBS contribution in each phase of equal importance?)

Select those that satisfy

- ☐ 1 Identification of new products
- ☐ 2 Prototype development
- ☐ 3 Final product development
- ☐ 4 Product testing
- ☐ 5 Product engineering
- ☐ 6 Marktet research
- ☐ 7 Marketing strategy

If in your opinion there is a phase not available, check the answer that best represents yur judgement. The order of the phases may vary by firm. There are multiple answers possible.

44 Upon reflecting on the project, do you have the idea that you were perfectly able to go through each phase? *

Answer this question only if the following conditions are met:
°If 'Partly, but terminated the relation' or 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related))

Please select from the following options:

- ○ Yes
- ○ Partly
- ○ No

45 Which phase(s) did you were less able to go through? *

Answer this question only if the following conditions are met:
°If 'Partly, but terminated the relation' or 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related)) *and* If 'Partly' or 'No' to question '44' (Upon reflecting on the project, do you have the idea that you were perfectly able to go through each phase?)

Select those that satisfy

- ☐ 1 Identification of new products
- ☐ 2 Prototype development
- ☐ 3 Final product development
- ☐ 4 Product testing
- ☐ 5 Product engineering
- ☐ 6 Marktet research
- ☐ 7 Marketing strategy

If in your opinion there is a phase not available, check the answer that best represents yur judgement. The order of the phases may vary by firm. There are multiple answers possible.

46 What was/were the reason(s) why you were less able to go through this/these phase(s)? *

Answer this question only if the following conditions are met:
°If 'Partly, but terminated the relation' or 'No' to question '14' (Did you use a Knowledge Intensive Business Service for the New Product Development? (Not for activities other than technical related)) *and* If 'Partly' or 'No' to question '44' (Upon reflecting on the project, do you have the idea that you were perfectly able to go through each phase?)

Enter your answer here:

F Ending

Thisis the end of the questionnaire. I gratefully thank you for your cooperation. If you like, you or the firm can receive the final report (thesis) of the research.

47 Do you want to receive the final report (thesis)? *

Please select from the following options:

- ○ Yes
- ○ No

48 Please fill in the email adress where you want to receive the final report. *

Answer this question only if the following conditions are met:
° If 'Yes' to question '47' (Do you want to receive the final report (thesis)?)

Enter your answer here: