Interdepartmental collaboration as a way to develop more sustainable product-service systems

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Abstract

A changing market, in which possession of goods is decreasingly guiding, has made way for solutions in which products and services are combined to varying degrees: Product-Service Systems (PSS). PSSs encompass sustainable alternatives for conventional products. Although much has been written about PSS in general, little is known about the organisational process that could induce PSS-development. In this thesis, the organisational process of interdepartmental collaboration is integrated with PSS development. Through a qualitative exploratory case study on five interdepartmental PSS-projects in an engineering firm, it is aimed to extend understanding on the main drivers and barriers for employees to get involved in such projects. 'Innovation' was reported as main driver, whereas the main barrier was 'a conflict due to billing'. The thesis proposes two frameworks: one for drivers for, and one for barriers to interdepartmental PSS development. In addition, the study provides suggestions on how strategies to interdepartmental collaboration could be used to foster drivers and/or overcome barriers to interdepartmental PSS development. The frameworks and strategies offer a broad perspective for future research on this topic and provide a basis for how engineering firms can make better use of in-house knowledge to stimulate PSS-development.

Key words: *Product-Service systems, interdepartmental collaboration, engineering firms, corporate sustainability, drivers to change, barriers to change, strategies to overcome barriers to change*

Preface

This is it, my Master thesis is finished. The time in University, which was characterised by inspiring lectures, trips, late nights and coffee, has come to an end.

This Master Thesis is part of the Master Sustainable Business and Innovation in the department of Geosciences at Utrecht University. The research performed for this thesis was conducted through an 8-month internship at Grontmij Netherlands BV, separated in two parts, from February 2015 till February 2016. The internship was set out by the company as a means to increase understanding on how they can make better use of existing knowledge in the company that could benefit developing new (combinations of) products and services.

Throughout the internship, there was an acquisition of Grontmij by the Swedish company Sweco, making Sweco the largest engineering firm in Europe. Grontmij will officially become Sweco in April 2016, and Sweco has announced that they want to increase efforts in collaboration and joint business opportunities. Thus, the situation of interdepartmental collaboration at Grontmij might change in the near future.

Acknowledgements

'*Four eyes see more than two'*, is a saying that touches upon the privileged situation I was in during my thesis. I was the lucky student who did not have one or two supervisors; instead five supervisors were concerned with my thesis. Therefore, I would like to express special gratitude to my University supervisors Rodrigo Lozano PhD and Ana Pocas Ribeiro MSc as well as my supervisors at Grontmij Wouter Truffino ing., Annemarijn Jelsma ir. and Rob van Hout ir. I would like to thank Rodrigo Lozano for his supervision throughout the entire period of writing this thesis. Not only has he provided professional guidance and analytical feedback, but also did he ask me just the right questions to ensure focus throughout my thesis. Ana Pocas Ribeiro, your critical insights and motivating speeches during the meetings have been very helpful for making it to the end. I am sure you will become an excellent scientist. I would like to thank Wouter Truffino, Annermarijn Jelsma en Rob van Hout for giving me the opportunity to do such an interesting internship at Grontmij. Because of you I was offered a challenging internship that was not only restricted to writing my thesis, but also enabled me to gain working experience in the field of engineering.

Also, thank you Simona Negro for critically reviewing my research proposal, which has ensured focus in the remainder of the process.

In addition, everyone who discussed the topic with me and/or allowed me to conduct an interview with them was of great value for finishing the thesis. Not only has this enabled me to learn much about the challenges with interdepartmental collaboration in an engineering firm like Grontmij, but also employees' personal motivations to help the company perform better were inspiring.

Finally, I would like to thank my family, friends and girlfriend for their loving support and always being there whenever needed.

List of abbreviations

CFT	Cross-functional team
CS	Corporate Sustainability
GUP	Grontmij Underground Pioneers
GT	Grounded Theory
PSS	Product-Service Systems
RTO	Recircle The Olympics
SQ	Status Quo
SQN	New Status Quo
UNEP	United Nations Environment Programme

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(Executive) Summary

Company question & research aim

Grontmij, a large engineering firm in the construction industry, initiated this research to gain insight in why there is so little interdepartmental collaboration within the firm. As a direct result, they sought to gain understanding on how such collaboration can be stimulated in order to develop more integral (combinations of) products and services to better serve a changing and saturating market. Hence, this thesis set out to learn from how and why people from different departments have collaborated in previous projects that resulted in product-service combinations; so called Product-Service Systems (PSS). Through these lessons, it was aimed to propose recommendations for how departments could foster positive practices and avoid/manage negative practices that could help future interdepartmental PSS development projects. There is limited academic literature that integrates interdepartmental collaboration and PSS development; thus, the research was of exploratory nature.

Scientific relevance

The trend of corporate sustainability and a market demand that is moving away from a focus on possession of goods have increased the development of PSS. As opposed to conventional product development, PSS often demand a wider range of knowledge (e.g. product development, energy efficiency, and data management) and therefore require expertise from different departments. Limited academic research has integrated the concepts of interdepartmental collaboration and PSS development; thus, the research was of exploratory nature.

Approach

Qualitative research on five interdepartmental PSS projects at Grontmij served as method to explore this topic. Within these projects, the drivers and barriers for employees to engage in these interdepartmental projects have been examined. In addition, existing strategies at the company that could induce interdepartmental PSS development have been evaluated on their potential to foster reported drivers and avoid/manage reported barriers. These topics have been explored by taking academic frameworks on drivers to change, barriers to change and strategies to overcome barriers to change as reference.

Main findings

Several internal and external drivers were found that ensured collaboration between different departments and/or served as stimuli to start the project. This means that employees were internally motivated to join the projects and recognised external incentives that advanced the projects. The most important internal driver was *innovation*, and implies that employees are more likely to join an interdepartmental PSS-project when the topic comprises something new/challenging. Important external drivers were *management support* to advance the project and the presence of a *competition*. The competition element increased employees' efforts to contribute to company profit by spending time on PSS-development.

A list of barriers to interdepartmental PSS development was obtained from the interviews. These were mainly present on group-level, however also barriers on individual and

organisational levels were observed. The main perceived barrier to interdepartmental PSS development was a *conflict due to billing*. This means that the organisational structure does not (yet) encourage interdepartmental PSS development. A reason is that such projects are unconventional and cannot directly show profit. As a consequence, the worked hours cannot be billed on a project-number.

Several existing strategies to foster interdepartmental collaboration at Grontmij were distinguished. The research showed that especially a wide variety of communication platforms or (in)formal groups could be better used to encourage interdepartmental PSS development. Hence, suggestions have been provided on how existing groups, or new group-forms including members from different departments, could be used to evaluate opportunities for PSS development.

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1. Introduction

Traditional transportation and mobility are increasingly considered to lead to social and environmental disadvantages regarding safety, traffic congestion, noise, land use, pollution, resource depletion and contribution to climate change (Freund, 2014; Kim et al., 2014; Sassi & Zambonelli, 2014). In addition, global population moves towards seven billion and standards of living around the world, including transportation, improve. As a consequence, engineering companies are forced to use the limited natural resources of the world to satisfy ever increasing human demands (Davidson et al., 2010). Discussions on alternatives have stressed the need to switch from selling physical products towards providing service solutions (Maussang et al., 2007). The need for sustainability measures and efforts to find innovative solutions have led to the emergence of new concepts, such as 'product-service systems' (e.g. Davidson et al., 2010; Grosse-Dunker & Hansen, 2011; Redding et al., 2014).

Ever since the introduction of the concept in 1999 by Goedkoop et al., discussions on product-service systems (PSS) increased and have led to more comprehensive definitions of PSS. Chapter 3.1 presents a more in depth discussion on these definitions, leaving this introduction with a simplified definition by Mont (2004); PSS emerged from the fact that consumers do not particularly demand products, but rather to seek the utility these products and services offer. Thus, in accordance with Mont (2004), the service provider remains owner of the product, which leads to producers finding new profit centres and extending involvement and responsibility for different phases in the product's life cycle. According to Maxwell and Van der Vorst (2003), a producer's and environmental benefit of PSS is that producers put maximum effort in increasing product lifetime, which results in fewer new production and/or maintenance costs. Thus, if products can be used longer, even though the material used for the product remains the same, the total environmental impact of consumption is reduced. UNEP (2002) summarised the benefits as win-win-win solutions.

The end result of a PSS regularly comprises a technological solution to better serve a changing market demand (Van Ostaeyen, 2014). Technological solutions, or technological innovations, often result from organisational processes and how they are arranged; e.g. by means of strategy and organisational structure (Davila et al., 2012; Hartmann, 2006; Keegan & Turner, 2002). Developing PSS could challenge this traditional organisational structure, as it is different from business as usual and requires contributions from employees with different expertise (i.e. knowledge on product development, service development and energy efficiency). Such integration of expertise could require increasing collaboration between different departments, which is difficult, typically in large engineering companies who are usually rigid and conservative (e.g. Blayse & Manley, 2004; Dubois & Gadde, 2002; Xue et al., 2014). However, a number of authors (e.g. Carnabuci & Operti, 2013; Dubois & Gadde, 2002; Hartmann, 2006; Tsai, 2001) have argued that one of the most important organisational processes to enhance technological innovation is interdepartmental[1] collaboration.

As just indicated, several studies have addressed interdepartmental collaboration in the context of technological innovation. Also, few researchers (such as Locket et al., 2011 & Lozano et al., 2014) have discussed the role of consumer-producer collaboration for PSS development. However, there has been limited research that integrated the concepts of interdepartmental collaboration and PSS development. This thesis has aimed to contribute to the academic community by examination of

[1] In literature the expressions 'department' and 'unit' are used interchangeably for referring to sections within a company (e.g. Majchrzak & Wang, 1996; Szulanski, 1996; Hansen, 1999). Due to consistency considerations, this thesis will only use the term 'department'.

several projects in which interdepartmental collaboration has led to new PSS development. In doing so, it is explored what has driven and what challenges occurred during these projects at an engineering firm. The study has been performed in the division[2] Transport & Mobility at Grontmij Netherlands BV, an engineering company in the construction sector. The division Transport & Mobility has acknowledged that parts of its market are somewhat saturated, which is why they have engaged in studies that explore opportunities for long-term success. Market saturation poses a problem for society as it is among engineering firm's core tasks to design the cities and societies of the future (Arcadis, 2016; Grontmij, 2016a). This, together with the overarching sustainability importance of limiting material use, comprises this study's societal relevance.

For Grontmij, the study is relevant as it builds on two previous Master theses at the company, one written by Endhoven (2014) and the other one by Singendonk (2015). Endhoven's (2014) study aimed at developing an innovation strategy for Grontmij. His results showed that more collaboration between Grontmij's departments is required in order for the company to remain innovative. Singendonk (2015) pointed out that Grontmij could have a better balance between exploration and exploitation, and hence better innovation, when more interdepartmental collaboration would be prevalent. Since both studies touched upon the topic of interdepartmental collaboration, this study aims to zoom into the matter.

2. Research objectives & Research questions

This section elaborates on how interdepartmental collaboration and the growing interest in PSS development form the basis of this thesis' main research objectives.

2.1 Research objectives

Collaboration between different disciplines (i.e. departments) within companies enhances product and/or service innovation, which in turn positively influences firm performance (Denison et al., 1996; Dougherty 1992; Lozano, 2008; Majchrzak et al., 2012). In addition, developing new PSSs could enhance firm performance because the innovation can increase sales and/or because a firm's image might increase since PSS is considered an approach to adhere with corporate sustainability (Grosse-Dunker & Hansen, 2011; Maxwell & Van der Vorst, 2003). According to Lozano (2008), only a few authors have discussed interdepartmental collaboration[3] in the context of CS; most literature that combines sustainability and companies has focused on individual or organisational context. Integrating the concepts of interdepartmental collaboration and the development of sustainable PSS is uncommon, and can therefore be classified as a 'gap' in scientific literature.

This thesis aimed to address this gap by exploring what can be learnt from previous sustainable innovations that were developed through collaboration between different departments, in order to gain insight in the process of developing new PSS. Within this gap, the focus lies on drivers that have fostered and barriers that were present in previous interdepartmental collaborations aimed at developing PSS. Another focus area is how these lessons can be of value for future collaboration between different departments. In order to structure this thesis, two guiding research objectives were formulated:

[2] Grontmij has several divisions. These divisions consist of various departments, which are composed by a number of units (See Appendix A).

[3] Lozano (2013) did not use the term 'interdepartmental collaboration', rather he argued that only a few authors have discussed 'group collaboration' in the context of CS. In earlier work (Lozano, 2008), the same author debated that 'group' is a broad term that could suit the function of categorising various clusters, i.e. departments.

- *1) To learn from how different departments within an engineering company in the construction sector have collaborated in previous projects for product-service system development; and*

- *2) To propose recommendations for how departments could foster positive practices and avoid/manage negative practices of interdepartmental collaboration in the context of devising integrated approaches when developing new product-service systems.*

2.2 Research questions

The following research question was directive in achieving the main objectives:

> *How can lessons learnt from previous interdepartmental collaboration projects on product-service system development be used to foster practices that went well and avoid or manage practices that did not?*

In order to answer the research question, the following assisting sub-questions are formulated:

- What degree of joint endeavour can be observed in interdepartmental PSS projects?
- What drives collaboration between departments in order to contribute to the development of PSS?
- What challenges collaboration between different departments in the development of PSS?
- What approaches and strategies exist that could help stimulate interdepartmental collaboration to induce PSS development?
- How could other companies learn from this study's findings?

Structure of the thesis

This thesis consists of eight chapters and eight appendices. The first chapter comprises an introduction to the thesis topic and the relevance of the thesis (Chapter 1). The next chapter presents the research objectives, research question and sub-questions (Chapter 2). Third, the theoretical body of the thesis is discussed in a literature review (Chapter 3). The subsequent chapter deliberates upon the used research methods (Chapter 4). This chapter ensures transparency and serves as a manual to replicate the study. Following, the study's findings are systematically presented (Chapter 5). These findings are discussed in the succeeding chapter (Chapter 6). This discussion compares the findings to the body of literature. In this chapter, the first four sub-questions are answered. The final chapter encompasses the conclusions, broader implications for science and practice (thereby answering the final sub-question) and recommendations for future research (Chapter 7). In the conclusion section the research question is answered. The final chapter, references, includes a list of all articles, books, and other sources used within the research (Chapter 8).

3. Literature review

As indicated in the introduction, PSS development is a form of CS that is becoming increasingly important for firms in the construction sector (i.e. Maussang et al., 2007; Redding et al., 2014). Hence, within this literature review the concept 'PSS' is introduced and briefly discussed (section 3.1). PSS development might be stimulated through interdepartmental collaboration[4] (e.g. Denison et al., 1996; Majchrzak et al., 2012). Collaboration as a term is often confused with communication, coordination and cooperation (Lozano, 2007), which is why the term is discussed in this literature review (section 3.2). As briefly mentioned in the introduction, interdepartmental collaboration is a work form that is often new to large firms in the construction sector (i.e. Dubois & Gadde, 2002; Xue et al., 2014). Consequently, embedding interdepartmental collaboration practices in an organisation requires organisational change. This is discussed in section 3.2.1. Drivers to change stimulate organisational change (Lozano, 2013); hence, the literature review presents an overview of potential drivers to change (section 3.3.1). Barriers to change obstruct organisational change, however these barriers could be avoided or managed by strategies to overcome barriers to change (Lozano, 2009). Therefore, reviews of potential barriers (section 3.3.2) and strategies to overcome these barriers to change (section 3.3.3) are provided. Together, the different sections in the literature review provide a theoretical basis for the most important concepts in this thesis. In addition, the overview of drivers, barriers and strategies to overcome barriers to change provides a basis for researching these three important factors in the context of interdepartmental collaboration for PSS development.

3.1 An introduction to Product-Service Systems

CS includes circular solutions (take, make, use, re-use or recycle) (Amini & Bienstock, 2014). Circular solutions can be fostered through PSS as such solutions provide the service the customer demands, without necessarily transmitting the ownership of the product (Mont, 2004). PSS offer a way for engineering firms to integrate products and services into one system, and enables to continue making profit in a market saturated by products (Artto et al., 2008).

Goedkoop et al. (1999) provided the first definition of PSS and explained that PSS are marketable sets of products and services that are capable of jointly fulfilling users' needs. Those authors highlighted that the product-service degree of a PSS can vary from case to case but also over time. This can be due to economic optimisation, technological development and/or changing needs of people.

Ever since Goedkoop et al. (1999), many definitions of PSS have been proposed that emphasised the potential of PSS or added some other elements (i.e. Mont, 2004; Steinberger et al., 2009; Tukker & Tichner, 2006). Tukker and Tichner (2006), for instance, argued that

[4] These authors did not explicitly state that interdepartmental collaboration could enhance PSS development. Rather, they had found that interdepartmental collaboration could stimulate product and/or service innovation.

PSS are a win-win-win scenario as it increases sustainable development, industrial competitiveness and customer satisfaction.

Mont (2004) defined PSS by emphasising that consumers do not particularly demand products, but rather seek the utility these products and services offer. Thus, the service provider (i.e. an engineering firm) remains owner of the product, which leads to producers extending involvement and responsibility for different phases in the product's life cycle. A benefit is that producers put maximum effort in increasing product lifetime, which results in fewer new production and/or maintenance costs. In doing so, the total environmental impact of consumption is reduced.

Mont (2004) further explained PSS through five key elements that address a product's use-phase: (1) product/service combinations/substitutions; (2) services at the point of sale; (3) different concepts of product use (subdivided into use oriented and result oriented); (4) maintenance services; and (5) revalorization services. Element 2 does not have clear interfaces with collaboration and is therefore less relevant for the current thesis. On the other hand, elements 1, 3, 4 and 5 do seem related. The first element -product-service combinations- addresses how new PSS aim at providing a service but can consist of something material. This element highlights the importance of knowledge on material as well as service provision, which could be attained through interdepartmental collaboration. The third element can benefit from interdepartmental collaboration as different experts could be clustered in order to develop either a specific use-oriented (i.e. the possibility of renting a car) or result-oriented (i.e. providing the possibility to buy a service: taxi ride) PSS. The fourth element comprises maintaining and upgrading PSS in order to prolong the PSS' lifetime. Learning and best practices from different experts could be adopted to ensure prevention of making the same mistakes. The last element, revalorization, aims at closing the material cycle. Whenever parts of a PSS break and cannot be re-used for their former purpose, these parts are re-collected by the company and used in other products or PSS. Collaboration can enable to envision complementarities of materials and services between different departments.

This introduction to PSS suggests that the development of new PSS requires input from experts on product development as well as service development. In engineering firms these capabilities do not necessarily exist within each department. Hence, improving collaboration between different departments could stimulate the development of new sustainable PSS.

3.2 Defining the term 'collaboration'

As the previous section indicated that interdepartmental collaboration could be important for PSS development, it is key to define what the concept of collaboration contains. According to Lozano (2007), some authors use the expression 'collaboration' without specifying its meaning while others use it interchangeably with coordination, communication and cooperation. Following Denise (1999), Lozano (2007) defined collaboration as '*using information, divergent insights and spontaneity to solve problems and develop new understandings or new products. It thrives on differences coming from sparks of dissent.'*

Denise (1999) moreover argued that the four terms (communication, coordination, cooperation and collaboration) should not be used interchangeably, as each term has a different meaning and requires different levels of involvement.

As opposed to Lozano (2007), Camarinha-Matos et al. (2006) classified the lowest level of involvement as 'networking', leaving a distinction between networking, coordination, cooperation and collaboration. Both Lozano (2007) and Camarinha-Matos et al. (2006) argued that collaboration is the most advanced stage with the highest level of involvement. Yet, higher levels of involvement do not necessarily lead to better results than lower levels (Denise, 1999). This is in line with Hansen (2013), who reasoned that collaboration is not a goal by itself; rather, collaboration should be pursued when it expectedly leads to better results. Denise (1999) and Hansen (2013) therefore appeared to agree that specific situations require different forms of joint endeavour. For example: if different people work together but all from different countries, the process of collaboration, which includes lots of face-to-face time and co-creation, would be very difficult to arrange (Hansen, 2013). In that case, cooperation, in which one party takes the lead and divides tasks among the other parties, may prove more efficient. Although there is discussion on whether collaboration always leads to the best results, it does contain a higher level of involvement than communication, coordination and cooperation. Figure 1 combines the studies by Denise (1999), Camarinha-Matos et al. (2006) and Lozano (2007)[5] into one model showing the difference between the four terms.

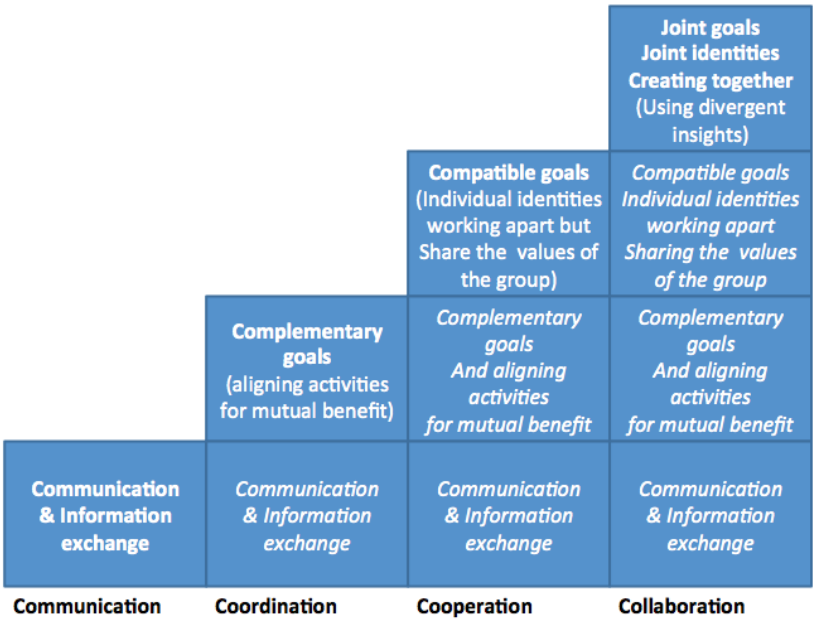

Figure 1: Differences between communication, coordination, cooperation and collaboration

Source: Adapted from Denise (1999); Camarinha-Matos et al. (2006); and, Lozano (2007)

[5] Lozano (2007) discussed the terms communication, coordination, cooperation and collaboration by means of Chilosi (2002), Denise (1999) and Oldero (2002). However, the publication by Chilosi (2002) has not been found online, which means that a reference is made to Lozano (2007) even if Chilosi (2002) might have been responsible for Lozano's input.

Communication is explained as exchanging information for mutual benefit (Denise, 1999). This knowledge can for example be shared by means of an online knowledge-sharing platform. Everyone could benefit from this information, but there is no common goal or structure that influences the timing or form of individual contributions (Camarinha-Matos et al., 2006). Coordination should be interpreted as having complementary goals: different goals per actor, yet one's goals could add to another's goals. It involves aligning activities for more efficient results (Lozano, 2007). An example could be when certain entities mutually time their lobby activities in order to generate the largest impact (Camarinha-Matos et al., 2006). In the case of cooperation, goals are compatible, not so different from each other and can be united with the other player's goals without any form of conflict (Denise, 1999). Absence of conflict serves as a stronger incentive to work together. The common plan is in most cases not defined jointly but rather designed by a single entity (Camarinha-Matos et al., 2006). Oldero (2002) stressed that cooperation breaks when one player, or several players involved, perceive that there is nothing to be gained for them. In contrary, collaboration does not stop when a single involved player feels that there is no more gain for him. Sharing of information, resources, risks and responsibilities will remain in order to jointly plan, implement and evaluate activities to achieve current or future goals (Camarinha-Matos et al., 2006). The added value of collaboration lies in benefits from differences in knowledge, perspectives and approaches; unlike cooperation, collaboration thrives on differences (Denise, 1999). Gulati et al. (2012) concurred with the former by arguing that cooperation and coordination are core components of collaboration. Thus, by using divergent insights and spontaneity, collaboration is different from coordination and cooperation (Camarinha-Matos et al., 2006).

As presented in the given definitions and shown in Figure 1, each of the four concepts comprise a "building block" for the next phase of involvement. Coordination includes communication; cooperation includes coordination; and, collaboration includes cooperation. Throughout the journey from communication to collaboration, an increasing amount of common goals, commitment, and shared resources is observed (Camarinha-Matos et al., 2006).

3.2.1 Interdepartmental collaboration in large companies

Collaboration showed to be an advanced form of joint endeavour that could induce the development of new products, services, or PSS. Especially for firms with a broad knowledge base, efforts that stimulate better combining employees' knowledge and skills can lead to improved use of existing assets, more innovation (such as PSS), competitive advantages and overall better performance (e.g. Camarinha-Matos et al., 2007; De Waal, 2007; Griffiths & Petrick, 2001; Hansen, 1999; 2013). However, such skills and knowledge sharing, not to mention collaboration, is often impeded in large, multi-unit companies (Kotter, 2012); typically, in large engineering companies who tend to be rigid and conservative (Blayse & Manley, 2004; Dubois & Gadde, 2002; Shaw, 2010; Xue et al., 2014). These large engineering companies are characterised by having traditional hierarchic structures, whereby different departments work in silos (Kotter, 2012). Such silos have the disadvantage that

knowledge appears to be 'sticky' and therefore difficult to distribute to other departments (Shaw & Dobrev, 2014; Szulanski, 1996).

A few discussed methods to decrease the silo-mentality and rigidness of large companies are, amongst others, a second operating system (Kotter, 2012), communities of practice (Brown & Duguid, 1991; Wenger, 2011) and cross-functional teams (Dougherty, 1992; Denison et al., 1996; Majchrzak et al., 2012). Kotter's (2012) second operating system is a system that keeps the organisational hierarchic structure but at the same time adopts a sort of collaborative innovation network from employees throughout the entire organisation. This 'network' can then for example be responsible for evaluating PSS opportunities and involving the right people/departments. Communities of Practice (CoP), as discussed by Brown and Duguid (1991) and Wenger (2011), encompass a team of employees from different departments. These employees try to solve common problems by sharing explicit and tacit knowledge that can be transformed into concrete innovations, such as PSS. Cross-Functional Teams (CFTs) consist of members from different groups in an organisation that share their knowledge and skills in order to cogenerate solutions and respond to market trends (Dougherty, 1992; Denison et al., 1996; Majchrzak et al., 2012), shifting power relationships with each new task (Aime et al., 2014). The difference between CFTs on one side and CoP or a second operating system on the other side is that CFTs have strict requirements for who is allowed in the CFT. Boundaries are set on disciplines and functions of individuals that will be part of the group. CoP and a second operating system are characterised by more fluid boundaries and are based on the assumption that individuals who have a shared passion will join forces, independent on their background. Such a passion could be the market opportunity for developing a specific PSS.

The common factor between the three discussed alternatives is that they all make use of knowledge/skills from different departments. Besides, it has been argued that these different alternatives to decrease the silo-mentality in large organisations could induce new PSS development. Yet, adopting either one of these alternatives implies a change of the organisational structure. A way of describing such a change has been proposed by Lozano (2013); a change from the status quo (SQ) towards a new status quo (SQN).

A means to get insight in how to reach this SQN is to examine previously conducted attempts towards a SQN. Within this context, important aspects are drivers to change, barriers to change and strategies to overcome the barriers to change (Lozano, 2013). Drivers to change are conditions that accelerate this change; i.e. the opportunity to develop new products and services (Camarinha-Matos et al., 2007; Tsai, 2001). On the other hand, new collaboration practices can prove difficult. It has been a common phenomenon that any change effort of the status quo faces resistance (Gill, 2002; Kotter & Schlesinger, 1979). Barriers to change are conditions that create this resistance; i.e. an unsuccessful previous attempt to reach a SQN decreases faith in future success (Lozano, 2013). In order to successfully adopt new interdepartmental collaboration practices, barriers to change should be identified and a strategy to overcome or avoid those barriers to change should be developed (Baker et al., 2010; Hansen, 2013; Lozano, 2013). The path from status quo (which is represented in this research by a traditional hierarchic way of working) to a new status quo (in this research it

would mean more interdepartmental collaboration to enhance PSS development) is summarised in figure 2. The figure was adopted from Lozano (2013), who originally designed the figure to present the path from an unsustainable SQ towards a more sustainability-oriented state that encompasses the SQN. To fit the topic of this thesis, interdepartmental collaboration for PSS development, the figure was adjusted. Kotter (2012) used a figure to represent the traditional hierarchic system, which is characterised by the term 'manage' (see the figure included in figure 2's left circle). In addition, Kotter (2012) used a more dynamic figure to represent a second operating system, characterised by the terms 'do, create, innovate and change' (see the most right figure in the circle on the right of figure 2). In figure 2, Kotter's (2012) representations have been used to visualise an organisational change to induce interdepartmental collaboration: from a traditional hierarchic system towards a system that includes either an additional second operation system (see Kotter, 2012), communities of practice (see Brown & Duguid, 1991; Wenger, 2011) or cross-functional teams (see Dougherty, 1992; Denison et al., 1996; Majchrzak et al., 2012) alongside a traditional hierarchic system.

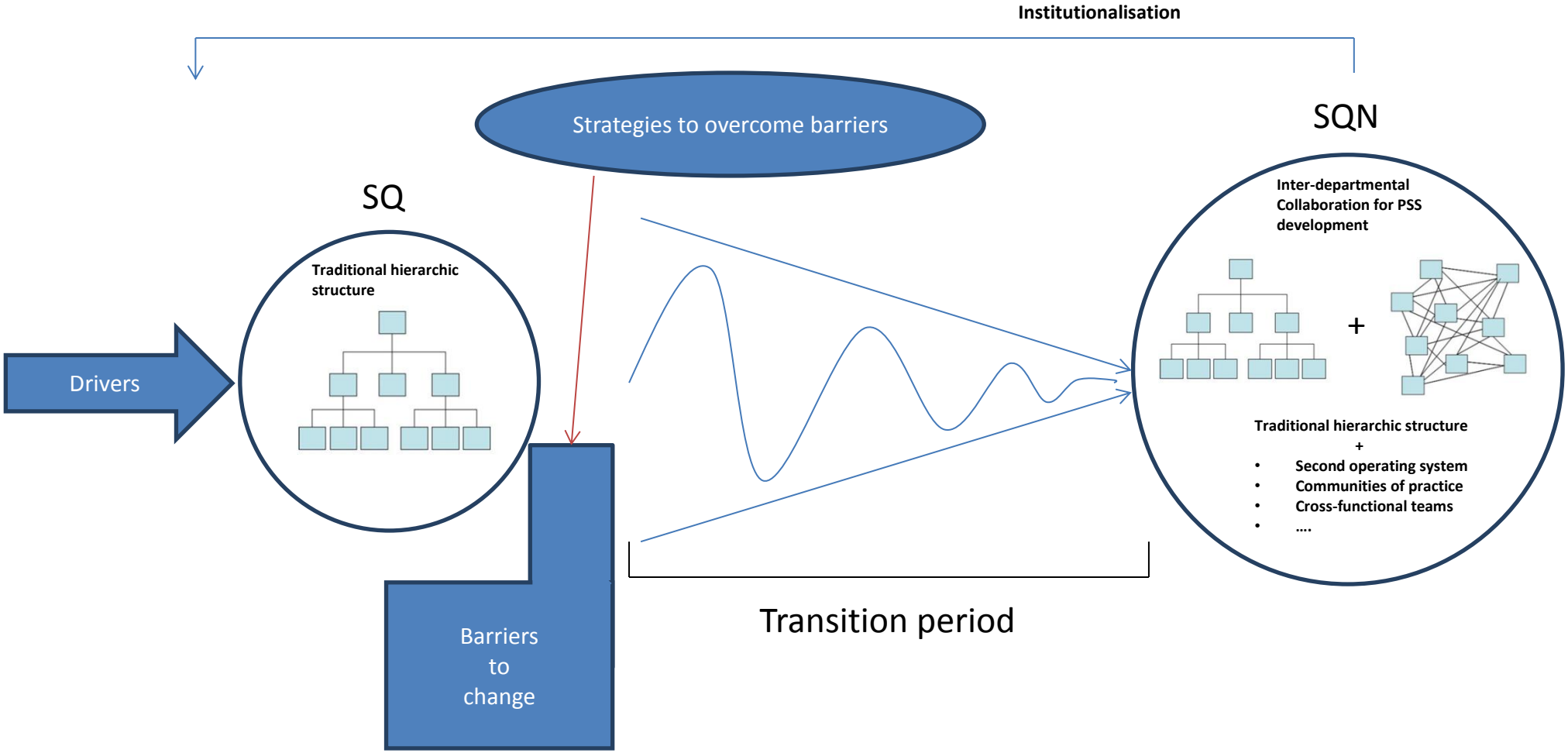

Figure 2: Organisational changes, moving from the Status Quo (SQ) to the New Status Quo (SQN)
Source: Adjusted from Lozano (2013) and complemented with Kotter (2012), Wenger (2011) and Majchrzak et al. (2012)

3.3 Towards interdepartmental collaboration for PSS development: Drivers for change, barriers to change & strategies to overcome barriers to change

In order to reach a SQN in which interdepartmental collaboration is included, it is key to learn from current work situations and adapt this learning to new situations (Daudelin, 1996). Hansen (2013) used three steps to discuss the lessons learnt from previous collaborations. Step one and two comprise opportunities for collaboration and barriers towards new collaboration respectively. According to him, the barriers could be solved by step three: tailored collaboration solutions. All of Hansen's (2013) steps are comparable with the terms discussed in the previous section that Lozano (2013) used to describe a change process from SQ to SQN: identifying opportunities versus drivers to change; barriers versus barriers to change; and, tailored solutions versus strategies to overcome barriers to change. The process of learning from previous positive and negative practices with interdepartmental collaboration for PSS development in a company, is in this thesis discussed by the terms that Lozano (2013) used:

1. Foster drivers to change;
2. Identify barriers to change; and
3. Propose strategies to overcome barriers to change

It must be noted limited research has discussed specific drivers, barriers or strategies to overcome barriers to interdepartmental PSS development. For this reason, literature has been collected that focused on different but potentially analogous situations. The articles were selected from seven study areas[6], and include literature on *Organisational change*; *Intra-organisational collaboration*; *Interdepartmental collaboration; Collaboration for sustainability*; *Corporate Sustainability*; *Innovation*; and, the *Construction industry*. These study areas all seemed relevant for this thesis, as they encompass (a combination of) changes in a company's organisational structure, collaboration processes, sustainability, innovative practices or the construction sector. Thus, all of these themes have interface with the topic of this thesis: organisational changes to encourage interdepartmental collaboration in order to develop new sustainable PSS. The wide spectrum of studies was collected to ensure a broad overview of drivers, barriers and strategies that could potentially be applicable to interdepartmental PSS development.

Although a variety of study areas have been consulted, the most comprehensive frameworks on drivers, barriers and strategies to overcome barriers to change have been found in literature on Corporate Sustainability (see Lozano, 2009; 2013). Hence, taking corporate sustainability frameworks as a basis, the next sections discuss, in respective order, drivers to change (3.3.1), barriers to change (3.3.2), and strategies to overcome these barriers or avoid/manage the same problems (3.3.3). These frameworks are complemented with additional drivers, barriers and strategies to overcome the barriers to change, as derived from the other literature clusters.

[6] An overview of which articles have been consulted per study area is provided in Appendix B.

3.3.1 Drivers for change

A driver for change can be internal, external or interconnecting (Lozano, 2009). Internal drivers are personal motivations that lead to a proactive approach to induce change (DeSimone & Popoff, 2000). Song et al., (1997) debated that, in the case of cross-functional cooperation, internal drivers have stronger impacts than external forces. This confers with DeSimone & Popoff (2000), who found that moving towards sustainability is less likely when only external drivers are present.

Some examples of internal drivers to change are: the presence of a *business case* (Garcia et al., 2008; Lozano, 2013), pro-active *leadership* (Denise, 1999; Lozano, 2013), Improve performance and generate more *profits and growth* (i.e. Lozano, 2013; Stacey, 2007), help increase employee *productivity and* product *quality* (i.e. Camarinha-Matos et al., 2007, Hansen, 2013), and opportunities for *innovation*; Innovation can be a personal motivation for employees to change towards a new situation because it could enhance company competitiveness (i.e. Hansen, 2002; Love & Roper, 2009; Zhou & Li, 2012) or the opportunity to develop new products, processes and services appeals to employees (e.g. Carnabuci & Operti, 2013; Cuijpers et al., 2011).

External drivers result in reactive measures as they are induced by external pressure (DeSimone & Popoff, 2000). Some examples are: *competitors benchmarking* (Lozano, 2013), *political lobbies* and *government regulations* (Lozano, 2013), and, *Market and customer expectations*; market demand is changing and organisations will have to adapt (Camarinha-Matos et al., 2007; Kotter, 2012; Lozano, 2013).

Interconnecting drivers are drivers to change that link the internal and external drivers (Lozano, 2009). Examples include enhancements in *corporate image* (Lozano, 2013), improving access to *markets and customers* (i.e. Camarinha-Matos et al., 2007; Fadeeva, 2004), and *stakeholder expectations* (Lozano, 2013); if a stakeholder expects the company to change (external driver), this could lead to an intrinsic motivation (internal driver) for the company to make this change happen (Lozano, 2013).

Lozano (2009) proposed a framework including the most important internal, external and connecting drivers for CS. In a follow-up study (see Lozano, 2013), the author complemented the framework with a few more drivers to CS, leading to figure 3. The figure was designed to pull together and illustrate a range of internal, external and connecting drivers obtained from different literature sources and empirical research. As can be observed, approximately the same number of internal and external drivers is presented. Following from figure 3, it is discussed how data from other literature sources could complement Lozano's (2009) driver-model.

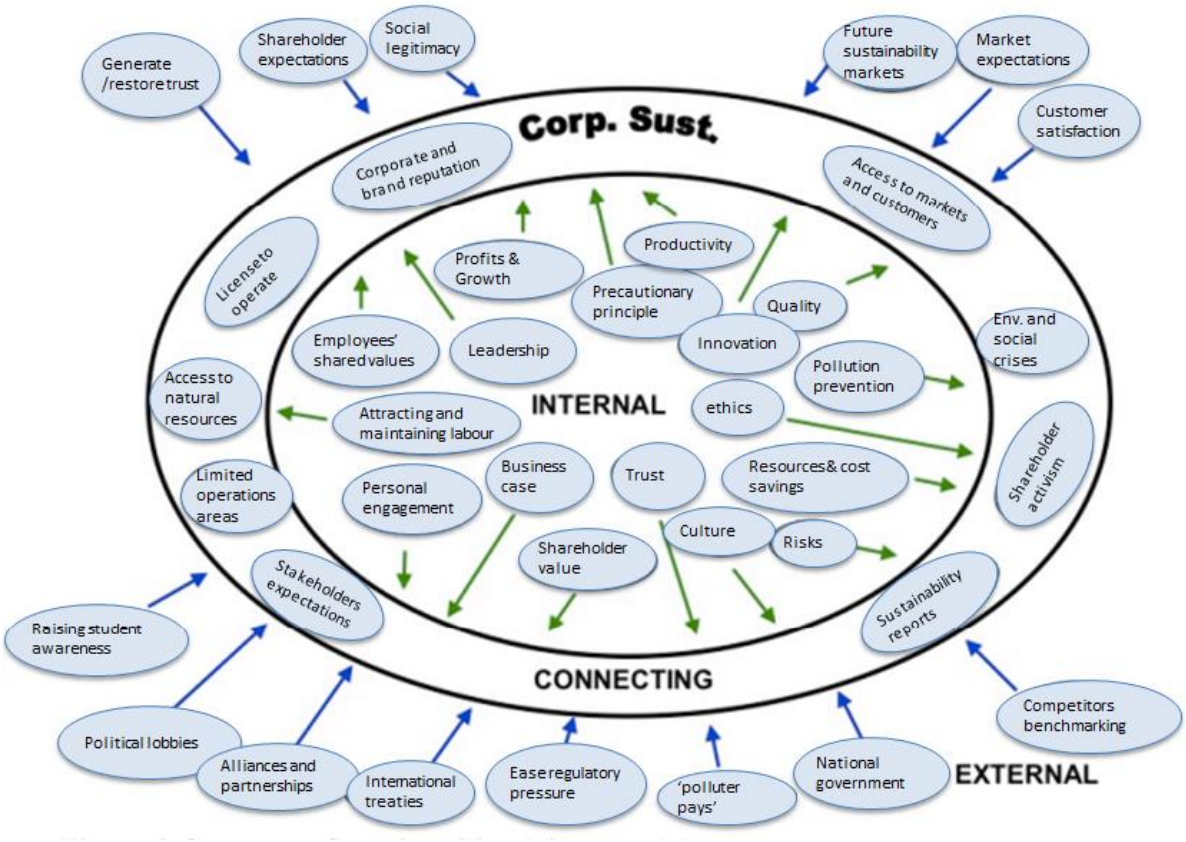

Figure 3: Corporate Sustainability driver model
Source: Redrawn from Lozano (2013)

Lozano's (2013) driver framework is designed for change to CS, which has interfaces with but is different from this thesis' topic of interdepartmental collaboration for PSS development. Hence, the framework serves as a broad basis for possible drivers to interdepartmental PSS development, but the thesis is not restricted to this framework.

Other studies (i.e. Carnabuci & Operti, 2013; Cuijpers et al. 2011; Hansen, 2013; Zhou & Li, 2012) also found drivers that are presented in Lozano's (2013) framework, but explained them in different contexts (e.g. collaboration; PSS development). Even though these drivers to change may not be complementary to the proposed framework, the explanation is complementary, which makes the reconfirmation of these drivers valuable for this thesis. A few examples include *benefit to employees*, *profits & growth*, and *markets & customers*. Lozano (2013) distinguished all of these drivers to change in the context of CS. However, Camarinha-Matos et al. (2007) and Tsai (2001) explained the driver *benefit to employees* as a possible driver for collaboration because employees want to learn from other departments in order to develop themselves. *Profits & Growth* has been explained as the market opportunity that PSS development provides for supplying a total offer (Goedkoop et al., 1999), increasing opportunities for cross-selling (Hansen, 2013) and that collaboration can lead to a shifting focus from short-term profit to long-term profit (Camarinha-Matos et al., 2007). The driver *markets & customers* was clarified as a driver for interdepartmental collaboration because

such collaboration enables more customer information to be processed, which makes it more likely that an innovation actually meets customer needs (Cuijpers et al., 2011).

These and other reconfirmed drivers to change that were backed up by explanations that seem to be fitting the topic 'interdepartmental collaboration for PSS development' have been included in Appendix D.

In addition, Lozano's (2013) framework can be complemented with a number of internal and external drivers to change, obtained from literature in different study fields than CS (i.e. innovation science and collaboration literature). Many of those drivers did not seem very applicable to the purpose of this study and are therefore excluded from this literature review (i.e. innovations from suppliers; stimulation of research). However, these drivers should not be ignored, because of which a list of approximately 60 drivers to change that are different from Lozano's (2013) framework have been included in Appendix C. A few additional drivers to change have been found that were specific to the context of (interdepartmental) collaboration, these are:

Internal:
Absorptive capacity; if a department is highly related to other departments, it will be relatively easy to gain new knowledge. This can be a driver to get involved with other departments (Tsai, 2001)*;*
A *history* of good experience with collaboration projects might drive future collaborations (Guimera et al., 2005); and,
A department's *network position* could drive the inclusion of a department in a project because that department is central in a particular network (Tsai, 2001).

External:
Sharing of *external best practices,* for example CFTs and CoPs in other organisations (Denison et al. (1996); Dougherty, 1992; Majchrzak et al., 2012);
Leadership through management support that stimulates change efforts (i.e. Denise, 1999; Keegan & Turner, 2002; Song et al., 1997);
Subsidies for innovative applications and materials (Bossink, 2004) and,
Rewarding employees for efforts concerning cross-functional cooperation (Song et al., 1997).

It should be noted that *leadership* is presented as addition to Lozano's (2013) framework because it is considered to be an internal driver in Lozano (2013) but has been explained as external driver in other studies (i.e. Denise, 1999; Keegan & Turner, 2002). Leadership can function as internal driver when it is used to stimulate change from a strategic level; i.e. by developing and communicating a corporate vision (Denise, 1999; Lozano, 2013). However, leadership is an external driver when it is interpreted as management support (Denise, 1999; Keegan & Turner, 2002). Management support implies that the management approves certain actions for change. In the case of this thesis, this could be the action of pursuing interdepartmental collaboration for PSS development. Management could induce those actions from top-down. Yet, individuals or groups in an organisation could also pursue the

new situation from bottom-up (they are internally driven), but the efforts might be hindered because of regulations or financial concerns (Thomson & Perry, 2006). At this point, the external driver 'management support' can ascertain regulative approval and/or finance to continue the change efforts.

3.3.2 Barriers to change

Fostering drivers to change could accelerate change, however, barriers to change sometimes obstruct the process towards a new situation (Lozano, 2009). These barriers can particularly be hindering if organisational change efforts threaten the status quo (Gill, 2002; Kotter & Schlesinger, 1979); i.e. (within the context of this study) moving from working within one department towards more interdepartmental collaboration. However, Dent and Galloway Goldberg (1999) argued that organisational change is not something that people or organisations automatically resist. Instead, they fear the unknown and believe the new situation goes along with a loss of pay, status or comfort. Within this section it is reviewed what barriers to change have been identified in literature. In order to create an as broad as possible basis for potential barriers to interdepartmental PSS development, an extensive framework on barriers to CS oriented change has been adopted from Lozano (2009)[7]. This framework is represented in Tables 19, 20, and 21 in Appendix C, and discussed later in this section. CS oriented change is related to the topic of interdepartmental PSS development, but so are other study areas. Hence, other studies have been consulted that describe barriers to change which has resulted in additional barriers to the reference framework. Following from Lozano's (2009) framework, these additional barriers are discussed.

Lozano (2009) categorised barriers to change on three different levels: individual, group and organisational. In his study, Lozano (2009) derived the barriers from a variety of literature sources in different study fields and complemented this with empirical data on change towards Corporate Sustainability.

Following Maurer (1996), Lozano (2009) categorised individual barriers to change in three levels:

Level 1. Resistance to idea itself: Produced when the individuals question, disagree, or oppose the idea. It includes issues such as *lack of information, dislike of the idea, surprise, lack of training,* and *lack of perceived relevance*;

Level 2. Resistance involving deeper issues: Produced by feelings of loss of control or power, status or respect. It includes *feelings of incompetence, of being deserted, of high levels of pressure and stress,* and *that change is too difficult*; and

Level 3. **Deeply embedded resistance:** This level contains the most entrenched form of resistance. It includes barriers to change that have to do with factors such as *cultural differences, race, religion and sex.*

[7] Lozano (2009) also distinguished between informational, emotional and behavioural barriers to change. This distinction has been left out of the tables presented in this thesis.

Lozano (2009) complemented Maurer's (1996) three levels with two aspects: **Aspect 1. Procrastination:** The individual considers the change to be too complicated; therefore he/she finds ways to delay the change. It includes barriers to change such as *inherent laziness* and *a lack of time*; and

Aspect 2. Power struggles: The struggle for power between people with opposing views. This often consumes abilities, energy and time that otherwise could be used to accelerate the change. '*Power struggles'* is the only barrier to change that Lozano (2009) categorised in this aspect.

Appendix C (Table 19) presents a comprehensive list of individual barriers to change, categorised in Maurer's (1996) three levels and Lozano's (2009) aspects. This list was adopted from Lozano (2009). The table shows many level 1 and 2 barriers to change, which can be more easily managed than the deeply embedded barriers (level 3).

As for group-level barriers to change, Lozano's (2009) overview only included a relative small number of barriers. This is simply because not much literature has explored group-barriers to change for sustainability. Due to the relative small number of barriers, no sub-categorisation has been made. Examples of barriers on group-level are the *group culture* that inhibits change towards CS (in the case of Lozano, 2009) and *keeping feuds* that hinder change. A list of group barriers to change is also presented in Appendix C (Table 20).

Organisational barriers to change can be sub-categorised. Lozano (2009) used the following sub-categorisation for organisational barriers to change in his framework on barriers to CS oriented change:

Managerial: Related to managerial issues, such as leadership, departmentalism, strategy, planning, and empowerment. It includes issues such as *short-term focus on economic aspects*, *lack of top management commitment/leadership*, *faith on market solutions*, and *lack of systems thinking*.

Organisational: Related to how the organisation is structured and aligned. It includes barriers to change that have to do with factors such as *failing to alter cultural trades*, *lack of trans-disciplinarity*, *lack of holistic focus in operations*, *organisational structures inhibiting collaboration*, and *lack of alignment in the organisation*.

Supportive: Barriers to change related to the support given or lacking to the employees. It includes concerns such as a *lack of systems, tools and instruments to operationalisation and implementation*, *lack of organisational knowledge and skills*, a *lack of resources* and a lack of *financial and managerial support*.

Historical: Related to the evolution of the organisation or the changes attempted within. It includes issues such as *unsuccessful incorporation attempts*, *operative profile of the company*, and *too many failed changes* that obstruct the willingness for new changes; and

External: Barriers to change that come from outside the organisation, where control is limited. These include *competitors' strength* and the *timing for change*, which is *related to external events* that are not controlled by the company.

The categorised organisational barriers to change are also presented in Appendix C (Table 21). Most of the barriers to CS oriented change are of managerial-level. Some barriers to change were considered on multiple levels by Lozano (2009). For example, a *lack of communication* is categorised in the groups Managerial and Supportive.

It should be noted that in the previous section on drivers to change, the importance of *leadership and management support* was highlighted. Hence it is no surprise that Lozano (2009) found the barrier to change a *lack of leadership/management commitment.* The same argument is valid for the barriers to change: *history* of unsuccessful incorporation attempts, *linear thinking* and a *lack of confidence in the concept/business case.* These three barriers to change are the opposites of the drivers: a *history* of positive experiences concerning interdepartmental collaboration (Guimera et al., 2005), the *ideology* and believe in systems thinking (Lozano, 2013; Senge, 1999), and *profits & growth* in which the presence of a strong business case is a key argument (Lozano, 2013).

Lozano's (2009) lists of barriers to change are extensive (see Appendix C). As a consequence, other studies in non CS-related context (i.e. Hartmann, 2006; Kotter & Cohen, 2012) proposed certain similar barriers to change (e.g. *conflicts*; *extra workload*; *insular thinking*; and, *lack of leadership*). For instance, the barrier to change *conflicts* was explained by Lozano (2009) as having incompatible and conflicting needs. However, Cuijpers et al. (2011) explained that conflicts could arise because of differences between departments. Other reasons for the barrier to appear are conflicting responsibilities; misalignment between interdepartmental responsibilities and responsibilities at the own department (Thomson & Perry, 2006). Appendix D provides an overview of barriers to change that were mentioned in Lozano (2009) and backed up by other studies with explanations that appear to be more suitable for the context 'interdepartmental collaboration for PSS development'.

In addition, Lozano's (2009) framework can be complemented with a number of barriers to change, obtained from literature in different study fields than CS (i.e. innovation science and collaboration literature). Many of those barriers did not seem very applicable to the purpose of this study and are therefore excluded from this literature review (i.e. regulation and legislation). However, these barriers should not be ignored and are thus listed in Appendix C.

Yet, a few additional barriers to change have been found that were more specific to the context of (interdepartmental) collaboration. These are presented in Table 1. The most mentioned ones were *Extra costs and/or time* due to project delays that are caused by extra preparation time, different backgrounds of employees or 'wasted' time for mobilising information from other departments (i.e. Hartmann, 2006; Mishra and Shah, 2009); *Institutionalised organisational memory*, which means that change is complicated because people are used to business as usual (Dent & Galloway Goldberg, 1999; Schilling & Kluge, 2009); and a *Language/culture barrier* that is caused by slow information processing between

departments since departments adhere to different operating principles (i.e. Cuijpers et al., 2011; Song et al., 1997);

The barriers to change that are complementary to Lozano's (2009) framework have also been categorised in individual, group or organisational level (Table 1). This categorisation has either been made by one of the authors that discussed the barrier or it has been categorised by the author of this thesis, based on the explanation of the barriers to change. In addition, some barriers consist of diverse explanations from different sources. These explanations can make sense to different organisational levels, which is why *extra costs and/or time* has been appointed to group and organisational level.

Table 1: Potential barriers that can hinder interdepartmental PSS development

Barrier	Explanation	Source
Individual		
Institutionalised organisational memory	Change of the status quo is difficult. People are used to business as usual. Working in own silos/departments.	Dent & Galloway Goldberg (1999); Schilling & Kluge (2009)
Status	Low status of innovator makes that people do not listen	Schilling & Kluge (2009)
Transfer barrier	People are not able to work with people they do not know well	Hansen (2013)
Group		
Extra costs and/or time	'Wasted' time for mobilising information from other departments	Cuijpers et al. (2011); Hartmann (2006); Keegan & Turner (2002); West (2000)
	Effective collaboration involves considerable preparation and operational costs / time	Camarinha-Matos et al. (2007)
	Project delays, because departments set different task priorities and pursue incongruent objectives or because of differences in educational backgrounds of employees	Cuijpers et al. (2011); Hansen (2009); Mishra and Shah (2009); West (2000)
Interdepartmental competition	How to split the gains? Competition with other teams/units leads to departments not wanting to share equally	Lozano (2013); Schilling & Kluge (2009); Singendonk (2015)
Language/culture barrier	Slow information processing since departments adhere to different operating principles, have different goals and technical jargon; low absorptive capacity	Cuijpers et al. (2011) from Dougherty (1992); Schilling & Kluge (2009); Song et al. (1997)
No clear goals	Lack of precise planning towards concrete goals	Schilling & Kluge (2009); Thomson & Perry (2006)
Pragmatic concerns	Free riding (those who choose not to participate but still get the benefits)	Chilosi (2003), from Lozano et al. (2014)
Risk	The business unit with the initial idea has to take the risks whereas other units are not willing to bear part of that risk	Hartmann (2006)
Organisational		
Extra costs and/or time	Fear of less Return On Investment	Camarinha-Matos et al. (2007)
Markets & Customers	Spatial separation with independent markets restricts interdepartmental collaboration to a minimum	Hartmann (2006)
Physical distance	The greater the physical distance between colleagues, the greater the chance of flawed communication. People miss out on brainstorming, decision making and socializing that leads to positive outcomes.	Geisler (2008)

* Schilling & Kluge (2009) compiled a list of barriers to organisational learning, based on different literature sources. In this thesis it has been tried to retrieve the articles from the original authors. Whenever this attempt was unsuccessful, a reference to Schilling & Kluge (2009) has been made, rather than referencing to the original authors. See the study *Barriers to organisational learning: An integration of theory and research* by Schilling & Kluge (2009) for an overview of their findings including references to the original authors.

Some barriers to change that add to Lozano (2009) seem contradictory to certain drivers to change as discussed in section 3.3.1. For example, while some research suggests that interdepartmental collaboration enhances timeliness of projects (García et al., 2008; Zeller, 2002), presented as driver *productivity & quality* in Figure 3 (p. 25), other authors argued that interdepartmental collaboration might actually create, rather than prevent, project delays (Hansen, 2009; Mishra and Shah, 2009; West, 2000). This is explained as the barrier to change *Extra costs and/or time.* According to Garcia et al. (2008) collaboration reduces time for accomplishing objectives. Yet, Mishra and Shah (2009) stated that interdepartmental collaboration often is 'time consuming and resource intensive', and Hansen (2009) suggested that collaboration between departments could cause delays in completing projects or delivering products and services. In addition, West (2000) argued that bringing together professionals from different fields in an effort to advance innovation may cause delays because integrating contributions from different knowledge areas requires additional coordination demands.

The interest in defining barriers to change is that this information provides the opportunity to think about solutions to solve the barriers. Finding strategies to overcome or manage distinguished barriers is an essential step for changing behaviour successfully (Baker et al. 2010; Lozano, 2006; 2009). The next section discusses such strategies to overcome barriers to change.

3.3.3 Strategies to overcome barriers to change

Lozano (2009) discussed strategies to overcome barriers to change in the same study as where the barriers to change were discussed. It makes sense to adopt this framework of strategies to overcome barriers to change since the strategies have been placed in the same categories as the barriers to change: individual (level 1; level 2; level 3; aspect 1 and aspect 2), group and organisational (managerial; supportive; organisational; historical; and external). Lozano (2009) explained that the strategies and approaches offered in his framework are not prescriptive regarding each of the barriers to change. Rather, they should be understood as a 'toolkit', where the strategies/approaches at a particular level are applied to barriers at the same level. As a consequence, no single approach to overcome the barriers will work in all circumstances. The lists with strategies to overcome individuals', groups' and organisational barriers to CS oriented change as distinguished by Lozano (2009) are included in tables in Appendix C.

Approximately a similar amount of strategies to overcome individual barriers to change have been offered for each category (Appendix C, Table 22). Only for the category 'aspect 1 barriers to change' no strategies were proposed in Lozano (2009). Following from the few group barriers to change that were distilled by Lozano (2009), the strategy framework also only shows a limited amount of strategies to overcome group-barriers to change. The strategies to overcome organisational barriers to change present the most strategies for the categories Managerial and Organisational, which are the two categories that also included the most barriers to change. Only for the category 'organisational external barriers to change' no strategies were proposed in Lozano (2009).

A comparison between the framework on drivers to change (Figure 3) and strategies to overcome barriers to change (Appendix C) leads to the insight that some drivers and strategies show overlap (i.e. *pressure from customers*, *use of champions* and *rewards*). The driver *rewards*, which was obtained from Song et al. (1997) and considered to be additional to Lozano's (2013) framework, is proposed as a strategy in Lozano's (2009) framework; *Incentives, rewards and compensations*. Thus, it appears that rewarding employees can be used to stimulate change efforts while at the same time it can be used to overcome resistance to change.

When comparing the frameworks of barriers to change (Appendix C, Tables 19-21) with the frameworks on strategies to overcome the barriers to change (Appendix C, Tables 22-24), it appears that fewer strategies have been distilled. A reason is that certain strategies could be applicable to more than one barrier. For example, the co-opting approach (a strategy to overcome level 2 and aspect 1 barriers), could perhaps be applied as strategy to overcome the barriers *perceived threat to job status/security*, *uncertainty*, *laziness*, *fear of not belonging*, *organisational structure*; *lack of interest from actors*; and, *extra work load*. The core element of this approach is the believe that change is accomplished by involving the people dissatisfied in current processes and helping them realise the benefits of making changes (Lozano, 2006, adopted from Luthans, 2002). As for interdepartmental collaboration, this strategy involves targeting employees that are not amused with current business processes. These employees have possibly already been thinking about alternative organisational

processes to regain joy in their business operations. Hence, if such actors can be convinced that interdepartmental collaboration is a step in the right direction, they could potentially turn into *champions* to pursue this change. Making use of *champions* is proposed in Lozano's (2009) framework as a strategy to overcome barriers on individual, group and organisational level.

The strategies to overcome barriers to change can also be compared with other strategies in the framework. As a result, it appears that different approaches can be used jointly (depending on the situation). For instance, individuals' level 1 strategy *Education/Providing new information/Communication*, organisational supportive strategies *Better information through the company* and *use of technology*, and the organisational managerial strategy *Adapting external models*. By jointly adopting these approaches, technology could be used to share current successes and thereby better communicate the new situation's potential. This is in line with Denise (1999) who argued that harnessing results through organisation wide communication of success stories is of importance for inducing change towards more collaboration. Such change can also be induced through building/communicating success stories from other organisations (Camarinha-Matos et al., 2007). In the context of interdepartmental collaboration for new PSS development, communication of success stories implies showing that collaborations can lead to prototypes of early new (combinations of) products and services. Positive stories may interest sceptics, provide the required knowledge for the unaware, show facts to those who were not convinced and offer hope to the ones who have had negative experiences with this specific change. In the end, sharing positive results may lead to the start of new collaboration programs or initiatives.

As mentioned earlier, Lozano's (2009) strategy framework is designed for change to CS, which is related to, yet different from this thesis' topic of interdepartmental collaboration for PSS development. Hence, certain strategies to overcome resistance to change that add to Lozano's (2009) framework can be of value for this thesis.

Such an approach to overcome certain barriers to change is to set direction from the top and consequently engage people below (Beer & Noriah, 2000). This combined top-down and bottom-up approach (top-bottom) is proposed as a means to create the largest support for employees to join the change.

Kegan and Laskow (2001) proposed that large organisations should start with small changes in order to change sustainably. Those authors approach to design a short-term (one-month) cross-department committee, dedicated to evaluate opportunities for new products/services. As the team would dissolve after a month, the members would be able to disengage themselves fairly quickly if they grow uncomfortable with the relationships. Nevertheless, the experience would force them to spend a meaningful amount of time with several colleagues from other departments. Whenever great ideas or positive energy is experienced in the group, an expected result is that the group intrinsically wants to continue with this interdepartmental team. Such positive experiences could then be harnessed, which may lead to an organisational wide adoption of similar teams. Organisational wide adoption in turn makes way for an organisation that keeps the traditional hierarchic structure but complements this with an

alternative structure that, for example, embraces interdepartmental PSS development. This alternative could lead to a New Status Quo of an organisation as depicted in figure 2 (p. 22).

Some strategies that complement Lozano (2009) and might help tackle possible barriers to interdepartmental collaboration have just been discussed. A list including several additional strategies/approaches is presented in Table 2. This list and the strategies proposed in Lozano (2009) are extensive to a degree that they cannot be discussed meticulously in this review. However, the ones that could be helpful for the specific situation at Grontmij are granted much attention in the separate recommendations document that will be provided to the company.

Table 2: Strategies/approaches that could help overcoming potential barriers to interdepartmental PSS development

Strategy/approach	Source
Set direction from the top and engage the people below (both top-down & bottom-up)	Beer & Noriah (2000)
Proactive opportunity brokerage in the market / society	Camarinha-Matos et al. (2007)
Building success stories	Camarinha-Matos et al. (2007)
Different levels of membership	Camarinha-Matos et al. (2007)
Transparent rules/regulations	Camarinha-Matos et al. (2007)
Harness results	Denise (2004)
Define the collaborators. Only expand this group when other people add essential additional content or value to the collaboration	Denise (2004)
Define the challenge, the boundaries and targets	Denise (2004)
Allow the time	Denise (2004)
Create the space	Denise (2004)
Incremental changes	Kegan & Laskow (2001)
Design a short-term cross-department committee	Kegan & Laskow (2001)
Look for contrary evidence; find interfaces	Kegan & Laskow (2001)
Touch upon emotions	Kotter & Cohen (2012)
Recognise office space as not just an amortized asset but also a strategic tool for growth. Try to reduce the number of offices as much as possible and strategically place coffee machines so that people meet there	Waber et al. (2014)

4. Methods

This chapter explains the methods used to explore interdepartmental PSS development in a large engineering firm. The research model consists of three research 'blocks'. First, desk research on relevant themes was performed. These themes comprised PSS, collaboration, interdepartmental collaboration, intra-organisational collaboration, innovation, change management, corporate sustainability, organisational science, the construction industry and behavioural change. Second, a case study through interviews was executed that assisted in collecting and analysing company information. The third block comprises the analysis of the findings by means of a discussion on the derived data. Besides, the conclusions and recommendations are formulated in this block. A visualisation of the three research blocks is presented as operationalisation scheme in Figure 4. Within block two, two research methods were utilised: case study and grounded theory. The two research methods are discussed in the next sections, by means of a research design, methods of data collection, data analysis, validity and the methods limitations.

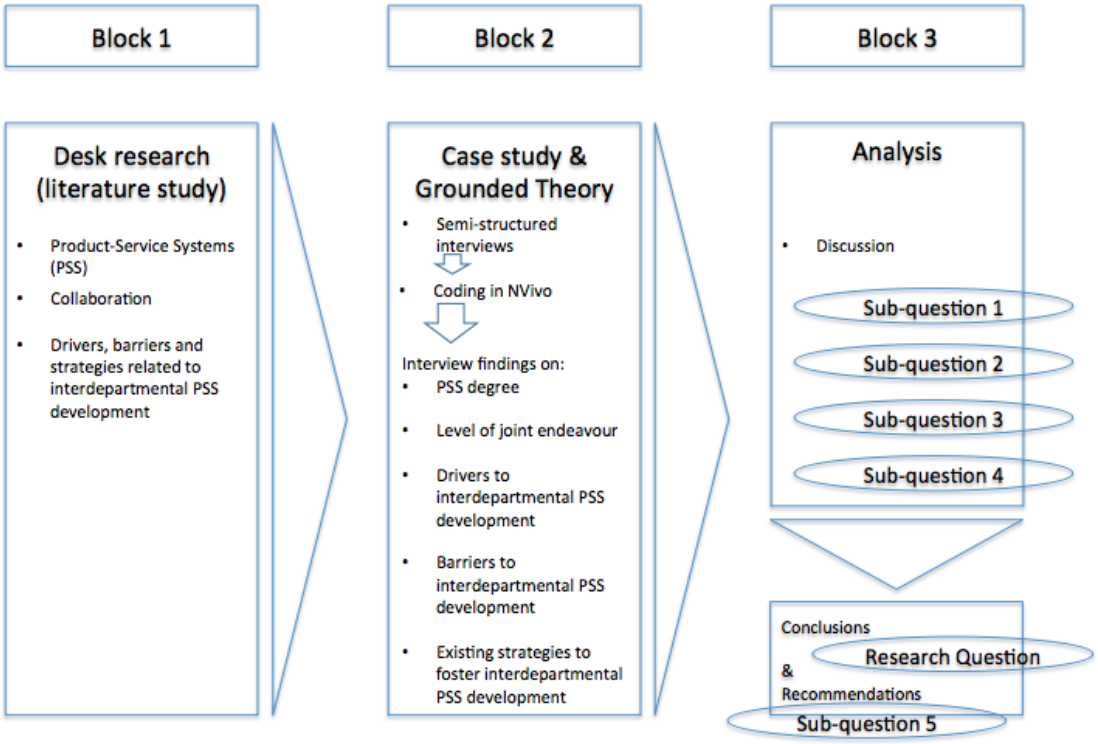

Figure 4: Operationalisation scheme providing an overview of the thesis' three general research blocks

4.1 Research design

The conducted research was of exploratory nature, meaning that no specific set of outcomes can be expected and findings should contribute to new insights on the topic (Saunders et al., 2009). According to Gable (1994), exploration is required when the topic is novel.

Single case with embedded units

Myers (2009) suggested that research of exploratory nature uses case research to discover relevant features, factors and identify issues that might also apply in other cases. In this situation, it should generate new insights on what has fostered and hindered interdepartmental collaboration in previous projects for PSS development at an engineering firm. The research

has been conducted at Grontmij Netherlands BV. Thus, the thesis adopted a single case perspective, however within this case several projects were explored. Those projects can to a certain degree be classified as PSS development by means of interdepartmental collaboration (for more detail on the projects, see 4.2.1 and 4.2.2). Baxter & Jack (2008) call this method *single case* (Grontmij) *with embedded units* (the projects). An introduction to Grontmij can be found in appendix A.

Grounded theory

Grounded Theory (GT) is a strategy that helps to develop and build theory from data and observations (Saunders et al., 2009; Strauss & Corbin, 1990). It is a method that supports structuring research of exploratory nature, where the researcher has basically no control over the phenomena being studied. GT moreover enables researchers to identify if there are causal relations between variables, and it allows generalising from a specific context (Bryman, 2004). Within GT, gathered evidence can be used to derive theoretical categories. The evidence is then used to further characterise the preliminary theoretical categories (Lozano & Huisingh, 2011). Important in GT is that analytic work is performed alongside data collection. Besides, the sample of interviews may be adjusted throughout the study (Strauss & Corbin, 1990). Thus, for this thesis, GT provides the researcher the possibility to perform a systematic analysis of the drivers and barriers experienced within interdepartmental PSS-projects. The findings can be used to detect whether they differ or confer with drivers and barriers to change from the reference frameworks on CS (by Lozano, 2009; 2013) and related literature domains (i.e. innovation; change management; intra-organisational collaboration).

4.2 Data collection

Data has been collected by means of secondary and primary data. Secondary data functioned to find projects that fit the requirements: (1) 'different departments were involved' and (2) some degree of 'PSS development'. Once the suitable projects had been distinguished, primary data was gathered (by means of conducting semi-structured interviews with employees involved in the different projects). Semi-structured interviews provide the opportunity to address pre-determined issues while also creating room for clarification and follow-up questions (Leedy & Ormrod, 2005). The next sections discuss the collection of secondary and primary data in more detail. A table describing the different projects and a list of interviewees are included in section 4.2.2.

4.2.1 Secondary data to find suitable projects

Different projects at Grontmij have been evaluated in respect to Mont's (2004) definition on PSS. Second hand data such as informal conversations with employees at Grontmij, YouTube videos about Grontmij's innovations and Grontmij's web innovation platform (Grontmij, 2015) served as most important input to get a clear view of potential projects. This first scan resulted in 11 potential projects for this research. Next, each projects contact person was approached via email and asked whether different departments had contributed to the PSS. This step led to six seemingly suitable projects whose contact persons were willing to be interviewed. After the first interview round, one of the projects turned out not to be

interdepartmental and was therefore deleted from the list. The five projects that remained comprise: Smart City, IMBY, Obsurv, N211c and Recircle the Olympics. Although these projects have not officially been classified as PSS, they can to different degrees be explained according to the PSS definition. Appendix E presents a discussion and a categorisation of the five projects on a product (1) to service (5) scale.

4.2.2 Primary data to detect drivers, barriers to interdepartmental PSS development and strategies to overcome these barriers

Per project, three interviews were conducted with three employees who were involved. This resulted in a total of 15 interviews, varying from junior to senior employees. Within each project, all interviewed people worked in different departments. Prior to the interview, a version of the interview questions had been sent to each interviewee. The questions were divided in four general themes. All interviews were recorded (with permission), backed up by notes and transcribed. The interviews lasted approximately 30 minutes to 75 minutes. Most of the interviews were conducted face-to-face, with one phone call-interview as exception. Every interview consisted of 33 questions in which some could not be answered due to time reasons. Whenever time was running out, only the most important questions were addressed. Within each interview, the interviewee was given a printed version of the interview questions (Appendix F) whereas the researcher had a printout of the questions as well as a topic list. The topic list (Appendix F) enabled a more informal structure and an easy way to make notes. Lastly, the interviews were conducted in Dutch as this could prevent translation problems during the conversation.

Table 3 presents a list of all interviews, including the interviewee's function, time in function, department, team, date, location and duration of the interview. The names of the interviewees have been left out because of confidentiality reasons.

Table 3: Overview of semi-structured interviews

Interviewee	*Function*	*Time in function*	*Department / Team*	*Date*	*Location*	*Interview time (min)*
Project: Smart Cities						
A	Senior consultant Mobility	23 years	Mobility / Smart Mobility	22-10-2015	De Bilt	33 min
B	Senior consultant ICT/Infra	6 years	Water & Energy / Installations Water & Infra	28-10-2015	De Bilt	51 min
C	Senior Consultant Soil	24 years	Area advice / Soil	29-10-2015	Houten	26 min
Project: IMBY						
D	Senior Consultant Management Of The Environment	2 years	Roads / Management Of The Environment	19-10-2015	De Bilt	52 min
E	Project leader & Sales GIS/ICT	2 years	GIS/ICT	02-11-2015	De Bilt	56 min
F	Web editor	17 years	Marketing and Communication	09-11-2015	De Bilt	31 min
Project: Obsurv						
G	Manager Business	1 year	GIS/ICT	02-11-	De Bilt	52 min

	Development			2015		
H	Project Leader / Senior Consultant	9 years	Mobility / Public Lighting	02-11-2015	De Bilt	47 min
I	Senior Consultant Asset Management Roads	15 years	Asset management & monitoring / Asset Management Roads	28-10-2015	De Bilt	72 min
Project: N211c						
J	Project Manager Roads	6 years	Roads / Infraprojects	22-10-2015	De Bilt	36 min
K	Project Manager Energy	5 years	Water & Energy / Sustainable Energy	03-11-2015	Rotterdam – Phone call	40 min
L	Risk manager & Contract manager	8 years	Water Constructions / Projects	05-11-2015	De Bilt	42 min
Project: Recircle the Olympics						
M	Consultant Mobility	2 years	Mobility / Smart Mobility	21-10-2015	De Bilt	42 min
N	Consultant Coasts & Rivers	2 years	Water construction / Coasts & Rivers	26-10-2015	De Bilt	64 min
O	Junior Consultant Obsurv	2 years	GIS/ICT / Management public space	26-10-2015	De Bilt	66 min

Table 4 presents a brief description of each project, the stage of completion and the departments involved. All of the projects can to some degree be classified as PSS development. Only the Smart City-project has never reached a stage of completion. Recircle the Olympics has reached a stage in which they presented their plan in a competition, yet this project has not generated any revenue. Even though the other three projects are still developing new versions or entering new phases of development, they have ensured income. Another key point from the table is that IMBY and Obsurv comprise projects to develop web-based applications. The N211c-project[8] is the only project that emerged out of direct client demand. As for all of the projects, at least three departments contributed to developing the PSS.

Table 4: Description of five case studies

Description of case/project	Stage	Contributing departments
Smart city comprises a compendium of smart solutions to cope with a growing urban population. The concept does not have a demarcated definition, which is why some individuals at Grontmij started discussing the degree to which Grontmij can offer solutions for this 'smart' city. This can apply to solutions in roads, traffic signs, soil, energy etc. Hence it is a very integral project that considers solutions that are not simply a product, but rather	Although the project has been running for over a year, not much is happening at the moment. A few get-togethers have led to small progress, but right now nothing concrete is happening.	Mobility, Roads, Soil, Technique, Area Advice, Commercial management and Installations Water & Infra.

[8] The 'c' means that the tender only comprised a specific part of the N211, however in the remainder of this thesis the 'c' will be left out of the denomination.

long-term service solutions with minimum waste.		
IMBY is a web-based application. It is a tool through which citizens can communicate their ideas, questions and complaints about construction activities in their living area. Instead of 'Not In My Back Yard-arguments', this platform can help create public support for certain changes in the living area. The product is the actual tool, and the service is the opportunity to solve resistance and complaints in order to minimise costs of failure (financial. social and environmental).	Operational. The tool is sold in one municipality, but the aim is to sell much more.	Roads, GIS/ICT and Marketing & Communication
Like IMBY, **Obsurv** is a web-based application. It enables asset managers and managers of public space to check the status of their assets (i.e. roads, constructions, sewerage, public green spaces etc.). It is the first GIS-based integral control system: planning and budgeting in one process. The product is the actual web application and the service is the possibility that one can check all assets by means of a computer screen. This results in great drops in transportation time, costs and emissions.	Operational. It is to a certain degree used internally and has been sold to several customers. However, the wider adoption by the entire company and more market players is the next focus step.	Mobility, GIS/ICT, Asset management, Roads and Water.
The **N211c** is the only classical project out of the five examined projects; a tender offer sent out by a province (in this case the province of South-Holland). The request was to design this road in order for it to be energy neutral throughout construction and energy positive once it is completed. The end result is a product; an actual provincial road. However, the goal is to provide the service of connecting place A to place B. Besides, the road will have positive impact on the environment and require minimal maintenance.	Grontmij has won the tender and has just started the contract phase.	Roads, Water construction, Area advice, Energy & Installations technology and Asset management.
Recircle the Olympics is an idea that could help attract the 2028 Olympics to the Netherlands. Within this concept everything that is built for the Olympics has already been sold for a second, post-Olympic, purpose. This means, for instance, that each building block of a stadium can easily be disassembled and function as part of a house, bridge or office. As a result, everything is built for the service it delivers instead of the physical product it is; product-service system.	In development. The idea is written in business case-format, and the second price for innovative ideas to attract the Olympics to the Netherlands has been received. To make this actually work, collaboration with third parties through SPARK (a centre for open innovation in the built environment) is currently taking place.	Mobility, GIS/ICT and Technique.

Source: Grontmij (2015)

4.3 Qualitative analysis based on Grounded Theory

4.3.1 Data analysis

Open coding

According to Corbin and Strauss (1990) there are three basic types of coding in GT: open, axial and selective. Whereas axial coding focuses on relations between categories and sub-categories, selective coding places all categories around a 'core' category. Open coding enables giving conceptual labels, which leads to similar events being grouped together and forming of categories and sub-categories. This is in accordance with Walker and Myrick

(2006) who argued that open coding can be understood as labelling answers in order to categorise them, which can in turn benefit developing new theories through GT. It is an advantage that the subject of interest can be researched in its entirety and is not limited by having to stick to predefined categories (Forman & Damschroder, 2008; Strauss & Corbin, 1990). Such unlimited specification possibilities further the precision of a grounded theory (Strauss & Corbin, 1990). Since this study aimed to construct categories and sub-categories but not wanted to be directed around one core category or being locked in by a focus on relations, open coding seemed a suitable method.

Constant comparative analysis

Glaser et al. (1967) proposed four approaches to help analyse qualitative data in GT. The constant comparative analysis offers the potential to generate theory more systematically than the other ones (Lozano & Huisingh, 2011), which is why it is considered to be most suitable for this thesis. According to Lozano & Huisingh (2011) explicit coding and analytic procedures are used that help identify, develop, and relate the concepts which allows making more systematic and creative building blocks of theory. Strauss & Corbin (1990) highlighted that using the constant comparative method ensures a high probability of achieving a relevant theory that corresponds narrowly with the case-data. The constant comparative method has four stages (Strauss & Corbin, 1990): (1) data is categorised, (2) categories are integrated, (3) the theory is derived from the categories, and (4) writing of the theory. How this thesis has used these stages is explained next.

In the **first** stage, basic categories of certain main themes were made: Drivers for interdepartmental PSS development; Barriers to change towards interdepartmental PSS development; Strategies to overcome barriers to change; Project stage; Product/service; Management; Intensity; Finances; Importance for Grontmij; Involved departments; Background information; and, Other.

In the literature review, primarily drivers, barriers and strategies to overcome barriers to interdepartmental PSS development were discussed. These 3 themes were also the key focus of the interviews and hence included the largest number of subthemes. The first subthemes were derived from the theoretical frameworks on drivers, barriers to change and strategies to overcome barriers to change. The data that did not correspond with literature was placed in the container-category ‘other’. Since the interviews had been transcribed, it was possible to categorise the content of the semi-structured interviews.

The tool used for this categorisation, in this case coding, was QSR NVivo10. Walsh (2003) stated that NVivo allows for information to be organised and coded in ‘nodes’. Such nodes are similar to categories developed through coding in GT. Additionally, NVivo enables data to be efficiently managed and categorised, integrate overlapping codes, recognise relationships between nodes and analyse results (Walsh, 2003). In stage one of the constant comparative method, only efficient management and categorisation is of essence.

How this categorisation was performed in practice is exemplified by means of 3 sub-themes that were highlighted in the literature review. In Table 5, marked with an (A) includes an

example of a node for a possible driver for interdepartmental PSS development, (B) encompasses an example of a potential barrier to interdepartmental PSS development, and (C) presents an illustration of a node for an existing strategy that could potentially stimulate PSS development. As can be observed, drivers, barriers and strategies that were phrased differently, but basically had the same meaning were grouped into one node. The table also includes key words for identifying the drivers, barriers to change and strategies to overcome barriers to change from the interview transcripts. For a complete overview, including the construction of the nodes that are complementary to the literature review, see Appendix D.

Table 5: Examples of nodes for a driver (A), a barrier to interdepartmental PSS development (B) t and a strategy to overcome the barriers (C)

Node	Indicator *The interviewee indicated that a reason for involving/engaging with interdepartmental collaboration was...*	Source
(A) Innovation	To enhance competitiveness / Competitive advantages	Hansen (1999); Tsai (2001); Zhou & Li (2012)
	To develop new products, processes and services Key words: *Innovation, competitiveness, work on a new product*	Camarinha-Matos et al. (2007); Carnabuci & Operti (2013); Fadeeva (2004); Hansen (1999); Kahn (1996); Love & Roper (2009); Lozano (2013); Tsai (2001); Stacey (2007)
	The interviewee indicated that a reason for interdepartmental collaboration to be hindered was...	
(B) Organisational structure	A hierarchical setting in place, which is risk-aversive / A rigid and conservative organisation	Blayse & Manley (2004); Davila et al. (2012); Dent & Galloway Goldberg (1999); Dubois & Gadde (2002); Hartmann (2006); Kotter (2012); Schilling & Kluge (2009); Shaw (2010); Xue et al. (2014)
	Trouble when altering cultural traits	Lozano (2009)
	Too much focus on planning & control Key words: *hierarchy, tradition, risk-avoiding, culture, control*	Keegan & Turner (2002)
	The interviewee indicated that a strategy used to increase interdepartmental collaboration efforts is...	
(C) Rewards	Financial benefits	Lozano (2009)
	Incentives, rewards and compensations Key words: *Winning a price, salary increase, pubic acknowledgement, rewards, compensations, incentives.*	Lozano (2009); Song et al. (1997)

The **second** stage of the constant comparative method encompasses integrating categories and their properties. In this stage, the container-category 'other' was opened and used to construct new nodes. These nodes were inductively derived from the observed data and complement the literature review. Also in this stage, the already categorised data was re-evaluated, re-categorised when necessary and overlapping nodes were integrated.

Due to this method it was possible to count the amount of specific drivers and barriers to change that were brought forward during the interviews. In addition, this approach enabled to determine which drivers and barriers were most prominent per project. Moreover, a specific driver or barrier could only be assigned once per interview. This has been done to avoid double counting.

In the **third** stage, theory should be derived from the categories. Although this was not directly done, analysis of the data showed certain relationships between nodes. Besides, data was juxtaposed from the categories to provide new insights into what has driven and what has hindered interdepartmental PSS development at Grontmij. Overall, first steps towards creating theory have been made as certain data from the literature review was confirmed and certain new data was observed.

The **final** stage is writing a new or modified theory, which can consequently be used to develop or test hypotheses. In this thesis no grand theory has been formulated. However, the proposed frameworks on drivers and barriers to interdepartmental PSS development, as presented in Figure 7 (section 6.2.1, p. 72) and Table 17 (section 6.3.1, p. 76), could provide a standard for future research into organisational changes for interdepartmental PSS.

Corbin & Strauss (1990) argued that open coding, and the way it uses questioning and constant comparisons, enables investigators to break through subjectivity and bias. Besides, these specific categories were analysed using the constant comparative analysis, whereby data are regularly compared to the categories for ensuring consistence in coding the data. Thus, if data was unintentionally placed in a category that was analytically wrong, the errors were eventually located by means of systematic comparing. In sum, the methods of data analysis (GT and constant comparative analysis) and tool (NVivo) offered a systematic way for analysing the interviews' content. The analysis helped to integrate collaboration issues and categories, to recognise relationships among the issues within each case, and finally to propose recommendations for interdepartmental collaboration possibly leading to new PSS development.

Methods of data Analysis: Drivers, Barriers and strategies to overcome barriers to interdepartmental PSS development

When all the interviews were coded, and the entire spectrum of different drivers and barriers for interdepartmental PSS development was complete, the nodes were categorised into more specific groups.

For drivers this comprised a division in internal and external drivers, and a division between drivers for the collaboration and drivers for the project. The internal/external division was done, following Lozano's (2013) driver framework. Yet, certain reported drivers were not

highlighted in Lozano's (2013) study and have therefore been categorised by the author of this thesis as either internal or external. Throughout the categorisation, the definition by DeSimone & Popoff (2000) was used: Internal drivers are personal motivations whereas external drivers are induced by external pressure for a person to, in this case, engage with interdepartmental PSS development. The subjectivity of this method is discussed in the next section. Although DeSimone and Popoff (2000) formulated the definition at the beginning of this century, their way of defining the difference between internal and external drivers seems still useful today. The author of this thesis also made the division between drivers for the collaboration and drivers for the project. This was mainly based on common sense. As matter of example, two quotes: *"It was something new, and I like innovation"* (Interviewee A); and, *"Obsurv is an integral system, so we needed complementary knowledge to make it a good product"* (Interviewee I). The former quote was categorised as driving the project, because this person seemed to want to engage with the project, independent on who else would be involved. The latter was categorised as driving the interdepartmental collaboration because the interviewee acknowledges the need to engage with colleagues that have complementary knowledge, implying colleagues from different departments.

As for the analysis of barriers to interdepartmental PSS development, a categorisation between organisational levels (individual, group, organisational) was made in NVivo. This categorisation was mainly based on Lozano's (2009) framework on barriers to CS oriented change. However, as with the drivers, the reported barriers that were dissimilar to Lozano's (2009) study were categorised by the author of this thesis.

Nodes for strategies to overcome barriers to interdepartmental PSS development were also initially constructed following Lozano's (2009) framework. However, after coding a few interviews, the reported strategies appeared to be rather Grontmij-specific. Hence, separate nodes were constructed that seemed to fit the strategies at Grontmij better. These nodes comprised categories such as *digital knowledge sharing platforms, formal groups* and *informal meetings.*

In addition, for drivers as well as barriers to interdepartmental PSS development, it has been examined which clusters of literature provided the best suggestions (Discussion section 6.3.2). For each reported driver/barrier it was checked which authors had suggested the driver/barrier. It must be noted that some clusters consist of more articles than others; literature on *Innovation* (15 studies), *Organisational change* (12 studies), *Interdepartmental collaboration* (10 studies), *Intra-organisational collaboration* (5 studies), *Construction industry* (5 studies), *Corporate Sustainability* (4 studies), and *Collaboration for sustainability* (2 studies). More articles generally increased the number of suggested drivers, with the exception of the cluster on *Corporate Sustainability*. In addition, in some articles the themes 'drivers' or 'barriers' were given a more central position, which led to higher numbers of drivers and barriers from the articles concerned. Thus, simply counting how many times the various drivers/barriers were mentioned by authors in a specific cluster seemed unfair. For this reason, the relation between drivers/barriers to interdepartmental PSS development and the literature clusters was simplified to Yes/No; if a driver was mentioned within a specific cluster of literature, it was visualised with 'Yes'. The following figure provides an example of

how this analysis was applied to the driver *innovation* (A) and how this was subsequently visualised (B) (see Appendix G).

(A)

Driver	Cluster of literature	Source	Depiction
Innovation	*Organisation change*	Hansen (2002); Stacey (2007)	Yes
	Intra-organisational collaboration	Camarinha-Matos et al. (2007); Carnabuci & Operti (2013); Tsai (2000)	Yes
	Interdepartmental collaboration	Cuijpers et al. (2011); Kahn (1996); Love & Roper (2009)	Yes
	Collaboration for sustainability	-	No
	Corporate Sustainability	Lozano (2013a)	Yes
	Innovation	Cuijpers et al. (2011); Carnabuci & Operti (2013); Kahn (1996); Love & Roper (2009); Zhou & Li (2012)	Yes
	Construction industry	-	No

(B)

	Organisational change	*Intra-organisational collaboration*	*Interdepartmental collaboration*	*Collaboration for sustainability*	*Corporate Sustainability*	*Innovation*	*Construction industry*
Internal drivers							
Innovation	Yes	Yes	Yes	No	Yes	Yes	No

Figure 5: Example of different literature cluster's Yes/No depiction for drivers/barriers to interdepartmental PSS development

4.4 Validity & replicability

The results of a study can be limited through various ways. This section addresses internal & external validity and replicability.

The internal validity is the degree to which logic reasoning in the research leads to confidence in the robustness of results (Bryman, 2012). Limitations on internal validity could be influenced by data collection quality, which comprises the question design, structure and the choice of people to be interviewed (Saunders et al., 2009). In order to maximise internal validity, each important decision made in the process was discussed with either the company or university supervisors.

External validity has been defined as the extent to which observed effects could be generalised outside the experimental setting (Hogarth, 2005). Data for this particular thesis has only been generated in one firm and sector. Such a specific scope and context may be prone to conditions that are not in place elsewhere (Saunders et al., 2009). A consequence is that findings should only be generalised with absolute caution, with awareness of this thesis' context and limitations.

Regarding replicability, it was aimed to be as transparent as possible concerning all the procedures for development and administration of the interviews, selecting the interviewees, data collection and data analysis. It is hoped that this transparency will enable other researchers to replicate the study and thereby verify findings.

4.4.1 Methods limitations

Different from validity issues, other limitations, such as participant bias and observer bias, might influence the reliability of this explorative thesis with semi-structured interviews (Saunders et al., 2009).

Participant bias occurs when interviewees do not feel safe to give honest answers or have wrongful memory of the exact experience (Saunders et al., 2009). It may have been the case that interviewees did not remember or remembered things differently than what actually happened. Or, they may have been confused and recalled drivers and barriers that had been experienced in a different project.

Observer bias contains the interpretation of the interviews (Saunders et al., 2009). Similarly, Starks and Trinidad (2007) argued that qualitative analysis is inherently subjective because the researcher makes all the judgments about coding, categorising, and decontextualising the data. In this thesis, the data were demarcated by the interpretation of the researcher. Other researchers might have interpreted similar findings differently; however, the findings provide a platform for further testing. Besides, observer bias was minimised since the researcher's most important assumptions and interpretations were shared with University or Grontmij supervisors. Nevertheless, observer bias was present with the driver *management support.* Instead of waiting for the interviewee to mention management support, the researcher asked specific questions concerning management. This has led to each interviewee elaborating on the degree of management support. The aim of this approach was to be able to better compare between the five projects, which succeeded. In general, daily influences may have induced observer bias as this study was conducted at a company where the researcher was situated on full-time basis.

Only 15 interviews with employees engaged in 5 projects have been conducted. If a larger population had been included, findings may have been confirmed by more people, which would make the findings more reliable. Besides, due to a larger population, a wider range of drivers and barriers might have been found. A reason for investigating only 5 projects is that simply no more projects at Grontmij fitted the interdepartmentally developed PSS definition. Even the 5 investigated projects did not encompass 'pure' PSS. Rather they comprise of projects/products that have interface with the definition of PSS. Within these projects, it might have been possible to interview more people. However, it was chosen to conduct an equal amount of interviews per project, and each of the three interviewees had to be from a different department. As one of the investigated projects only had three departments involved (IMBY), more interviewees would have meant that people from the same department had been interviewed on their experiences in the same project.

Furthermore, no corrections for age, function, years of employment and more of such personal details have been made. The sample size was so low that no hard conclusions could have been drawn, even if for instance the youngest age group showed different results than the elder age groups. However, adopting a quantitative method alongside a qualitative method is proposed as a recommendation for future research in chapter 7.

Another cause that might have led to minor errors is a translation barrier. The interviews were conducted in Dutch, and transcribed in English. Possible mistranslations and therefore misinterpretations might have resulted from this method.

A final point, on a more general note: case study-based research has limitations in terms of generalisability. However, it provides insights into company dynamics (Lozano, 2009).

5. Findings

This chapter presents the findings of the research. As indicated in Table 3, 15 interviews with Grontmij employees served as input for the findings. In order to orderly present the findings, this chapter is separated in different sections. First, case study evidence is presented about the relevance of interdepartmental collaboration for Grontmij (5.1). Following from this section, the findings on five interdepartmental PSS projects at Grontmij are offered (5.2 – 5.6). For all projects, case study data is presented on: the level of joint endeavour that was present; drivers to interdepartmental PSS development; and, barriers to interdepartmental PSS development. Each of the sections on drivers and barriers contains tables with reported drivers/barriers and illustrating quotes. Whenever more than interviewee mentioned a particular driver/barrier, the according number is placed in parentheses just after the driver/barrier. Drivers/barriers that are complementary to the literature review are shown in italics. The findings section concludes with an overview of existing strategies at Grontmij that could foster interdepartmental PSS development (5.7).

5.1 The importance of interdepartmental collaboration for Grontmij

14 out of 15 interviewees argued that, in a knowledge intensive firm like Grontmij, interdepartmental collaboration is key in order to remain competitive. The same number of interviewees stressed that this form of collaboration does not happen enough. According to most, more interdepartmental collaboration would lead to higher chances of winning large tenders as well as new PSS development. As matter of example, Interviewee A: *"Interdepartmental collaboration is essential for Grontmij. If we actively engage with this, we compete with other engineering firms. If we fail to collaborate, we compete with freelancers and other small firms. Such firms are cheaper, which will ultimately result in Grontmij going bankrupt."*

There was one interviewee who did not highlight the importance of interdepartmental collaboration for Grontmij. This interviewee did not deny it either: *The problem is not a lack of interdepartmental collaboration, but a lack of product development. Per product we should evaluate whether more departments need to be involved"* (Interviewee N). Thus, he reasoned that product development is most critical and that interdepartmental collaboration could benefit this development, but not necessarily in all cases. The following sections discuss five of those cases in which a certain degree of PSS development and interdepartmental collaboration were present.

5.2 Case study project 1: Smart City

5.2.1 Assessing the degree of joint endeavour for project Smart City

The Smart City team is best explained as an unstructured group of colleagues who believe that Grontmij should connect its business with this popular term. For instance, Interviewee C explained: *"I believe that Grontmij should join this hype. Personally I am working within my expertise on some products that could fit the 'smart' definition."* Like Interviewee C, most of the participants saw the relevance for Grontmij as well as potential for increasing sales for

their department. Furthermore, the group members have to some extent tried to divide tasks in their joint endeavour efforts. The problem that occurred was that no one took ownership of the project and therefore no one kept the team-members to their tasks; Interviewee A: *"We should have started formulating targets for ourselves, stopped complaining about money and held each other to their responsibilities."*

5.2.2 Drivers for interdepartmental PSS development

For the Smart City-project, the interviewees identified 6 internal and 3 external drivers. From the 6 internal drivers, 2 drivers are complementary to the drivers presented in the literature review: *Challenge*; and, *Combining disciplines*.

The internal drivers mentioned most were *Profits & Growth* (3 times) and *Innovation* (2 times). All interviewees seemed intrinsically driven to help Grontmij grow and generate more profit. The interviewees could not directly expect financial benefits for themselves, yet they seemed driven to contribute to increasing organisational performance. Innovation is the other internal driver mentioned by more than one interviewee. Such innovation may be especially relevant for a project like the Smart City-project as it comes along with new or 'smart' ideas to assist future proof construction of the built environment.

From the 3 external drivers, 1 complements the literature review: *(Informal) gathering of employees*. The importance of this complementary external driver for the Smart City-project is stressed since it was reported in all three interviews. 'GUP[9]' was the informal gathering where the idea for the Smart City-project was first pitched. In this case it proved to be a platform for employees from different departments to start working together. Whether this joint endeavour would have happened without the GUP is uncertain, and therefore the GUP seems to be a good platform to start multidisciplinary projects. Table 6 provides an overview, including illustrating quotes, of all the reported drivers in the Smart City-project.

Table 6: Drivers for interdepartmental PSS development in Smart City-project

Driver	Quote
Internal	
Profits & Growth (3)	"*I was triggered by the theme, and I thought Grontmij should find a commercial answer and join this hype*" (Interviewee B)
Innovation (2)	*"It was something new, and I like innovation"* (Interviewee A)
Productivity & Quality	*"I had the believe that someone from Mobility had to be included in order to ensure more comprehensive knowledge"* (Interviewee A)
Personal benefit for employees	*"Personally I am working within my expertise on some products that could fit the 'smart' definition; sales could be boosted"* (Interviewee C)

[9] GUP is short for 'Grontmij Underground Pioneers' and is basically a lunch meeting, hosted every other week, where employees can share knowledge, ask for help or pitch an idea and thereby connect with people who are interested in the topic.

Challenge	*"The challenge of finding use for this hype within Grontmij was appealing"* (Interviewee A)
Combining disciplines	*"The smart city concept seemed to be a great opportunity for combining disciplines"* (Interviewee A)
External	
External best practice	*"Cities, like 'Smart Amsterdam', who have already engaged with this show the relevance of the topic"* (Interviewee B)
Champion (employee) (2)	*"Employee X' enthusiasm ensured that the project took off, and that follow up meetings were planned."* (Interviewee B)
(Informal) gathering of employees (3)	*"My enthusiasm was triggered through the GUP"* (Interviewee C)

5.2.3 Barriers to interdepartmental PSS development

The interviewees from the Smart city-project identified 14 barriers. 10 barriers were distinguished in the literature review, whereas 4 new barriers were reported: *Conflict due to billing*; *Lack of ownership*; *Lack of knowledge on how to approach*; and *Unequal contribution*.

The barriers mentioned most were *No clear responsibilities* (3 times) and *Conflict due to billing* (3 times). Conflict due to billing means that individuals in Grontmij have to be able to bill their working hours on a project that is paid by clients. If, for example, 80% of an employees' hours are billable, this 80% percent can be recovered from clients. Traditional engineering firms make their profits of the margins they receive for the employees' billed hours. Thus, a conflict due to billing means that the employee has to be billable but at the same time wants to spend time on projects that are not issued by clients and therefore cannot be billed. When this time is not granted, time on innovations such as the Smart City will have to be spent in employees' spare time.

The other most mentioned barrier to interdepartmental collaboration, *No clear responsibilities*, might be related to the conflict due to billing. In line with Interviewee A (2015) quote in Table 7, the involved people were not held responsible by one another. He argued that a reason for this was that everyone contributed to the project in their spare time, which makes it difficult to demand output. Following from Table 7, the more project specific barriers will be discussed.

Table 7: Barriers to interdepartmental PSS development in the Smart City-Project

Barrier	**Quote**
No clear responsibilities (3)	*"We could not really hold each other responsible because everyone worked in their spare time"* (Interviewee A)

No clear goal / vision (2)	"*We simply did not have goals*" (Interviewee A)
Extra costs and/or time (2)	"*We worked on it in the 'lost hours', after work"* (Interviewee C)
Lack of leadership / No management support (Departmental) (2)	*"My department management could not approve before I could show how we would make money"* (Interviewee B)
Lack of leadership / No management support (Higher) (2)	*"It was the higher management that said that as long as we did not show how to make money, we should stop putting effort and time in it. This was the point where all the energy sank out of the Smart City team*" (Interviewee C)
Lack of confidence in the concept	*"We did not have a clear business case"* (Interviewee B)
Pragmatic concerns	*"The leader/initiator of the group left the company"* (Interviewee B)
Extra work load	*"I also had other things to do"* (Interviewee C)
Institutionalised organisational memory	*"It is new to intensively collaborate with other departments outside of your normal projects. That is why we return to old habits"* (Interviewee A)
Physical distance	*"Not everyone worked at the same office"* (Interviewee B)
Conflict due to billing (3)	"*It would have been great if management had given us billable hours to work on this. But billing has become the culture, resulting in few efforts to spend significant time on something innovative"* (Interviewee A)
Lack of ownership (2)	*"No one was in charge, no one showed ownership, no one gave orders"* (Interviewee B)
Lack of knowledge on how to approach	*"We had no idea on how to approach with such an innovation. We did not have a blueprint for the innovation process"* (Interviewee C)
Unequal contribution	*"Not everyone was equally involved and, for instance, filled out the forms on how your department's efforts can be related to Smart Cities"* (Interviewee B)

In the Smart City-project, certain reported barriers to interdepartmental collaboration are not specific to this project. For example *Conflict due to billing*, *Extra work* and *Extra cost and/or time* are barriers that have been reported in most project studies. This will become clearer in the next sections. The recurring barriers will be better discussed in the Discussion section.

Beside those barriers, barriers specific to the Smart City-project have also been observed. There was for example no common idea about the concept, which may have added to not having clear goals. Interviewee B argued that the biggest challenge was: "*different opinions of what a Smart City is/should be. Because no one was in charge of the 'project', there was no right or wrong*." Related barriers are the lack of ownership and no clear responsibilities, which were the biggest challenges according to Interviewee A. According to Interviewee B,

this lack of responsibility became even more apparent when the person who used to take most initiative, Employee X, left the company.

A further important finding is that there was no real management support for the Smart city-project, neither from departmental nor from top-management. Interviewee C even considered this to be the biggest challenge. He exemplified this by explaining that his department management did not provide space (in billable hours) and the higher management informed them to stop working on Smart Cities as long as they could not show how to make money with the concept. Lacking management support was thus a true problem; support might have helped overcoming the earlier mentioned barriers of conflict due to billing, extra time and work.

5.3 Case study project 2: IMBY

5.3.1 Assessing the degree of joint endeavour for project IMBY

People with knowledge on software building and other people with knowledge about construction activities had to be included in the IMBY-project. In this case, the team 'Projects' was in the lead and connected suitable people. As Interviewee D explained: "*Beforehand, I didn't know the people I ended up working with. We were matched based on skills.*"

For another departments it seemed more of a commercial task. For instance, Interviewee E: *"Of course we needed to be paid, we are a commercial department. If our payments had stopped for some reason, we would have had to stop contributing."*

5.3.2 Drivers for interdepartmental PSS development

The interviewees from the IMBY-project identified 4 internal and 5 external drivers. From the 4 internal drivers, 1 complements the literature review: *Champion (department).*

The internal driver mentioned most was *Innovation* (2 times). Apparently it was appealing for the interviewees to be involved in something that is not their daily business.

From the 7 external drivers, 3 complement the literature review: *Logical to get involved*; and *Competition (internal or external).*

The external drivers most mentioned were *Logical to get involved* (3 times), *Higher management* (3 times), *Internal competition* (2 times) and *Departmental management*. Both departmental and higher management has always been in favour of the idea, and ultimately opened up a project number. The (financial) support was vital in order to develop IMBY. However, it was reported that this process took longer than expected and therefore the interviewees sometimes doubted whether there was actual management support. The driver *logical to get involved* was applicable to all involved departments. This is because a complete different department, who did not have the skills to develop it, had come up with the idea for IMBY. Therefore they connected suitable departments and transferred the idea to them. So each of the interviewees was approached based on their knowledge and/or skills. The last

external driver mentioned in more than one interview is *internal/external competition*. In this case it was an internal competition 'Het Beste Idee van Grontmij (translation: The Best Idea of Grontmij)' hosted by team Projects, which has led to the idea of IMBY and therefore has driven the realisation of the actual 'product'. Table 8 provides an overview with illustrating quotes of all the reported drivers in project 'IMBY'.

Table 8: Drivers for interdepartmental PSS development in IMBY-project

Driver	Quote
Internal	
Innovation (2)	*"Developing a project, and thereby connecting our product, GeoWeb, with Grontmij's business is very rare and new"* (Interviewee E)
Champion (employee)	*"The owner of the idea did not have the required skillset to develop this idea, therefore she connected people from different relevant disciplines"* (Interviewee D)
Productivity & Quality	*"Collaboration between market context (what does the market want?) and our expertise. We are good in making stuff, but we do not know the market"* (Interviewee E)
Champion (department)	*"Department X contacted my department, and asked if we wanted to be involved"* (Interviewee E)
External	
Higher management (3)	*"Ultimately, they opened a project number which made the work on IMBY billable"* (Interviewee D)
Departmental management (2)	*"My management was in favour because they see it as our job to assist other departments"* (Interviewee F)
Markets & Customers	*"Connecting our products with Grontmij's business may lead to more sales in the future"* (Interviewee E)
Logical to get involved (3)	*"They asked me, because they needed someone from Management of the Environment, which is my expertise"* (Interviewee D)
Competitions (internal or external) (2)	*"We won the 2014 internal competition 'The Best Idea of Grontmij'" (*Interviewee E*)*

5.3.3 Barriers to interdepartmental collaboration

The interviewees from the IMBY-project identified 8 barriers. 6 barriers had already been distinguished in the literature review, whereas 2 new barriers were reported: *Conflict due to billing*; and, *Time to get finance*.

The barriers mentioned most was *Time to get finance* (2 times). The finance to develop IMBY was unexpectedly difficult to get. Although IMBY had won the internal competition, no budget was made available. It took a lot of effort and time to finally get this budget.

Table 9 provides an overview with illustrating quotes of all the reported barriers in project 'IMBY'.

Table 9: Barriers to interdepartmental PSS development in IMBY-project

Barrier	**Quote**
Language/culture differences	*"There was a culture difference. We needed some time to get to know and understand each other"* (Interviewee E)
Conflict in time	*"Sometimes I had to choose between jobs. We are with few people nowadays, hence I must choose the most important tasks"* (Interviewee F)
Pragmatic concerns	*"Poor recording equipment"* (Interviewee F)
Risk	*"The full financial risk was with my department. I would have wanted to share this risk with the other involved departments"* (Interviewee D)
Lack of leadership / management support	*"We thought we would easily get budget, because we had won the internal competition. This was not the case. To me it feels weird to host this competition, trigger employees' creativity, and in the end not putting effort in realising the winning idea"* (Interviewee E)
Organisational structure	*"The organisation is not structured for product development like this. Every euro had to be arranged before we could start doing something"* (Interviewee E)
Time to get finance (2)	*"I had to fight really hard to get finance. It cost me 3 months"* (Interviewee D)
Conflict due to billing	*"The time spent on IMBY had to be written on acquisition, which is not billable. This made it difficult for me to reach the required billing in this period"* (Interviewee D)

Interesting in the IMBY-project is that all barriers, except for one, have only been reported in one interview each. This could be due to the interviewees' different roles in the process of PSS-development. One interviewee developed the PSS, one had nothing to do with the development but was responsible for the internal and external communication, and one interviewee managed the project. Within each task, different barriers were perceived. The one barrier that was mentioned twice, *Time to get finance*, has stalled the whole operation and was therefore experienced by more people involved.

5.4 Case study project 3: Obsurv

5.4.1 Assessing the degree of joint endeavour

Obsurv is software that can help monitor all assets. In order to make this product/service, different departments had to be included in the development process; these departments could contribute with complementary knowledge that could benefit the software. However, the larger part of the work and the planning was done by GIS/ICT; the other departments provided input to create a more comprehensive end result. As matter of example, Interviewee G: *"My department took control, made choices and involved the right people from other departments."*

Other factors that could influence collaboration are the gains that involved departments could expect. Interviewee H: *"My department could not gain any profit from Obsurv, however my manager and I acknowledged the general value for Grontmij, so I remained involved."* Judging on Interviewee H, limited gain did not influence his department's involvement.

5.4.2 Drivers for interdepartmental collaboration

The interviewees from the Obsurv-project identified 5 internal and 5 external drivers. 4 out of 5 internal drivers had already been distinguished in the literature review, leaving *Champion (department)* as the only complementary driver.

The internal drivers mentioned most were *Avoiding risk* and *Champion (department)* (both 2 times). Risk can be perceived as increasing costs, decreasing stakeholders relationships, mismatch between market demand and company offer, and so on. The Obsurv-project was driven by the awareness of a growing mismatch between what Grontmij could offer and what the market demanded. Consequently, an answer to this 'risk' was sought and resulted in Obsurv. The driver *Champion (department*) is appointed to GIS/ICT who consulted and involved experts from different departments.

From the 5 external drivers, 1 complements the literature review: *Logical to get involved*.

The external drivers mentioned most were *Higher management* (3 times) and *Departmental management* (2 times).. Management support certainly drove the progress of Obsurv since a large budget was necessary to develop the software. Employees had to be given space to develop this 'product'. The main reason for the higher management to be in favour, as reported by the interviewees, were the exposure for Grontmij and the potential increase in sales. The department management shared the concern of lacking behind competitors and therefore supported this initiative.

Table 10: Drivers for interdepartmental PSS development in Obsurv-project

Driver	Quote

Internal	
Avoiding risk (2)	"*The older version of Obsurv was out-dated and could not ensure market share* " (Interviewee H)
Innovation	*"Making a better version of the old program DigiDialog"* (Interviewee I)
Productivity & Quality	*"Obsurv is an integral system, so we needed complementary knowledge to make it a good product"* (Interviewee I)
Champion (employee)	*"In the beginning, I took control, made choices and involved the right people"* (Interviewee G)
Champion (department) (2)	*"GIS/ICT needed experts from different disciplines. The 'matter experts', which are representatives from each department, were included in this process and approached by them"* (Interviewee I)
External	
Higher management (3)	*"The division director approved it because of the possibilities for exposure of Grontmij"* (Interviewee G)
Departmental management (2)	*"My management acknowledged that we were lacking behind, and thus saw the necessity of doing something differently"* (Interviewee G)
External best practice	*"Some young guys on TV showed how much impact they had generated with a simple program. That triggered me to get to action"* (Interviewee G)
Markets & Customers	*"It could lead to more customers for Grontmij, because customers working with Obsurv might want to have other problems solved by people who understand Obsurv"* (Interviewee I)
Logical to get involved	*"I was approached because my predecessor quit. I was second in line and I had knowledge in this field"* (Interviewee H)

5.4.3 Barriers to interdepartmental collaboration

The interviewees from the Obsurv-project identified 9 barriers. 4 barriers had already been distinguished in the literature review, whereas 5 new barriers were reported: *Conflict due to billing; Communication/not involved enough; Wrong people involved; Too ambitious;* and, *Top-down approach.*

The barriers mentioned most were *Communication/not involved enough* (2 times) and *Conflict due to billing* (2 times). Both Interviewee H and I stressed the former by explaining they had been consulted too marginally; they felt like they could have added more value if they were better used. Besides, they reported that there had been no communication about when they would start being less involved in the process. Table 11 provides an overview with illustrating quotes of all the reported barriers in project 'Obsurv'.

Table 11: Barriers to interdepartmental PSS development in Obsurv-project

Barrier	Quote
Language/culture differences	*"There were cultural differences between departments, but I think we adjusted our language well"* (Interviewee G)
Extra costs and/or time	*"It costs much time to meet up, I think that is why it happened so little. That is a shame"* (Interviewee I)
Lack of leadership / management support	*"I thought my management was in favour, yet they did not grant me extra space"* (Interviewee I)
No clear goal / vision	*"Only now we have a vision of where we want to go to. This was not clear in the beginning"* (Interviewee H)
Communication / not involved enough (2)	*"Sometimes I felt like I was calling in a desert. They did not want to hear how my module could be included"* (Interviewee H)
Conflict due to billing (2)	*"The need to get my billing led to me not pushing to hard for more involvement. Although this may been good for the product"* (Interviewee I)
Top-down approach	*"At first, GIS dictated. Right now it is getting better and most steps are discussed with the involved actors"* (Interviewee H)
Wrong people involved	*"We started off with the wrong product manager. We should have changed him earlier"* (Interviewee G)
Too ambitious	*"I believe that the ones in charge were too ambitious. We should have approached it more stepwise in my opinion, and they were reaching for the sky"* (Interviewee I)

Specific for the development of Obsurv is that different stages resulted in different experienced barriers to interdepartmental collaboration. At first, the goals and the vision for Obsurv were not clear for some of the involved departments; there seemed to be little communication. Also, in the earlier stages the hours worked on Obsurv could not be billed. Besides, in the beginning the actions were pure top-down due to which decisions were dictated instead of discussed. Lastly, an incompetent product manager played a prominent role and was ultimately replaced by a very competent substitute. As can be noticed, the line of argument here is that the Obsurv-project experienced quite some trouble in the beginning but the situation has improved.

5.5 Case study project 4: N211

5.5.1 Assessing the degree of joint endeavour

The N211 (engineering an energy neutral road) is a project structured in a way that is common for an engineering company; an incoming tender. This tender enters a specific department (in this case Roads), and that department involves colleagues from its own and

from other departments that can have an added value for this tender offer. Interviewee L represented one of those departments that got involved at a later stage and explained: *"The subject included contract management and risk, we happen to specialise in that. Therefore they needed someone from our department."* Interviewee J, who was the project leader, confirmed this and reasoned: *"The product 'road' can become much better if different expertises share their thoughts."*

5.5.2 Drivers for interdepartmental PSS development

The interviewees from the N211-project identified 6 internal and 4 external drivers. Two internal driver complement the literature review: *Champion (department);* and *Challenge*.

The internal drivers mentioned most were *Innovation* (2 times) and *Profits & Growth* (2 times). Both internal drivers have also been reported in most other projects, and the explanation for the N211-project is not much different. The interviewees seem to care about Grontmij and therefore like to engage in projects that could lead to more profits and growth for the company. They are internally motivated to create a better position for their organisation. The other most mentioned internal driver, *innovation*, concerns the individual; they like to work on projects that have a highly innovative character.

From the 4 external drivers, 2 complement the literature review: Tender; an *Logical to get involved.*

The external drivers mentioned most were the *Departmental management* (3 times) and *Tender* (3 times). As for the departmental management, all three involved departments were in favour of this project. More specifically to this project, an incoming Tender was a major driver for people to get involved in the collaboration. This tender enters a specific department (in this case Roads), and that department involves colleagues. Interviewee J acknowledged that it was not his department's first thought to directly include other departments: "*The first thought is: can we do it ourselves? If not, we ask others*." Table 12 provides an overview with illustrating quotes of all the reported drivers in project 'N211'.

Table 12: Drivers for interdepartmental PSS development in N211-project

Driver	**Quote**
Internal	
Innovation (2)	*"I really liked the topic, because of its innovativeness"* (Interviewee K)
Profits & Growth (2)	*"The opportunity of creating a template for other customers appealed. This might lead to more work in the future"* (Interviewee K)
Productivity & Quality	*"We have all the knowledge in house. If you manage to blend and integrate this, you can add value. The product 'road' can become much better if different expertises share their thoughts"* (Interviewee

	J)
Champion (employee)	*"Inspiring 'leader' who knew everything about the content and spread a 'we will win' vibe"* (Interviewee L)
Champion (department) (2)	*"As soon as it was decided that I would lead the tender, I was responsible for involving other people/departments who I considered relevant"* (Interviewee J)
Challenge	*"An interesting challenge, we had never done something like this before*" (Interviewee K)
External	
Departmental management (3)	*"My management sees it as the core of the business we do"* (Interviewee L)
Higher management (2)	*"Such projects fit the vision of Grontmij. Among our core areas are Infra and Energy. If we can do projects where we combine the two, the top management is highly in favour"* (Interviewee K)
Tender (3)	*"The tender entered my department […]"* (Interviewee J)
Logical to get involved	*"I sort of had to get involved as someone from our department was required"* (Interviewee L)

5.5.3 Barriers to interdepartmental PSS development

The interviewees from the N211-project identified 6 barriers. 5 barriers had already been distinguished in the literature review, whereas 1 new barrier was reported: *Wrong people involved*.

The barriers mentioned most was *Conflict in time* (3 times). The former was basically due to the amount of work that had to be done for this project, while at the same time other projects required effort too. This resulted in prioritising one over the others without necessarily making more money through that project. Table 13 provides an overview with illustrating quotes of all the reported barriers in project 'N211'.

Table 13: Barriers to interdepartmental PSS development in N211-project

Barrier	**Quote**
Conflict in time (3)	*"I prioritise this, which means that I can spend less time on other projects. That is sometimes difficult"* (Interviewee K)
Language/culture differences	*"There was a culture and a language barrier. However, this was solved when we met up. Then one could explain themselves, which is more difficult via email"* (Interviewee J)
Extra costs and/or time	"*It costs extra time to find the right people. But it will result in*

	saving time during the project" (Interviewee J)
Risk	*"We had to drop our price. This led to fewer profits and therefore higher risks"* (Interviewee J)
Interdepartmental competition	*"There was a part competition. Do we let other people write the contracts, or shall we do it ourselves? Normally you choose for you own department"* (Interviewee J)
Wrong people involved	*"The chosen substitute of employee X did not match the profile that I had in mind. So I had to kick him out and look for a more suitable person"* (Interviewee J)

Barriers to interdepartmental collaboration reported in de N211-project that have been observed in most of the explored projects are: *Conflicts in time*, *extra costs/time* and *language/culture differences*.

A barrier specific to this project is *Interdepartmental competition*. Interviewee J highlighted that this phenomenon is inherent to the way the organisation is structured, and implies that he does not totally agree with this structure: "*Usually you choose to engage people from your own department and only ask others if you do not have space. In the end it is all about Grontmij, so it shouldn't matter who does the work."*

5.6 Case study project 5: Recircle the Olympics

5.6.1 Assessing the degree of joint endeavour

Recircle the Olympics was the output of an external competition to attract the Olympics to the Netherlands. The project is different from the other projects because the order, from idea to collaborative group, was reverse. In this event, first employees from different disciplines volunteered to form a project group. Once this group was defined, brainstorm sessions to create and develop an idea were held. From here onwards the project borders slowly became clearer.

Interviewee O explained that, within this group, all group members fulfilled similar functions: *"We did not really have different roles. Everyone was equally responsible for idea generation as well as the rest of the process."* Also, it appeared that everyone was equally responsible for the end result, Interviewee M: "*Although we could not all spend an equal amount of time on this, the result really was a team effort to which everyone contributed a significant share.*"

5.6.2 Drivers for interdepartmental PSS development

The interviewees from the RTO-project identified 3 internal and 4 external drivers. All three internal drivers had already been distinguished in the literature review.

The internal drivers mentioned most were *Personal benefit for employees* (3 times), Champion (employee) and *Innovation* (both 2 times). Innovation and champions have been reported in almost all researched projects, and is not much different with RTO. The internal driver mentioned most, *personal benefit for employees*, is however more specific to the RTO-

project. All three interviews argued to some extent that they were keen to use this project as a possibility to learn from others and from other departments. They showed a drive to develop themselves. Interdepartmental collaboration seemed the right fit. This is different from the other projects, where the product/service appeared as stronger incentive for the collaboration. A reason for this finding could be the function and working experience of the interviewees: juniors as opposed to seniors and managers in the other projects under study.

From the 4 external drivers, 1 complements the literature review: *Competitions (internal or external)*.

The external drivers mentioned most were the *Higher management* (3 times) and *Competition (internal/external)* (3 times). The higher management supported the idea, as Grontmij's general manager is a member of NL-engineers, whose youth branch organised this competition. Besides, it offered a way of exposure for Grontmij. For the involved employees, the main external driver was the competition organised by young NL-engineers. By means of this competition, a problem was framed. It was up to the teams of applicants to come up with solutions. Without the competition, the project would most probably have never emerged. Table 14 provides an overview with illustrating quotes of all the reported drivers in project 'RTO'.

Table 14: Drivers for interdepartmental PSS development in RTO-project

Driver	**Quote**
Internal	
Personal benefit for employees (3)	*"Personally I wanted to learn from different departments, and get out of the little bubble I am working in"* (Interviewee O)
Innovation (2)	*"I think the Olympics are amazing. So, to think of smart ways how to attract these games to the Netherlands really appealed"* (Interviewee O)
Champion (employee) (2)	*"Employee X sent an email around to connect people"* (Interviewee M)
External	
Higher management (3)	*"General manager Ton de Jong was in favour of the idea. His main reasons were: exposure for Grontmij and improving visibility for engineering firms"* (Interviewee N)
Departmental management (2)	*"My department management thought this was something good, especially for networking and my personal development. Therefore, I could write hours for learning days etcetera without getting into trouble"* (Interviewee M)

Profits & Growth	*"External opportunity provided by NL-engineers to get some media attention to the engineering sector. This could benefit future processes"* (Interviewee O)
Competitions (internal or external) (3)	*"The driver behind this idea was the external competition, organised by young NL-engineers, to get rid of the solid and grey image of the engineering sector"* (Interviewee N)

5.6.3 Barriers to interdepartmental PSS development

The interviewees from the RTO-project identified 6 barriers. 4 barriers had already been distinguished in the literature review, whereas 2 new barriers were reported: *Unequal contribution*; and, *Conflict due to billing*.

The barriers mentioned most were; *Unequal contribution* (3 times) and *Physical distance* (2 times). The interviewees explained that it would have been preferable if all involved actors could have contributed equally, however everyone had been very transparent about the time they could spend on RTO. Thus, it was a perceived barrier but it did not lead to serious friction. Physical distance or, in other words, not working in the same office was reported to be hindering the collaboration. For this reason it was more difficult to arrange meetings and team members sometimes turned up too late because of traffic jams. Table 15 provides an overview with illustrating quotes of all the reported barriers in project 'RTO'.

Table 15: Barriers to interdepartmental PSS development in RTO-project

Barrier	**Quote**
Physical distance (2)	*"Not working in the same office. Distance to travel for a meeting was annoying"* (Interviewee N)
Lack of leadership / management support	*"We did not get budget for this"* (Interviewee M)
Language/culture differences	*"There were language barriers. For instance GIS/ICT have never heard of a contract"* (Interviewee N)
Lack of interest from actors	*"Not everyone found it equally interesting. Because we started with big ideas, but ended up with a smart form of a contract"* (Interviewee N)
Unequal contribution (3)	*"Not all departments contributed equally. I have worked some nights until 12, while others have not. But we discussed this beforehand"* (Interviewee M)
Conflict due to billing	*"This project did not make money, which was a reason why we could not spend too much time on it. However, within my department we have to be 90% billable. So, the other 10% can be spent on things like this. If I, for instance, would reach only 80% but I have filled my time working on Recircle the Olympics, that would not have been a*

problem." (Interviewee O)

Barriers specific to this project are *Unequal contribution*, which has been discussed above Table 15, and *a lack of interest from actors*. The latter can mainly be explained by the non-specificity of the project. With RTO, first a team of enthusiastic colleagues was made, and second this team started brainstorming about ideas. From these brainstorm sessions, several ideas emerged, one of which was RTO. Involved colleagues might have been more in favour of a different solution to the presented problem and might therefore have slowly become less enthusiastic throughout the project's progress.

The previous sections presented empirical findings on drivers and barriers that interviewees have experienced in five interdepartmental projects. In the following section, an overview is given of existing strategies within Grontmij that could potentially foster the drivers and overcome reported barriers to interdepartmental PSS development.

5.7 Strategies to foster interdepartmental collaboration

The reported barriers to interdepartmental collaboration were reported in the context of the specific cases, while the strategies were reported in the general context of Grontmij's initiatives for inducing interdepartmental collaboration. The reported strategies either directly contribute to interdepartmental collaboration, through collaboration practices, or indirectly, by means of knowledge sharing which could lead to interdepartmental collaboration. The two most mentioned ways that could increase interdepartmental collaboration are: *Insite* (9 times mentioned) and *GUP* (8 times mentioned). Insite is a digital platform on which all kinds of information are shared and where each employee's contact details are registered. Therefore it is a means to share knowledge, and it can serve to find the appropriate people for a task. Although most interviewees acknowledged the potential of Insite, they were not solely positive about it. For instance, Interviewee E: *"Functions or publications/trends on Insite are always written in technical jargon. Non-specialists have to be able to find you. We find external parties via Google, but we cannot even find our own people via Insite!"* GUP is short for 'Grontmij Underground Pioneers' and is basically a lunch meeting, hosted every other week, where employees can share knowledge, ask for help or pitch an idea and thereby connect with people who are interested in the topic. Like Insite it is meant to connect people, which could in turn lead to interdepartmental collaboration. An example of the GUP's potential to increase inter-departmentalism can be found in another strategy for interdepartmental collaboration: *Commercial activity Vuilfuik*. The Vuilfuik is an invention by Grontmij that was not commercialised well enough, and hence did not reach its commercial potential. Through the GUP, different departments joined forces to 'sell' this product together. As opposed to Insite, GUP merely received positive comments from the interviewees. For example, Interviewee G: "*GUP is a great form to stimulate multidisciplinary collaboration because of two reasons. One, it is a bottom-up initiative, and two, people just try to help each other, without being counteracted/locked in by departmental interests."*

Another recognised strategy to induce interdepartmental collaboration (by 5 interviewees in total) is *team projects*. This is a team that is specialised in managing projects, although they do not possess specific knowledge on the content. They work with different departments each time and can therefore apply lessons learnt in previous collaboration to new situations.

Internal and *external competitions*, mentioned 2 times each, also provide the opportunity for inter-departmentalism. Engaging with the internal competition 'The best idea of team projects' and external competition 'Doe en Durf' have resulted in interdepartmental collaboration. Subscribing to or hosting such competitions could thus be explained as a strategy to foster interdepartmental collaboration.

The last strategy discussed is a knowledge sharing method that is not aimed at integrating departments, but rather at integrating teams within a department: *Weekly team discussions*. It is a way to update each other on what all the different teams are doing. According to Interviewee H, it is better to "*Keep it small. It is easier to understand what people in a different team from the same department are doing than what someone from an entirely different expertise is doing".* With this statement, Interviewee H seems to imply that employees should first know what their own department is capable of, before focussing too much on knowledge sharing between departments.

Some strategies/approaches to promote interdepartmental collaboration at Grontmij are recognised by more interviewees than others. Recognition does not provide any evidence as to the value of a specific strategy. Nevertheless, the most recognised strategies are probably better communicated throughout the organisation (e.g. GUP) or integrated in daily business (e.g. Insite). The interviewees at Grontmij reported 25 strategies/approaches (Table 16). From the 25 strategies, 7 are aimed at promoting collaboration through digital means and 8 through invoking formal groups or formal meetings. The first column in Table 16 encompasses the category to which the strategies/approaches have been appointed. The second column presents the strategy/approach and the third column shows the number of times an approach was mentioned in the interviews.

Table 16: Existing strategies to induce interdepartmental collaboration at Grontmij

Category	Strategy or approach to foster interdepartmental collaboration	# of times mentioned
Competition	Engaging in external competitions	2
	Internal competition: 'the best idea of team projects'	2
Decrease distance	Abolition of different business units	1
	Decrease in number of offices (encouraging physical proximity)	1
Digital communication	Conference calls	1
	Enabling Lync-calls[10]	1
	Webinars	1
Digital knowledge share platforms	Insite	9
	Knowledge platforms/team sites	1
	Newsletters	1
	PROUD-sheets[11]	1

[10] Communications software to make or receive a phone call via your computer, for free.

	Yammer[12]	1
Formal groups	Team projects	5
	ALV (general staff meeting)	1
	Company Boards (energy, water, roads)	1
	LPV (Staff association)	1
	Young Grontmij	1
Formal meetings	Lunch readings/ knowledge share sessions	4
	Networking days	1
	Weekly team discussions	1
Informal meetings	GUP	8
	After work drinks	2
Other	Commercial activity Vuilfuik	1
	Education of regional teams, by other departments	1
	Engagement in big tender projects	1
	Top-bottom approach	1

[11] Grontmij's database of project references. Using PROUD-sheets makes information on Grontmij projects easy to retrieve. In addition to Dutch Grontmij projects, also Belgian, Danish, French and Growth segment projects can be found there.

[12] Yammer is a private social network that helps employees collaborate across departments, locations, and business apps.

6. Discussion

In this chapter the project-specific findings are compared and discussed in relation to each other and the literature review. This chapter aims to provide answers to the first four sub-questions formulated in chapter two. The same topics as in the findings section are discussed respectively: Level of joint endeavour, drivers for interdepartmental PSS development, barriers to interdepartmental PSS development and strategies to foster interdepartmental collaboration.

6.1 Different levels of joint endeavour

In this section, the findings attributed to the joint working processes are related to literature (see section 3.2, p. 18). The main reference is Camarinha-Matos et al. (2006), complemented with Oldero (2002) and Lozano (2007). Based on these sources, the levels of joint endeavour in the five investigated cases can be classified as (combinations of) communication, coordination, cooperation or collaboration. This discussion therefore provides an answer to the sub-question: *What degree of joint endeavour can be observed in interdepartmental PSS projects?*

Smart City

Interviewee C stressed that, apart from smart city group goals, he had goals for his own department. This is in line with the definition of coordination by Camarinha-Matos et al. (2006), who stated that actors might have different goals, yet one department's goals could add to one another's goals. Interviewee A pinpointed the lack of ownership and responsibility as reasons that hampered the joint endeavour. Ownership and responsibility are elements that are included when aligning activities, which is of major importance in coordination (Camarinha-Matos et al., 2006). Based on Interviewee A, such alignment was not properly in place throughout the Smart City-project. Thus, it appears that the form of joint endeavour was **coordination**. However, efficient coordination was not even in place yet.

IMBY

Interviewee E argued that their department is commercial and would not have continued working on IMBY whenever the payments had stopped for some reason. Oldero (2002) defined cooperation similar to collaboration, however if one player feels that there is nothing to gain anymore, the collaboration will end. That is when the difference between collaboration and cooperation becomes apparent. Judging on Interviewee E, a stop in payments would have ended the department's efforts to contribute. Therefore, in the IMBY-project, **cooperation** seems to have been in place.

Obsurv

Interviewee G highlighted that his department was in control and made all evident choices. This concurs with Camarinha-Matos et al. (2006) who explained that cooperation is in place whenever one actor defines the common plan and the other actors contribute by providing pieces of the puzzle. These authors furthermore stated that within cooperation, the goals of all involved actors are compatible since their results can be composed in a value chain leading to

the end product or service. This situation was present in the Obsurv-project, as all separate goals seemed compatible and contributed to the same end PSS: Obsurv.

Interviewee H provided a different perspective and argued that his department could not gain any profit but still continued to contribute. This is contradictory to Oldero's (2002) definition of cooperation, who stated that cooperation breaks when one actor feels there is no more gain for them. This continuation of joint endeavour, even though no direct gain could be observed, is a characteristic of collaboration (Oldero, 2002). Thus, the joint efforts throughout Obsurv's development can mainly be classified as **cooperation**, complemented with some **collaboration** aspects.

N211

The findings showed that the Roads department was in charge of the planning and took care of the larger working load of this project. According to Camarinha-Matos et al. (2006), if the lead is taken or the plan is made by a single entity, the level of joint endeavour is cooperation. However, within N211 space was provided for all involved departments to brainstorm and influence the end result. Each project-member was encouraged to come up with creative solutions. Camarinha-Matos et al. (2006) consider jointly planning, evaluating activities and being mutually engaged to solve problems together characteristics of collaboration. Accordingly, the project can be seen as partly **cooperation** and partly **collaboration**.

RTO

Interviewee M and Interviewee O explained that each team member was equally important for idea generation, planning, and the rest of the process. Camarinha-Matos et al. (2006) stressed that jointly planning, implementing and evaluating activities and thereby sharing information and responsibilities in order to achieve current or future goals is a key characteristic of collaboration. Moreover, Camarinha-Matos et al. (2006) argued that collaboration involves mutual engagement of participants to solve a problem together. Thus, the level of joint endeavour derived from the RTO-project concurs with literature on the definition of **collaboration**.

Figure 6 presents the building block model from the literature review (which was based on Camarinha-Matos et al., 2006, Denise, 1999 and Lozano, 2007), but then edited to visualise the observed level of joint endeavour in the different projects. The figure serves as a summary of the discussion above on the levels of joint endeavour.

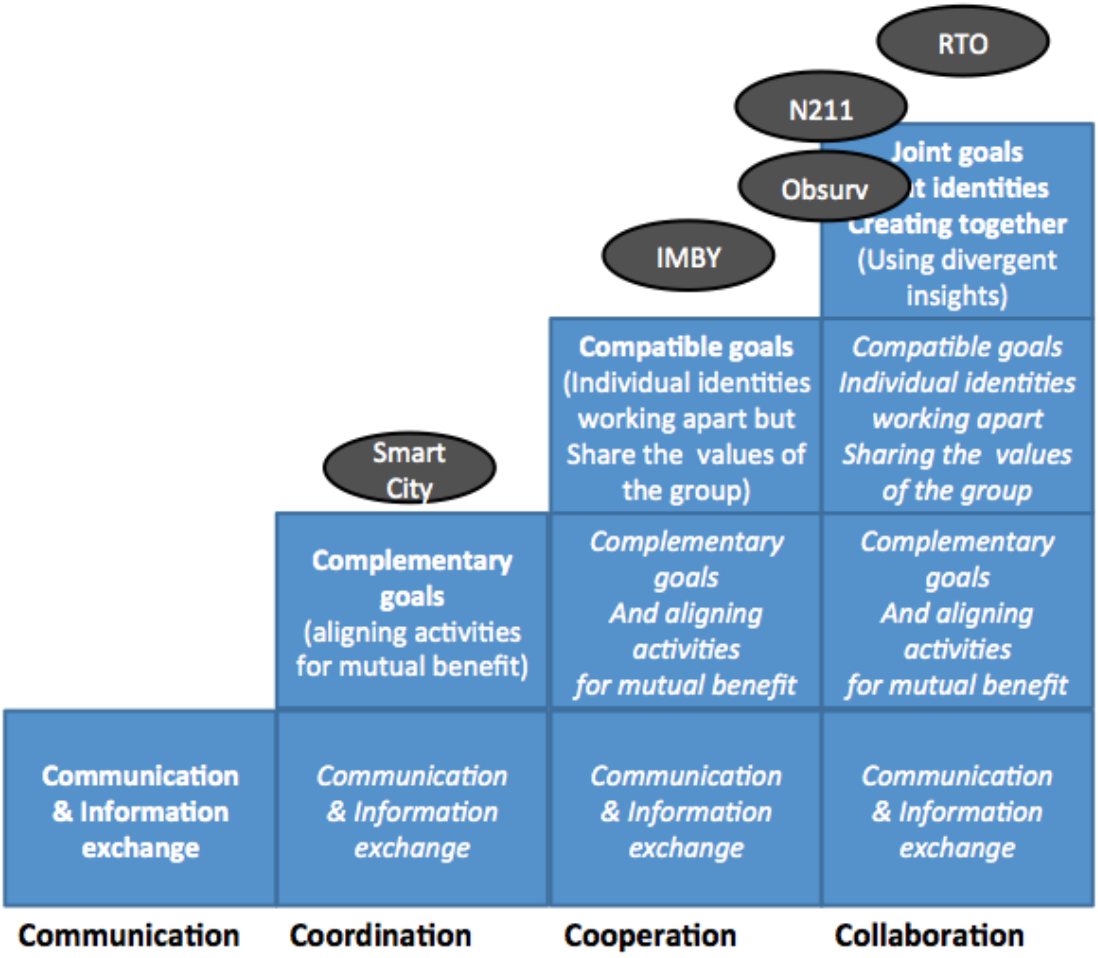

Figure 6: Classifying the five projects according to the level of joint endeavour that was present

Camarinha-Matos et al. (2006) and Lozano (2007) discussed that collaboration is the most advanced stage of joint endeavour. Neither author stressed that one level is better than another or likely leads to better results. In addition, Hansen (2013) argued that the goal of collaboration is not collaboration, but to increase results. He therefore agrees that other forms of joint endeavour can sometimes be more suitable. For instance, the Obsurv and N211-projects have so far generated most returns of the five projects (see Table 4, p. 38), and neither did work by means of complete collaboration. Thus, the above categorisation of joint endeavour does not mean that RTO applied the best way of working together. Nevertheless, from the five projects, the Smart City-team worked according to the least advanced form of joint endeavour. At the same time, this project produced fewest results. Arguably, this form of joint endeavour has influenced the project, but it cannot be appointed as reason for the lack of results. Many other variables, such as available finance, the people involved and case specific drivers and barriers, play part for the end result.

6.2 Drivers for interdepartmental PSS development at Grontmij

Since all the empirically found drivers per project have been distinguished, it is possible to filter the most evident findings. In section 6.3.1 the most important internal and external drivers are discussed. The section concludes with a compendium of all the reported internal and external drivers, divided between drivers for the interdepartmental collaboration and

drivers for the PSS-project. This compendium presents an answer to the sub-question: *What drives collaboration between departments in order to contribute to the development of PSS?*

6.2.1 Discussing the most important drivers for interdepartmental PSS development

Internal drivers

There were two internal drivers observed in each of the five projects: *Innovation* and *Champions*.

Innovation implies that, independent on the case, it has triggered team members to work on something novel. It could be that this is especially evident with employees within an engineering company; it is among their core tasks to design the cities and societies of the future, which comprises innovative solutions (Arcadis, 2016; Grontmij, 2016a). Nevertheless, in the literature review, innovation was reported as an internal driver in Lozano's (2013) framework, and reconfirmed in a variety of studies that did not focus on engineering firms. For example, Carnabuci & Operti (2013) reasoned that a key motive to join intra-organisational networks (sector independent) is to increase chances for innovation. Cuijpers et al. (2011) arguably concurs most with this thesis' situation, as that particular study found that innovation is a reason to engage with interdepartmental collaboration. The driver 'innovation' concerns the topic of the project, and would, based on the quotes in Tables 6, 8, 10, 12 and 14, perhaps also be present when the topic included innovation within one department. Therefore, innovation is considered to be driving the project, but not necessarily the interdepartmental collaboration.

Champions are employees who bridge the gap between the innovator and the organisation. They function as internal drivers who can accelerate the process by enthusing, involving and connecting the right people (Lozano, 2006; 2013). For Grontmij this means that for some employees the borders of their own departments are not restricting. It should be noted that also a different form of champions was reported as a driver; *Champion (department)*. This driver means that a department embodied the connecting role, rather than a single champion. Since champions connect people, the drivers are understood as driving the collaboration, rather than the project directly.

An internal driver that was reported in most of the projects (4 out of 5) is *Productivity & Quality*. It implies that certain team members are, already before the actual collaboration, aware of the opportunity and benefits from accessing knowledge/skills from other departments. This finding was reported in Lozano's (2013) driver framework. It furthermore appears to concur with Stacey (2007) who suggested this driver by arguing that accomplishing interdependent tasks that one could not do alone, is an internal driver partly responsible for the existence of collaboration. Hence, it seems that this driver has primarily driven the collaboration more so than the project.

External drivers

The external drivers mentioned in most projects are *Support of Higher management* and *Department management* (both 4 out of 5). This finding shows the value of having

management approval for PSS development. Innovations cost time and money, which management can make available. Therefore, management is considered a driver for the project to pursue but not necessarily for the interdepartmental collaboration. The four projects that were to some extent supported by management have all reached a stage of completion. The one project that did not, can present the least advanced results (Smart City). In the literature review, management support has been referred to as 'Leadership'. Leadership is often considered to be an internal driver in literature (e.g. Lozano, 2013), as it comprises top-down leadership to pursue changes. In this thesis, there was no strong top-down leadership perceived throughout the projects. In most projects there seemed to have been only management support to develop the innovation (as proposed by Denise, 1999; Keegan & Turner, 2002). In some projects (IMBY and RTO) employees were even supported to subscribe for a competition. This can be related to for example Carter et al. (2012) or Gill (2002) who argued that management support comprises motivation efforts and empowerment of employees. Denise (1999) took it a step further and explained that management support requires leadership, which encompasses management who develops and communicates a corporate vision on, in this case, interdepartmental collaboration for PSS development. Camarinha-Matos et al. (2007) understand leadership as 'Management's use of personal power to organise success stories'. The latter two have not been observed in the five investigated projects. Thus, no guiding leadership (internal driver) but a basic form of management support (external driver) was present.

In addition, an external driver worth mentioning is *internal and external competitions.* Although competitions were not explicitly mentioned as drivers for change in the literature review, a related driver, *Rewarding employees,* was mentioned (see Song et al. 1997). It appears that rewarding employees does not necessarily have to be through financial means. Instead, enabling employees to join a competition can work as an incentive for interdepartmental PSS development. Since the competitions resulted in employees forming interdepartmental teams, competitions are in the context of this thesis considered to be driving the collaboration.

General discussion on drivers

The Smart City-project showed the most differences in relation to the other projects. For instance, when the reported internal and external drivers are compared. It shows that only for the Smart City-project the drivers were mostly of internal kind. In the four other projects, external drivers were main reasons for the collaboration to occur. At the same time, 'Smart City' is the only project that has never reached a stage in which actual products were made or services were delivered (see Methods section 4.2.2, Table 4, p. 38). Based on these findings, it could be argued that external drivers are more important for the advancement of PSS projects at Grontmij. Yet, Song et al. (1997) and DeSimone & Popoff (2000) highlighted the opposite. These authors argued that internal drivers have stronger impacts than external forces on changing towards cross-functional integration and CS respectively. This difference might be explained by the nature of the distinguished drivers. Whereas Song et al. (1997) and DeSimone & Popoff (2000) speak about a strong intrinsic organisation-level will to change, the investigated projects concern drivers to change on employee-level. In other words, if an

organisation's top management is intrinsically motivated to change towards a new situation, they can utilise their power to make this change happen; the internal driver is considerable. If an employee is intrinsically motivated to change the status quo in an organisation, the person likely has to involve powerful people to make this change happen. If those powerful people get involved, they can be considered external drivers for the employee to make the change happen. Hence, as most interviewees are 'normal' employees, the external drivers appear to have had the most substantial impact.

The reported level of management support can exemplify the just described difference between literature and empirical findings. In contrast with the other four projects, the Smart City-project interviewees reported an absence of any form of management support. Thus, this external driver helped the other projects continue, whereas the lack of it hindered the Smart City-project.

A final point of discussion is the driver *Profits & Growth*. This driver can be considered a remarkable finding as it is presented as internal driver in two projects (N211 and Smart City), which complies with Lozano (2013), and as an external driver in one project (RTO), which is additional to the theoretical framework. The difference is that in the first two projects, the interviewees seemed intrinsically motivated to help the company a step further; the appealing opportunity for extra business. In the RTO-project it was not an internal drive for employees to ensure Grontmij's growth. Rather, when pursuing the idea of RTO, the team realised their idea/innovation could lead to more work and hopefully more profit in the future.

In order to provide a comprehensive overview, a compendium of all reported internal and external drivers is presented in Table 17. The same number of internal and external drivers to interdepartmental PSS development has been found. This could indicate that there is personal motivation from the employees as well as recognition of external stimuli to change the organisation towards more interdepartmental PSS development. The key points from Table 17 have already been discussed in the previous paragraphs. Moreover, a division has been made between drivers that can be classified as drivers for the project and drivers that have induced the collaboration. In parentheses is shown how many interviewees from a specific project reported the driver and the drivers in italics comprise the ones that are additional to the literature review.

Table 17: Compendium of internal drivers and external drivers for interdepartmental collaboration, based on 5 project studies

Internal drivers (project)	**Project where the driver was mentioned**
Innovation	IMBY (2), N211 (2), Obsurv, RTO (2), Smart City (2)
Profits & Growth	N211 (2), Smart City (3)
Avoiding Risk	Obsurv (2)
Challenge	Smart City, N211

Internal drivers (collaboration)	
Champions	Smart City (2), N211, Obsurv, IMBY, RTO (2)
Productivity & Quality	Smart City, Obsurv, IMBY, N211
Personal benefit for employees	RTO (3), Smart City
Champion (department)	IMBY, N211 (3), Obsurv (2)
Combining disciplines	Smart City
External drivers (project)	
Higher management	IMBY (3), N211 (2), Obsurv (3), RTO (3)
Departmental management	IMBY (2), N211 (3), Obsurv (2), RTO (2)
External best practice	Obsurv, Smart City
Markets & Customers	IMBY, Obsurv
Profits & Growth	RTO
Logical to get involved	IMBY (3), N211, Obsurv
Tender	N211 (3)
External drivers (collaboration)	
Competitions (internal or external)	IMBY (2), RTO (3)
(Informal) gathering of employees	Smart City (3)

New empirical data

The empirical research confirmed the existence of a number of the drivers to change highlighted in the literature review, which indicates that these drivers can also be of relevance for interdepartmental PSS development. 6 out of 9 internal drivers and 4 out of 9 external drivers had already been identified in the literature review. The empirical research also provided new drivers, not mentioned in the literature review. The new internal drivers *Challenge* and *Combining disciplines* were only mentioned once and are therefore considered as drivers for an individual, but not necessarily for a whole project or an engineering firm. The third internal driver, *Champion (department)*, was mentioned more often; one department taking the lead and involving other departments. It has served as an important driver for interdepartmental collaboration and PSS development to start. This implies that people would like to engage in interdepartmental PSS development, yet they would rather join whenever some department takes initiative instead of taking own initiative. From the new external drivers, two comprise stimuli to which the interviewees did not have any control: *Tender* and *Logical to get involved.* It means that the interviewees were placed in specific project-teams, independent on their own preferences. Such placement was induced from top-down and certainly drove interdepartmental collaboration for PSS development. *Competitions* have been discussed prior to table 17, and *(Informal) gathering of employees* comprise meetings in which people come together to discuss market opportunities, company risks and innovative ideas amongst others. These meetings drive knowledge sharing and could result in interdepartmental PSS development projects. The last external driver is *Profits & Growth* and

is new because it was highlighted as an internal driver in the literature review, but reported as internal and external driver in this thesis (as explained on p. 70).

Frame*work of drivers to interdepartmental collaboration for PSS development*

As indicated before, drivers for interdepartmental PSS development can either encompass stimuli to collaborate with other departments, or stimuli to develop a PSS. Table 17 already included such a division. This division is important for a company to gain understanding on whether there is enough incentive for employees to work together with other departments and whether particular projects appeal enough.

By adding this division to Lozano's (2013) drivers-framework in the literature review (Figure 3, p. 25) whilst keeping the division between internal, external and connecting drivers, Figure 7 is proposed. The connecting drivers are somewhat different from Lozano (2009), who explained them as drivers to change that link the internal and external drivers (Lozano, 2009). In figure 7, the connecting drivers encompass drivers that can induce the project as well as the interdepartmental collaboration and can therefore still be internal or external. In the figure, the top layer (1) includes drivers that could induce interdepartmental collaboration, whereas the bottom layer contains drivers that could induce a PSS project (2). The connecting drivers separate the top and bottom layers. In addition, similar to Lozano (2009), drivers inside the circle represent internal drivers, whereas those outside the circle are external drivers.

In this figure, drivers that were mentioned in the literature review and confirmed in the empirical data are highlighted in green. Those that were mentioned in the literature review but not reported in the findings are presented in yellow, whereas the drivers in blue represent the drivers that are complementary to the literature review. Even though the drivers represented in yellow were presented as drivers to CS oriented change in the literature review (and have not been confirmed in this research on interdepartmental PSS development), they are included in figure 7. The main reason for this is that including those drivers ensures a broader baseline for future research in interdepartmental PSS development. The aim of figure 7 is to offer a broad basis and better understanding of drivers for interdepartmental PSS development.

When interpreting figure 7, it appears that mostly internal drivers for interdepartmental PSS development can serve as stimuli for the collaboration, whereas mostly external drivers could induce starting PSS-projects. This might be the case because external drivers (such as *market expectations* and *subsidies*) relate to the output of firms; the PSS that can be commercialised. The process that led to such a PSS (in this case interdepartmental collaboration) is only an indirect consequence of the demand for a PSS. Internal drivers (such as *culture* and the expected increase of *productivity & quality*) basically provide a basis from which PSS development can start. In other words, people find personal motivation to collaborate with colleagues from other departments at first, which can consequently lead to developing new PSS. As mentioned before, the connecting drivers can stimulate both the collaboration and the project. For example, *attracting and maintaining labour* is an internal connecting driver that can be explained by means of the innovation output of a firm; employees are keen to work for firms that are known for developing (PSS) innovations. At the same time, if a company is

known for offering employees an environment of working together with and therefore learning from different departments, this could also attract and maintain labour. In addition, *Leadership*, *access to markets and customers* and *corporate and brand reputation* are connecting drivers that could be driving the projects/collaborations internally as well as externally. For example, *leadership* could imply management approval to start a PSS-project or approval of employees' collaborative actions with other departments (external connecting driver). Similarly, *leadership* can also be pro-actively used; use of power to create interdepartmental teams or PSS-projects (internal connecting driver).

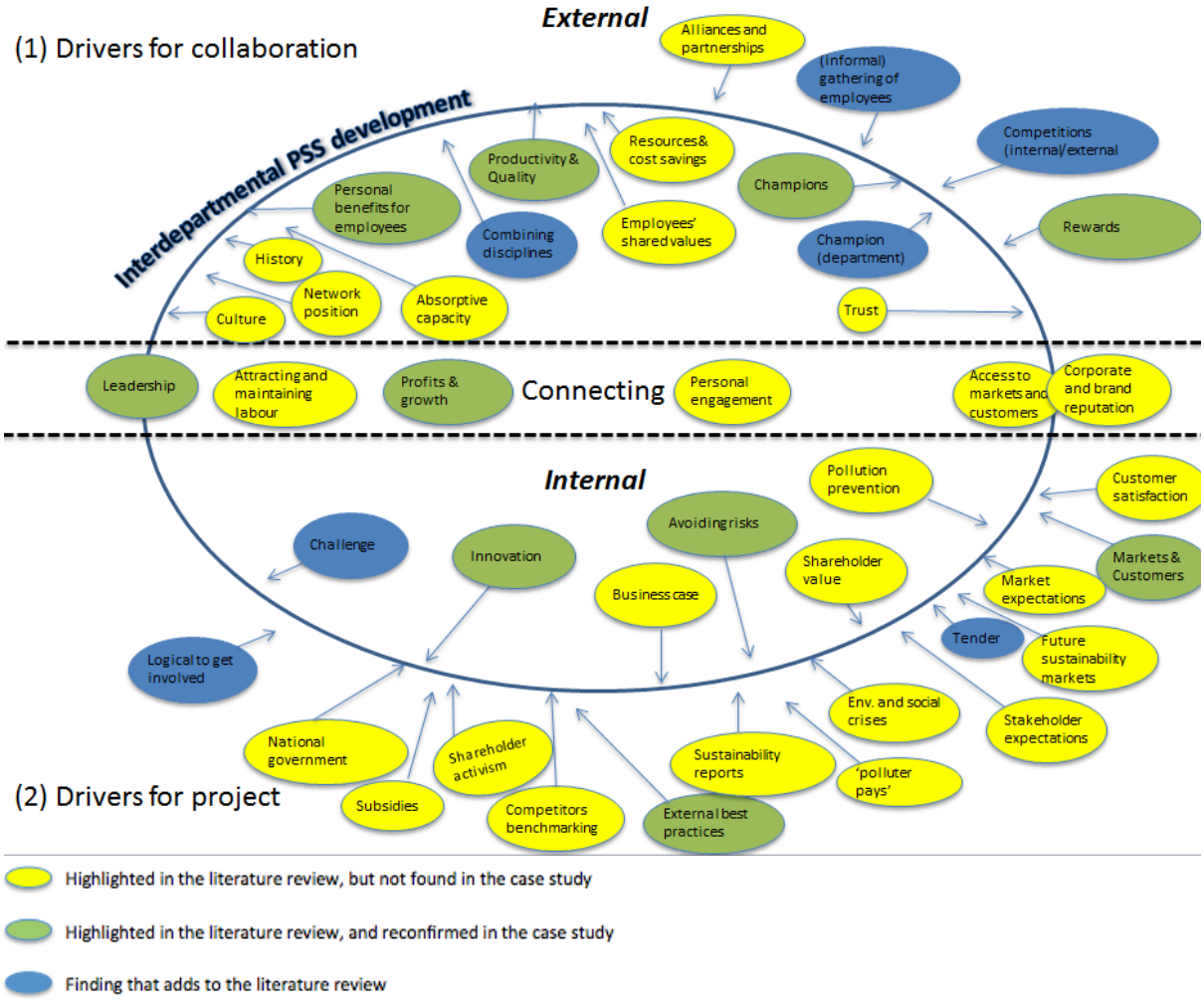

Figure 7: Framework of drivers for interdepartmental PSS development, separated between internal and external drivers and drivers for the project or the collaboration[13]

[13] Lozano (2009) included some more drivers for CS oriented change in his framework. Since these drivers could not directly be placed in one of the proposed categories, they have been excluded from the figure. These excluded drivers are: ethics; precautionary principle; generate/restore trust; social legitimacy; ease regulatory pressure; international treaties; raising student awareness; limited operations areas; access to natural resources; and, license to operate

6.3 Barriers to interdepartmental PSS development at Grontmij

The reported barriers to interdepartmental PSS development were examined per project, which makes way to compare the findings between the projects. In 6.4.1, the most important barriers to change are discussed. Following, a compendium of all the reported internal and external drivers is presented (Table 18). This compendium provides answers to the sub-question: *What challenges collaboration between different departments in the development of PSS?* The section concludes with a discussion of the empirically derived drivers and barriers related to the different literature clusters (6.4.2).

6.3.1 Discussion of reported barriers to interdepartmental PSS development on three organisational levels

Each project reported a different main barrier to interdepartmental PSS development, which implies that several factors can hinder interdepartmental PSS development. Yet, common in most projects was that group-barriers to interdepartmental PSS development were much reported. This is interesting because the barrier-framework in the literature review distinguished most barriers to change on individual and organisational level, and only a few on group-level. However, since this study focused on departments (which can be considered to be groups), this finding is no real surprise. In the following paragraphs, some of the most mentioned individual, group and organisational barriers to interdepartmental PSS development are discussed.

Individual-level barriers to interdepartmental PSS development

The most mentioned individual barrier to interdepartmental PSS development is also most mentioned of all the reported barriers to interdepartmental PSS development: a conflict due to billing. It was reported in four out of five projects and means that interviewees had to work on the PSS-projects in their spare time, because their normal working hours had to be billable. The four projects concerned (IMBY, Obsurv, RTO and Smart City) did not directly arise out of client's demand, and thus could not promise direct profit. As derived from the interviews, it is not the culture of Grontmij to pay hours on projects like these. For IMBY, Obsurv and RTO the conflict due to billing has led to difficulties in the process of PSS development. It could be argued that these projects might have been developed faster or better if the particular conflicts had not been in place. Similarly, for the Smart City-project this conflict might have been a barrier that played an important role in not reaching the stage of an actual PSS. N211 is the only project where this barrier was not reported. Reason is that this project originated from a tender offer, which is how Grontmij has traditionally been doing business. Hence, all involved departments could bill their hours on the tender. Nevertheless, if the tender is lost, all the worked hours are lost as well. Thus, a tender seems to comprise a risk that is not much different from the risk of PSS development; an investment is made or a risk is taken to start the project, and in the end this will lead to profits or losses. Yet, a difference is that where the market for PSS is uncertain, in a tender it is known that, for example, one out of five competitors will win. In addition, the price for winning the tender is known beforehand, whereas this is indefinite for new PSS development.

Group-level barriers to interdepartmental PSS development

The group-barrier to interdepartmental PSS development *language/culture difference* has also been reported in four projects: in all but Smart City. This finding concurs with Schilling & Kluge (2009) who argued in their study on barriers to organisational learning, that information processing between organisational units is more difficult as they adhere to different operating principles and technical jargon. In other words, different departments have different working processes, knowledge and/or terminology. Constructive collaboration could thus be complicated. However in all of the interviews where this barrier was mentioned, it was also argued that the language/culture barrier never caused serious conflict.

A group-barrier to interdepartmental PSS development present at Grontmij that was only reported once is *interdepartmental competition*. The literature definition by Lozano et al. (2014) comprises competition with other teams/units, leading to departments not wanting to share equally. Since departments at Grontmij are currently not valued on whether their employees work on interdepartmental projects or on PSS development, the phenomenon of interdepartmental competition did not come out the empirical data as a major concern. Nevertheless, almost all interviewees argued that as soon as interdepartmental PSS development would become common company business (including the possibility to bill hours on such projects), interdepartmental competition would become an issue. The interviewees stressed that with 'normal' projects, this competition is perhaps the biggest concern. For instance, Interviewee C: "*Departments rather have their own people on the job than the best people. Such competitiveness could become a key problem with PSS development too*."

The final reported group-barrier to interdepartmental PSS development discussed is a *top-down approach*. This is interesting because leadership, which assumes top-down leadership, had been classified as a possible driver for change (see i.e. Carter et al., 2012 and Gill, 2002) rather than hindering it. Thus it seems that there can also be such a thing as too much top-down influence, which leads to the proposition that each situation requires a tailored amount of top-down and bottom-up input.

Organisational-level barriers to interdepartmental PSS development

The most mentioned organisational-barrier to interdepartmental PSS development was *a lack of leadership/management support*. However, this barrier was also reported on group-level. The difference is a result of referring to a lack of higher management support (organisational) or department management support (group). Similar to *conflict due to billing*, only interviewees from the N211-project did not mention this barrier. A possible explanation could again be that management is familiar with the business process of N211, and not with the other business processes. A lack of leadership/management support is a barrier that was recognised by several authors in the literature review. For instance, Lozano (2009) argued that change towards more CS is difficult when support by management lacks. Kotter & Cohen (2012) did not specify on a specific theme and explained that management support is important in any form of change, independent on the context. Yet, they argued that it is often the management's fear for change that hinders progress towards the new situation. This was also the case at Grontmij; the management wants to hold on to their targets, and therefore

fears engaging with business that is not proven to generate revenue. It should be noted that management support was stressed as an important driver in section 6.3.1 and is argued to be an important barrier to interdepartmental PSS development in the current section. Two explanations can be given to rationalise this phenomenon. The first could be that, within each project, employees from different departments have been interviewed. Thus, if two interviewees for example said that their departments did approve of the PSS development and the other one reported the opposite, a project has been classified as possessing the driver *management support* while at the same time showing the barrier *lack of management support* (i.e. Obsurv). A second possible explanation is that interviewees discussed the entire timeframe of the project; for example, the management did not provide financial support at first, but later on in the project they did (i.e. IMBY). Thus, at first the lack of management support was hindering the development of the PSS, but at a later stage it drove the PSS development.

In order to provide a comprehensive overview, a compendium of all reported barriers to interdepartmental collaboration with respect to PSS development at Grontmij is presented in Table 18. The key points from this table have already been discussed in the previous paragraphs. In the table, a division has been made between barriers on three organisational levels (individual, group and organisational). Within these levels, the reported barriers are sorted in a similar way as Lozano (2009) did: individual (level 1; level 2; level 3; aspect 1 and aspect 2), group and organisational (managerial; supportive; organisational; historical; and external). Only Level 1 and Level 2 individual barriers to interdepartmental PSS development were found in this thesis, whereas no other organisational barriers than the categories Managerial and Organisational were found. In the literature review no sub-categorisation was made for group-level barriers to change. Due to the relatively large number of reported group-barriers to interdepartmental PSS development, this thesis proposes a sub-categorisation for such barriers (see table 18). Within Table 18, the number of interviewees from a specific project that reported the barrier is presented in parenthesis. The reported barriers to interdepartmental PSS development written in italics encompass the ones that had not been distinguished in the literature review.

Table 18: Compendium of barriers to interdepartmental collaboration in the five projects

Category	Barrier	Project
Individual		
Level 1: Resistance to idea itself	Lack of interest from actors	RTO
	Lack of ownership	Smart City (2)
Level 2: Resistance involving deeper issues	Conflict in time	IMBY, N211 (3)
	Extra workload	Smart City
	Conflict due to billing	IMBY, Obsurv (2), RTO, Smart City (3)

Group		
Culture	Interdepartmental competition	N211
	Language/culture differences	IMBY, N211, Obsurv, RTO
Group work	Lack of confidence in the concept	Smart City
	No clear responsibilities	Smart City (3)
	Communication / not involved enough	Obsurv (2)
	Lack of knowledge on how to approach	Smart City
	Top-down approach	Obsurv
	Unequal contribution	RTO (3)
Financial	Lack of leadership / management support	Obsurv, Smart City (2)
	Risk	IMBY, N211
	Time to get finance	IMBY (2)
People	Extra costs and/or time	Smart City (2), N211, Obsurv
	Unequal contribution	Smart City, RTO (3)
	Wrong people involved	N211, Obsurv
Pragmatic	Pragmatic concerns	IMBY, Smart city
Vision	No clear goal / vision	Obsurv, Smart City (2)
	Too ambitious	Obsurv
Organisational		
Managerial	Lack of leadership / management support	IMBY, RTO, Smart City (2)
Organisational	Institutionalised organisational memory	Smart City
	Organisational structure	IMBY
	Physical distance	Smart City, RTO (2)

Although mostly group-barriers to interdepartmental PSS development have been found, the boundary between group and individual on one side, and group and organisation on the other side does not seem stringent. For example, *time to get finance* is considered a barrier on group level, as the department management did not directly provide finance. However, the department management should get approval from higher management, which means that it is also an organisational barrier. As for the boundary on the other side, *too ambitious* was a reported barrier to interdepartmental PSS development that reflected the ambition of one person. Nevertheless, this person was in charge of the project, and therefore his ambition made the group goals arguably too ambitious.

New empirical findings

The empirical research confirmed the existence of a number of the barriers highlighted in the literature review to potentially be relevant for interdepartmental PSS development. 3 out of 5 individual barriers, 9 out of 17 group barriers and 4 out of 4 reported organisational barriers had already been proposed in the literature review. This implies that this research especially adds to literature on group-level barriers to change. No barriers were directly appointed to organisational-level. A reason is that some barriers may be rooted in organisational causes, but are perceived on individual or group-level. For instance, a *conflict due to billing* reflects a

contractual commitment that is an organisational choice, but the consequences are felt on individual level where employees find it difficult to join projects that are not billable.

Three of the new barriers to change were reported in more than one project: *Conflict due to billing; Unequal contribution;* and, *Wrong people involved.* The other new barriers to change were project-specific and only mentioned in one interview each: *Lack of ownership; Communication / not involved enough; Lack of knowledge on how to approach; Top-down approach; and, Too ambitious*.

6.3.2 Relating the reported drivers and barriers to interdepartmental PSS development to the different clusters of literature

From a scientific perspective it is interesting to find out what sort of literature, in the literature review referred to as 'cluster', is related to the findings of this thesis. By comparing the different clusters of literature to this thesis' findings, it can be examined what study areas provide the best suggestions as to drivers or barriers to interdepartmental collaboration for PSS development. Hence, the next paragraphs discuss only the empirical data that had also been distinguished in the literature review. The discussion in this section is backed-up by Appendix G, in which each specific driver/barrier to interdepartmental PSS development is related to specific clusters of literature.

As for drivers to interdepartmental PSS development, literature on *interdepartmental collaboration*, *intra-organisational collaboration*, *corporate sustainability* and *innovation* reported respectively eight, seven, seven and seven of the ten drivers to change that were already suggested in the literature review. Hence, these four clusters seem to provide the best indicators for what drives interdepartmental collaboration for PSS development in engineering firms.

The empirical research on barriers to interdepartmental PSS development showed that literature on *Organisational Change* and *Corporate Sustainability* have provided the most suggestions, with respectively twelve and nine out of fifteen barriers to change that were already suggested in the literature review. A possible explanation could be that those study areas, as opposed to the other five literature clusters, specifically address a change (respectively from situation A to situation B, and from little sustainability orientation towards more sustainability orientation). Literature on such concrete changes is therefore often pointed at 'what are the advantages/disadvantages; what could hinder the change?' and so on. The other literature clusters mainly discuss the new situation and what this potentially could bring. Certainly some factors that could hinder a transition from A to B are acknowledged, but the emphasis lies on the advantages of the new situation, which could function as drivers to change. As a consequence, each empirically found driver to change was suggested in about five clusters of literature, whereas the average number with barriers to interdepartmental PSS development lies between two and three.

It is furthermore noteworthy that not a single study on the *construction industry* revealed a driver similar to the ones found in the empirical research. Yet, this literature cluster did suggest three of the barriers that were found in the empirical data on barriers to interdepartmental collaboration.

Since the drivers and barriers to interdepartmental PSS development have been explored, it is relevant to discuss the strategies that already exist at Grontmij that might be able to foster these drivers and help overcome the reported barriers.

6.4 Strategies to induce interdepartmental collaboration for PSS development

The empirical data provided a list of existing strategies to foster interdepartmental collaboration at Grontmij. In the literature review, a framework of strategies to overcome barriers to change from Lozano (2009) was proposed and complemented with strategies offered by other authors (for example by Kegan & Laskow, 2001 and Kotter & Cohen, 2002). The following paragraphs discuss to what extent the existing strategies at Grontmij concur with literature. Besides, it is discussed whether particular strategies at Grontmij have the potential to foster reported drivers and overcome reported barriers to interdepartmental PSS development. In doing so, this section aims to answer the sub-question: *What approaches and strategies exist that could help stimulate interdepartmental collaboration to induce PSS development?*

Many of the reported strategies to foster interdepartmental collaboration at Grontmij are knowledge-sharing strategies[14]. Whereas the specific reported strategies do not correspond with the literature review, the overarching general strategy 'knowledge-sharing' has been proposed. For example, sharing of knowledge and successes as a strategy to induce collaboration concurs with Denise (1999), Camarinha-Matos et al. (2007) and Kegan & Laskow (2001) and Lozano (2009). Denise (1999) argued that it is important to harness results through organisation wide communication of success stories, and Camarinha-Matos et al. (2007) proposed to communicate success stories from other organisations. Kegan & Laskow (2001) suggested providing evidence/examples of impressive innovations by other departments as a strategy to increase support, whereas Lozano (2009) proposed better communication and information sharing through the company as a general strategy to overcome barriers to change. Since still so many barriers to interdepartmental PSS development exist within Grontmij (i.e. *a lack of confidence in the concept; extra costs and/or time*) it could be argued that the knowledge sharing practices do not focus enough on interdepartmental collaboration for PSS development. If the knowledge-sharing mechanisms are better used to communicate internal (Denise, 1999; Kegan & Laskow, 2001) and external success stories about interdepartmental collaboration practices (Camarinha-Matos et al., 2007), certain drivers to interdepartmental PSS development could also be fostered (i.e. *innovation*; *productivity & quality*; and *personal benefit for employees*)

Another strategy to induce interdepartmental collaboration mentioned was the *Company Boards (energy, water or roads)*. Although these boards have a very different purpose, they can be related to Kegan and Laskow (2001) who proposed designing a short-term (one-

[14] Options for digital knowledge-sharing include *Insite; Knowledge platforms/team sites; Newsletters; Yammer;* and*, PROUD-sheets*;
Options where direct interaction is possible are *Webinars; Conference calls; Lunch readings/knowledge share sessions; Weekly team discussions;* and*, GUP;* and
Formal groups that include members from different departments: *ALV (general staff meeting); Boards (energy, water, roads); LPV (Staff association);* and, *Young Grontmij*.

month) cross-department committee, dedicated to evaluate possible opportunities for new products/services. Various reported barriers could be overcome by introducing the cross-department committee. For instance, the *organisational structure* and according *institutionalised organisational memory* will clearly be challenged if this committee becomes operational. Moreover, the reported barrier *lack of interest from actors* might be overcome because it can be expected that the majority of employees can appreciate the extra responsibility and will therefore gain interest in interdepartmental PSS development. The last reported barrier that could be diminished is *language/culture barrier*, for the deputies from each department can notify each other about potential language/culture differences.

Strategies aimed at enabling people to connect despite working at a different office or department are *Enabling Lync-calls*; *Fewer offices;* and, *Abolition of different business units*. Waber et al. (2014) proposed a similar strategy and argued that the number of offices should be reduced as much as possible in order for people to meet. In doing so, the barrier *physical distance* is minimised. An engineering company the size of Grontmij and clientele all around the Netherlands is likely to always have different offices. Therefore, with three strategies to reduce the problems that may arise when colleagues work together but do not see each other, the organisation seems to acknowledge the importance of reducing distance.

Internal and external competitions have been reported in the empirical data as strategies to induce interdepartmental PSS development. Such competitions were not distinguished as strategies to overcome barriers to change in the literature review, however using *incentives, rewards and compensations* to reinforce change was proposed (see Beer & Noriah, 2000; Kotter & Cohen, 2002; Lozano, 2009; Song et al. 1997). In the context of this thesis, the possibility to join a competition might just be the needed incentive for an employee to approach colleagues from different departments. Rewards and compensations could, amongst others, be financial benefits, acknowledgement, or increased responsibilities and freedom. Noteworthy is that all interviewees who reported the strategy *competitions* had taken part in such a competition. This suggests that the other employees are rather unaware of the possibilities to attend competitions at Grontmij and the role they could play for interdepartmental PSS development. So, staying aware of, communicating and organising such competitions/rewards could foster the driver *internal/external competition.*

Within this section, only a few existing strategies at Grontmij and a number of strategies to overcome barriers to change from the literature review have been discussed. Some of the existing strategies have the potential to foster reported drivers and overcome barriers to interdepartmental PSS development. This implies that the organisation does not necessarily need to adopt entirely new strategies; rather, acknowledging the potential and making better use of the existing strategies should be the first step.

In order to provide a more complete overview, Appendix H presents a table including all the existing strategies at Grontmij, complemented with strategies to overcome barriers to change from literature. Within this table, it is highlighted which empirically found drivers can potentially be fostered and which reported barriers to change might be overcome by adopting or better using the strategy are. In addition, a separate company document provides concrete

examples and recommendations as to how Grontmij can make better use of existing strategies, complemented with suggestions for concrete application of strategies to overcome barriers to change from literature.

6.5 Limitations of findings

The study has offered an exploration of factors fostering and hindering interdepartmental collaboration for PSS development, and was conducted by means of interviews at a large engineering firm in the construction sector. As a direct consequence of this methodology, the study encountered a number of limitations, which need to be considered.

As pointed out in the method's limitations (section 4.4.1, p. 44), there were few projects at Grontmij that fitted the definition of an interdepartmental PSS-project. The ones that did fit the requirements and thus included in the case study, were not equal in size, budget or stage of completion. It can be presumed that a project with a small budget encounters different problems than relatively costly projects. A similar argument can be given for the size and stage of completion, as these factors might also influence the empirical data. Due to the limited choice in projects, it was difficult to overcome this limitation.

A few empirically found drivers or barriers to change have been specified more meticulously than was done in literature. For instance, *organisational structure* is a barrier to change, found in many different studies (e.g. Davila et al., 2012; Kotter, 2012; Lozano, 2009), but was only reported once in the findings. The major reason for this is not that the organisation is highly progressive; rather 'organisational structure' is quite an umbrella concept. In the findings section of this thesis, certain reported barriers could have been placed under this umbrella concept (e.g. interdepartmental competition; conflict due to billing). Without this subdivision, the *organisational structure* would have been the most mentioned barrier. Finding a strategy to overcome the barrier 'organisational structure' leads to general recommendations. Therefore it seemed more valuable to make a separation into specific barriers, to which specific strategies to overcome the barriers can be sought.

Innovation was in each of the projects reported as an important driver. Drawing from this finding it could be argued that stressing the innovative character of PSS development and interdepartmental collaboration is key to stimulate it. Yet, the interviewed employees have all been engaged in innovative projects, which could imply that they are innovation frontrunners. Perhaps, the average employee at an engineering firm does not see innovation as a vital argument to engage with interdepartmental PSS development.

The interviewees were also to some extent proud of what they developed. Learning from positive practices is useful, but learning from negative practices is at least equally as important for future projects (Hansen, 2013). Therefore, it would have been interesting if more projects that had failed before generating results, like the Smart City-project, had been investigated.

In general, the lists of drivers, barriers to interdepartmental PSS development and strategies that could increase interdepartmental PSS development mentioned by the interviewees may

not be complete. This could be due to the small number of interviewees, the drivers/barriers/strategies being taken for granted, considered as unimportant, ignoring them or the interviewees not being aware of them.

7. Conclusions & recommendations

This thesis was set out to learn from previous projects in which different departments worked together for Product-Service System (PSS) development. By learning from these projects, another aim was to propose recommendations for how departments could foster positive practices and avoid/manage negative practices to induce such projects. The concept has been explored by qualitative research on five interdepartmental PSS projects in an engineering firm.

The empirical research showed that several different drivers and barriers affect interdepartmental PSS development.

The main internal drivers for interdepartmental PSS development found in this thesis are *innovation* and the influence of *champions,* whereas the main external driver is *management support/leadership.* This implies that interdepartmental PSS-projects advance when the topic comprises something new/challenging, a colleague takes the lead in connecting and enthusing suitable people, and the higher levels in the organisation support the project.

Most barriers to interdepartmental PSS development were observed on group-level, of which the main ones were a *lack of leadership/management*, the *extra costs and/or time* that interdepartmental projects require, and *language/culture differences* between departments. The former basically reconfirms the just mentioned driver of leadership/management support. *Extra costs and/or time* and *language/culture differences* imply that, especially in the beginning of an interdepartmental project, extra effort is required from people in order to make use of knowledge/skills from other departments. Nevertheless, the most reported barrier to interdepartmental PSS development was perceived on individual level: a c*onflict due to billing,* This suggest that people were hindered to fully engage with an interdepartmental project because a given percentage of their working hours had to be billed on other projects.

It was suggested that better or different use of certain existing strategies could result in fostering reported drivers and avoiding/managing particular reported barriers to interdepartmental PSS development. Especially, making use of existing knowledge sharing platforms, (in)formal groups and hosting/subscribing to competitions could advance interdepartmental PSS development.

Although no grand theory has been formulated, the findings of this research were used to develop frameworks of drivers and barriers to change in the context of interdepartmental collaboration for PSS development. These frameworks offer first insights on how companies can be more proactive in facilitating interdepartmental PSS development. In addition, the frameworks could provide a baseline for future research into organisational changes for interdepartmental PSS development.

Broader implication for science

As mentioned in the introduction chapter of this thesis, there has been limited research that integrated the concepts op interdepartmental collaboration and PSS development. Hence, the empirical research adds to literature as it provided frameworks on drivers and barriers to change, specific to the context of interdepartmental PSS development. These insights provide a basis for future research on this topic. In addition, the new drivers and barriers to change that were obtained could add to the general frameworks on drivers and barriers to change. However, these drivers and barriers to change were found specifically in the context of new PSS development by means of interdepartmental collaboration at a large engineering firm. As a consequence, generalisation of these findings should only be done with absolute caution as the findings have yet to be reconfirmed in other studies.

Other studies, on related themes, showed overlap with this thesis' topic. Since driver and barrier-frameworks were adopted from studies on Corporate Sustainability (CS), it was no surprise that some findings coffered with proposed drivers and barriers to CS oriented change. Yet, also literature on Intra-organisational Collaboration, Interdepartmental Collaboration, Organisational Change and Innovation showed to provide a number of suggestions that were found in the empirical data. This implies that change in different contexts is, to a certain extent, characterised by similar stimuli and factors obstructing the change. Hence, frameworks on drivers and barriers to change, in either one of the just mentioned study fields, could serve as a general basis for new exploratory research on drivers and barriers to change in related study fields.

Another implication of this thesis is that one of the study's main elements, PSS development, could perhaps be substituted by other elements without drastically compromising the results. PSS development is not labelled as such by the company. It is a categorisation that could be given to the particular projects based on the presence of service as well as product components. Yet, within Grontmij the different projects were referred to as 'product development' or 'innovations'. Consequently, a theoretical implication is that findings can to some extent be generalised to interdepartmental collaboration for innovation or new product development at large engineering firms in the construction industry.

Managerial implications

This section provides answer to the final sub-question: *how could other companies learn from this study's findings?*

Other large companies (e.g. large engineering firms) often have a wide knowledge base that is not always used to its potential. This thesis showed that a way for better using this knowledge could be interdepartmental collaboration. Such collaboration could in turn lead to integral PSS development. In order to pursue interdepartmental PSS development, it is advised to consult the most mentioned drivers and barriers to interdepartmental PSS development as reported in this thesis. The drivers should be fostered whereas the barriers should be managed/avoided.

More specifically, the following can be recommended to Grontmij as well as other companies:

- Try to utilise available communication platforms to express the relevance and market opportunity for PSS development.
- Make use of existing (in)formal groups, or design new interdepartmental groups to evaluate opportunities for (interdepartmental) PSS development.
- Take notion of the similarities between conventional Tender-projects and unconventional PSS-development projects. Both cost money prior to making profit, which poses a risk. However, the price for winning is ascertained with a Tender-project, whereas this is unknown for a PSS-project.
- Try to organise or subscribe to competitions. Such competitions tend to trigger employees to find creative solutions to problems in the market.
- Whenever possible, try to adopt a top-bottom approach when pursuing a new project. Involvement of higher-ranking employees can create leverage in the organisation whereas lower-ranking employees can accelerate the project on a smaller level: by developing it.
- Stress the advantage the company has, compared to smaller firms, because of its broad knowledge base.
- Highlight the opportunities that large firms, like Grontmij, provide for learning from colleagues in different knowledge fields/departments.
- Reward people who show efforts to increase inter-departmentalism, as this could benefit long-term results.
- Stimulate/provide space for (in)formal gatherings such as after-work drinks, networking days and underground meetings (e.g. GUP).
- In general, make sure that the vision, ambitions and responsibilities within a project are transparent and well communicated.

Recommendations for future research

The study's limitations pointed to interesting opportunities for future research. For instance, as all the findings in this thesis are based on qualitative data, derived at a specific company, country and sector, it can be recommended that future studies on this topic be extended beyond the scope of this research. A replication of this study in a different context (e.g. basically any large firm that has different departments) could be a useful first step.

A second recommendation is to investigate a greater sample size than 15 interviews and 5 projects. More empirical data leads generally to a stronger representation of recurring data.

Thirdly, if future studies have the possibility to choose from a large sample of projects, it can be recommended to decide on certain critical factors that should be similar in order to better compare the findings in each project. Examples of such factors could be the project's size, budget and stage of completion.

Assuming that a researcher has the possibility to choose between projects, a fourth recommendation is to find a better balance between projects that have reached an end stage and projects that have not. Perhaps, more barriers to interdepartmental PSS development in general can then be distinguished, providing a more comprehensive overview. Besides, this

would make it possible to better relate barriers to interdepartmental PSS development to specific stages in a project.

Fifth, future research could adopt a method quantitative alongside a qualitative one. Such a method could for instance provide insight in whether specific barriers are more perceived by people within similar functions or age groups. Such statistics would enable to tailor strategies and approaches to the specific groups. In order to derive significant results, a precondition for this approach is that the sample size is large enough to perform statistical analysis.

As a final recommendation, it is suggested to not solely focus on employees that have worked on interdepartmental PSS projects. The section ‘limitations of findings’ indicated that these employees might have a tendency to engage with innovative projects; hence, they are perhaps not representative when it concerns drivers/stimuli to engage with such projects. Thus, future research could explore the drivers and barriers to engage with interdepartmental PSS development for people who have never engaged in such innovative projects.

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Appendices

Appendix A: Introduction to Grontmij

Grontmij was founded in 1915. Back then, it focused on reclaiming land, helping farmers to protect against flooding and cultivating wasteland (Grontmij, 2016b). Today, Grontmij finds itself with 7.500 employees, among the largest engineering firms in Europe. Grontmij provides consultancy, management services and design & engineering in a wide range of market sectors related to the natural and built environment (Grontmij, 2016c).

Grontmij strives to be a European leader in the areas of (Grontmij, 2016c):

- Energy; smart solutions for conventional and bio power
- Highways & Roads; Mobility as means to economic growth and sustainable infrastructure is crucial
- Sustainable buildings; Energy reduction in both new and existing buildings
- Water; (Waste) water treatment as well as flood protection and coastal security

Error! Reference source not found.4 presents a schematic overview of the company structure. In the figure, the departments that engaged with interviews in this thesis are highlighted in glowing orange. Glowing purple signifies the departments that did contribute to one of the PSS-projects, however no interview has been conducted with employees from those departments. The Grontmij Group comprises ten different 'country' companies that represent Grontmij throughout Europe (The Netherlands, Belgium, Denmark, Germany, France, The United Kingdom, Sweden, Switzerland, Poland and Turkey). Within the Netherlands, Grontmij has five explicit divisions and many more departments. Each department is subdivided into some more specialist units. The division 'Transport & Mobility' requested this particular study. This division acknowledges that parts of its market are somewhat saturated, which is why they have engaged in studies that explore opportunities for long-term success.

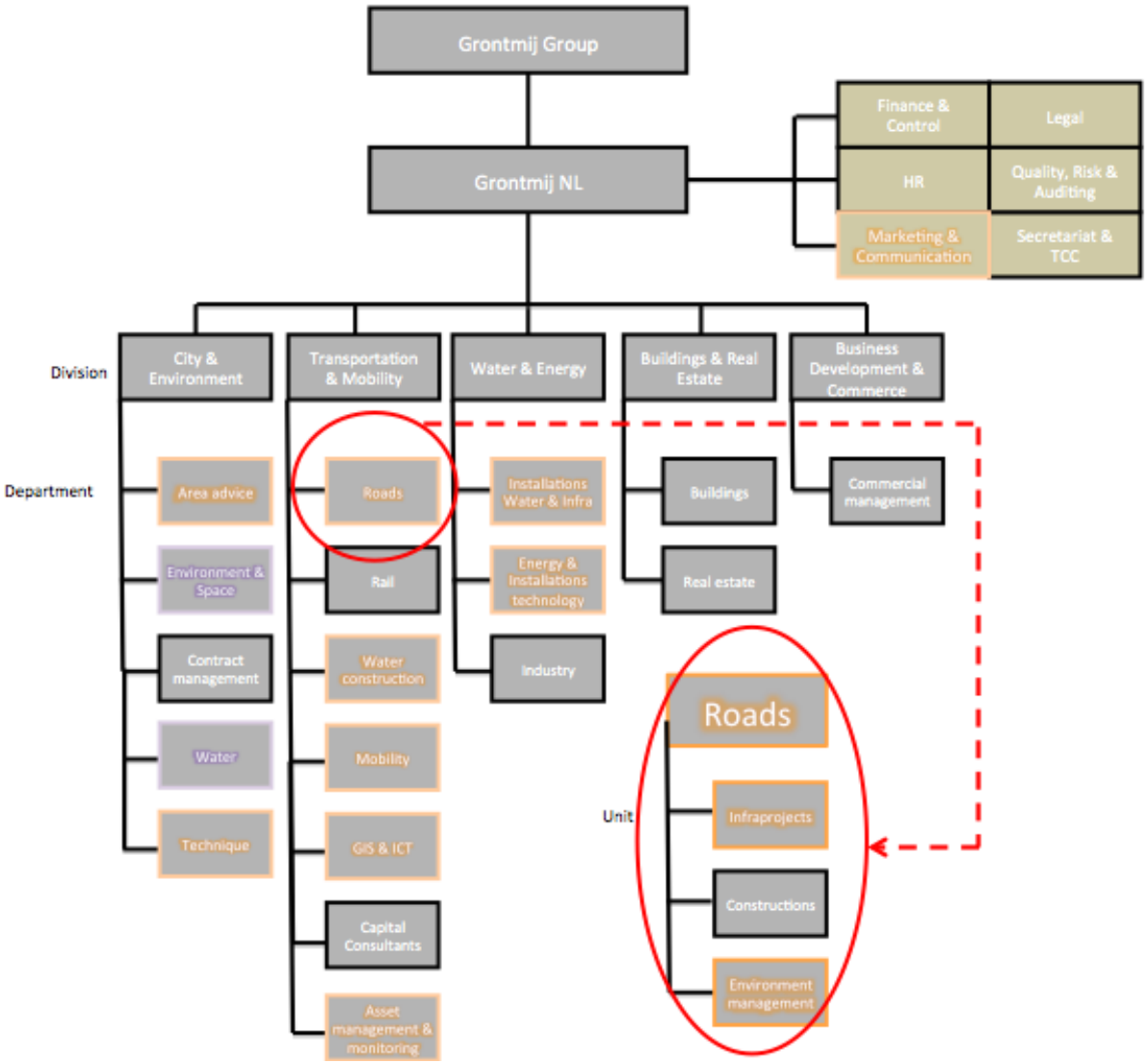

Figure 8: Schematic overview of Grontmij Netherlands' organisational design. More detail is provided on the roads department.
Source: based on Grontmij (2014a)

Customers & Competitors

Marketwise, two important factors can be distinguished: customers and competitors. Grontmij has a large customer base varying in type of activities, size etc. The company has made a selection of customers they consider as 'Top clients'. These add up to approximately 200 (Grontmij, 2014b). Examples of these clients are Rijkswaterstaat, Prorail and the Province of North Holland.

Grontmij is a project-based firm active in the construction industry. The main competition consists of other large engineering firms in the Netherlands such as Arcadis, Royal Haskoning BV, Tauw, Witteveen & Bos, Antea, DHV and Movares.

Appendix B: Specification of articles used in the consulted study fields

Although articles have been grouped into a cluster, each article may have a different focus area. The following paragraphs briefly describe the topic of each article that is included in a cluster.

In literature on *organisational change* (13 studies), the following topics turned out to provide information that could be useful for interdepartmental PSS development: knowledge sharing in multi-unit companies (Hansen, 2002); organisational change management through leadership (Gill, 2002); organisational change and its effect on employee satisfaction (Carter, 2012); how people change their organisations (Kotter & Cohen, 2012); strategic management of organisational dynamics (Stacey, 2007); collaboration versus communication, coordination and cooperation (Denise, 1999); new management systems to replace hierarchies (Kotter, 2012); Challenging traditional management theory and stressing the importance of CSR (Weymes, 2004); Barriers to organisational learning (Schilling & Kluge, 2009); five dimensions of collaboration (Thomson & Perry, 2006); and, Strategies for building a learning organisation (Senge, 1999) and to resist change (Dent & Galloway Goldberg, 1999; Pieterse et al., 2012). f

The cluster of *Intra-organisational collaboration* comprises 5 studies: Knowledge transfer in intra-organisational networks (Tsai, 2001); Collaborative networks (Camarinha-Matos et al., 2007); Team performance in collaboration network (Guimera et al., 2005); Intra-organisational networks for innovation (Carnabuci & Operti, 2013); and, Cross functional teams for better R&D in pharmaceutical industry (within organisation and between organisations) (Zeller, 2002).

10 studies were selected from scientific literature on *Interdepartmental collaboration,*. Interdepartmental collaboration is together with PSS the key element in this thesis. The subtopics of the consulted articles are: cross-unit collaboration and how to do this effectively (Hansen, 2013; Song et al., 1997); Methods to create Cross functional teams (Denison et al., 1996; Majchrzak et al., 2012); Cross functional teams for better R&D in the pharmaceutical industry, within organisation and between organisations (Zeller, 2002); Barriers to collaboration within an organisation (Geisler, 2008); new product development due to interdepartmental collaboration (Garcia et al., 2008; Kahn, 1996); innovation through interdepartmental collaboration (Cuijpers et al., 2011) and innovation by means of cross-functional teams (Love & Roper, 2009).

The last of three collaboration-related clusters is literature on *Collaboration for sustainability.* It comprises 2 studies: Regional collaboration between stakeholders for sustainability (Fadeeva, 2004); and, Collaborative business models in chemical leasing (Lozano et al., 2014).

Another sustainability-related study area is *Corporate Sustainability* (3 studies), and also counts few articles: Organisational change for corporate sustainability (Lozano, 2009; 2013); and, Challenging traditional management theory and stressing the importance of CSR (Weymes, 2004).

From *Innovation* literature, 15 studies were selected. The subtopics of these studies were new product development due to interdepartmental collaboration (Garcia et al., 2008; Kahn, 1996) or intra-organisational collaboration (Mishra & Shah, 2009); innovation through - interdepartmental collaboration (Cuijpers et al., 2011), -cross-functional teams (Love & Roper, 2009), -intra-organisational networks (Carnabuci & Operti, 2013) and -knowledge

sharing (Zhou & Li, 2012); innovation management in project based firms (Keegan & Turner, 2002); innovation management in construction firms (Blayse & Manley, 2013; Hartmann, 2006; Shaw, 2010; Xue et al., 2014); making innovation work (Davila et al., 2012); Implications of information processing challenges for innovation (West, 2000); and, barriers to new product development (Dougherty, 1992).

Lastly, literature on the *Construction industry* (5 studies) has been consulted. Subtopics encompass innovation management in construction firms (Blayse & Manley, 2013; Hartmann, 2006; Shaw, 2010; Xue et al., 2014); and, the construction industry as a loosely coupled system: implications for productivity and innovation (Dubois & Gadde, 2002).

Appendix C: Framework on drivers to change, barriers to change and strategies to overcome barriers to change

Drivers and barriers can be derived for a wide variety of purposes. Although the literature review is supposed to provide a complete overview of the current status of research on the topic concerned, such an overview would have decreased the focus of the thesis. Yet these drivers/barriers should still be acknowledged. An overview of drivers and barriers to change in different contexts that were deemed less applicable to the context of this thesis is given in the following sections. Hereafter, the frameworks used for this thesis on barriers to change and strategies to overcome barriers to change are presented. Both frameworks have been derived from Lozano (2009).

Drivers to change (not directly applicable to the context of this thesis)

The following have been derived from various authors, but majorly from Bossink (2004) and Plessis (2005):

Build up direct customer relations to intensify contact or to increase contact frequency; communicate innovations (hardware innovation is easier to communicate than an intangible innovation); create superior value for clients; escape from a commodity market searching for unique selling points; extend service;

Bossink (2004): governmental guarantee for market for innovative firms; governmental clients with innovative demands; innovation stimulating regulations; subsidies for innovative applications and materials; product evaluating institutions; programmes promoting access to technology; finance for pilot projects; technology fusion; technology leadership strategy; technology push; stimulation of research; creation of knowledge networks; programs promoting collaboration; integrated and informal R&D function; effective information gathering; training of workers on the site; lateral communication structures; integration of design and build; involvement of the client; innovations from suppliers; explicit coordination of the innovation process; strategic alliances; long term relationships;

Plessis (2005) knowledge attrition; more effective decision making; internet, improved telecommunication an technology; organisational and geographical distribution; internal inefficiencies; knowledge hoarding; increased richness; and, reach of knowledge.

Barriers to change (not directly applicable to the context of this thesis)
The majority of these barriers to change was adopted from the lists of barriers that Schilling & Kluge (2009) compiled:

Branch with unclear criteria of success; considered as a fad; denial about operations' effects to the environment and societies; difficult to measure the effectiveness of implementation; economic focus that disregards or consider environmental and social aspects as costs; faith in technological solutions; fear/despair about needed changes and how to deal with them; fear of disadvantages; fear of losing core values; high level of stress; ignorance,; lack of holistic focus in operations; lack of information; lack of knowledge about impacts on and from suppliers and customers; lack of rationale and purpose clarity; lack of trained employees, *i.e.* universities not yet preparing them; misunderstanding the information; narrow focus of sustainability, *i.e.* confusing it with pollution prevention, recycling, waste management, or eco-efficiency; not seen as adding value; not seen as priority; operative profile of the company; organisational blame culture (scapegoating); patriarchal thinking and structures; stocks and inventories which cover process errors; and strict work rules and regulations.

Framework on barriers to change (Lozano, 2009)

Table 19: Individual barriers to CS oriented change

Level 1	Ignorance of CS
	Lack of awareness of CS
	Lack of information about CS
	CS being perceived as fairly difficult concept to explain
	Misunderstanding/Lack of communication about CS
	Lack of ability to face the problems
	Surprise
	Fear of a poor outcome
	Perceived lack of relevance
	Dislike of the change
	Slight negative image of the CS concept
	Not-invented-here syndrome
	Considered likely to incur cost/price premiums
	Difficult to see the connection or relate it to everyday activities or jobs
	Denial about operations' effects on the environment and societies
	Inertia
	People do not understand how to incorporate it
	Poor training
	Lack of empowerment towards the change
	Flaws in change strategy
	Lack of help and support
	Failure of senior management to 'walk the talk'
	Lack of time or bad timing
Level 2	Linear thinking
	Fear of losing core values
	CS not seen as a priority
	CS seen as a threat to company core values
	Emotional side effects
	Lack of trust
	Fear of failure/Loss of respect

	Fear/despair about needed changes and how to deal with them
	Perceived threat to job status/security
	Fear of not belonging
	Uncertainty
	Bureaucratic culture
	Belief in the *status quo*
	Lack of commitment
	Work group break-up
	Peer pressure
	Unsupportive punishment and rewards systems
	Extra work added to day to day activities
Level 3	Cynicism
	Conflicting value and vision
	Personality conflicts
	Historic animosity towards CS
Aspect 1	Lack of time or bad timing
	Perceived as being too expensive to engage
	"Why do something if we're not doing anything wrong?"
	Laziness
Aspect 2	Power struggles

Source: Lozano (2009)

Table 20: Group barriers to CS oriented change

It is difficult to see the connection or relate it to everyday activities or jobs
Ignoring institutions in the group
Individual – Group conflict
Difficult to incorporate into the pragmatic short-term mental models of some functions
Keeping feuds
Group culture

Source: Lozano (2009)

Table 21: Organisational barriers to CS oriented change

Managerial	Short-term and discounting perspectives focusing on economic aspects
	No clear business case
	Not yet seen as adding value to the company
	Not seen as related to the financial bottom line
	Disbelieve or disagreement on possible consequences or results of continuing with 'business-as-usual;
	Narrow focus of sustainability
	Need to generate profits for the shareholders in the short-term in the stock markets
	Wanting to make money fast
	Middle management short-term constraint
	Linear thinking
	Cause-effect confusion
	Lack of communication
	Lack of strategy/long term plans
	Economic assumptions of green goods
	Threat of bankruptcy
	Economic focus that disregards environmental and social aspects or consider them as costs
	Lack of motivation amongst middle- and lower-level staff
	Lack of systems thinking
	Patriarchal thinking an structures

	Lack of rationale and purpose clarity
	Faith on technological solutions
	Lack management commitment
	Faith on market solutions
	Reticence or fear of transparency and reporting
	Status quo
	Seen as a threat to company core values
	Considered likely as price/cost premiums
	Insular thinking and acting
	Purely economic focus
	Costs externalisation
	Lack of top management commitment/'walking the talk'
	Failing to have short-term wins
	Failing to institutionalise changes
	Departmentalism
	Lack of employee engagement/empowerment
	Lack of champions
Organisational	Insufficient mechanisms for learning
	Lack of trans-disciplinarity
	Failing to alter cultural traits
	Difficult to incorporate into the pragmatic short-term mind set of some employees
	Failure to institutionalise sustainability
	Purely managerial change efforts
	Lack of holistic focus in operations
	Organisational structures inhibiting collaboration
	Lack of alignment in the organisation
	Bureaucracy/Patriarchal models
	Politics
	Lack of measurement
	Difficult to measure the effectiveness of the implementation
	Lack of understanding that it is an integral part of the business
	Systems and scorecards established to rewards short-term individual performance
	Trade offs
Supportive	Lack of trained employees
	Lack of organisational knowledge and skills
	No clear vision of sustainability that leads to mere compliance with regulations
	Threat of diminishing resources to keep on CS efforts
	Lack of support (managerial and financial)
	Lack of resources
	Lack of incentives
	Lack of available technologies to produce more sustainable products
	Not being specifically asked for, thus no resources should be allocated
	Inappropriate technology
	Lack of communication
	Lack of systems, tools and instruments to operationalisation and implementation
	Lack of incorporating sustainability in core policies and procedures
Historical	Too many failed changes
	Complacency
	Lack of responsibility and accountability
	Unsuccessful incorporation attempts
	Employees "retired on the job"
	Too much or little compliance
	Large installed plant capacity with long expected life
	Operative profile of the company
	Considered as a fad
External	Timing related to external events
	Competitors' strength

Source: Lozano (2009)

Framework on strategies to overcome barriers to change (Lozano, 2009)

Table 22: Strategies to overcome individuals' barriers to CS oriented change

Level 1: The idea itself	Discussion
	Education/Providing new information/Communication
	Examples and local activities
	Facilitation
	Financial benefits
	Empirical-rational
	Political support
Level 2: deeper issues	Resolving discrepancies
	Manipulation
	Co-opting approach
	Negotiation
	Normative-re-educative
	Use of champions
Level 3: deeply embedded	Use of fear
	Influence of peers and friends
	Normative-re-educative
	Participations
	Power-Coercive
Aspect 1: Procrastination	Discussion
	Facilitation
	Use of fear
	Co-opting approach
	Influence of peers and friends
	Normative-re-educative
	Participation
Aspect 2: Power	*

*None of the presented approaches and strategies can be used to reduce or eliminate the power struggles
Source: Lozano (2009)

Table 23: Strategies to overcome groups' barriers to CS oriented change

Group participation in change design and development
Restructuring
Individual-group interactions
Group meetings and communication
Champions
Reducing group standards/changing group values

Source: Lozano (2009)

Table 24: Strategies to overcome organisational barriers to CS oriented change

Managerial	Engaging top levels and obtain support
	Internalising environmental and social costs
	Making it compelling to employees
	Sharing a common vision
	Changes in governance
	'Walking the talk' and 'Talking the walk'
	Adapting external models
	Applying know-how
	Awards
	Better work-life balance
	Developing new strategies, policies and framework
	Equal pay for equal jobs
	Firing people, as last resort

	Give managers responsibility
	Greater work force diversity
	Identifying champions
	Make CS business case
	Managing the change
	Profit sharing and share ownership schemes
	Reporting and showing progress on goals
	Set goals and objectives
	Transparency
	Using power and authority
	Champions
	Leadership
	Linking it to the company's institutional framework
	Strategic planning
Organisational	Changing organisational paradigms
	Using game theory and collaboration
	Aggregation/Collaboration
	Challenging politics
	Complementing technological changes with socio-cultural ones
	Empowerment of employees
	Improvements and renewals of systems
	Making it part of performance
	New metrics for assessment and reporting
	Restructuring
	Extending CS to all functional and business units
	Alignment in all key factors, e.g. leadership, vision, attitudes and the system
	Changing and aligning systems to include CS
	Changing attitudes
	Collaboration and share values among individuals, groups and society
	Deploying more controlled crises
Supportive	Better information through the company
	Build awareness
	Educated workers
	Lifelong learning
	Providing new information and skills
	Changing mental models
	Create and make support
	Giving incentives
	Incentives, rewards and compensations
	Linking to existing programmes
	Multiplier effects
	Peer pressure
	Providing support and resources
	Use of technology
	Using Six Sigma programmes
Historical	Increasing sense of urgency
	Collaboration with other companies
	Job security
	Pressure from customers
	Pressure from regulators or media
	Publishing sustainability reports
	Stakeholder communication and engagement
External	*

*None of the presented approaches and strategies can be used to reduce or eliminate the external struggles

Source: Lozano (2009)

Appendix D: Indicators for nodes in QSR NVivo 10

This appendix is meant to clarify how the semi-structured interviews with the various candidates have been analysed. Table 25, 26 and 27 below distinguish indicators for specific drivers and barriers to interdepartmental PSS development and strategies to induce interdepartmental PSS development. The tables include drivers, barriers and strategies that were derived from literature, as well as those that are new and created throughout the analysis based on empirical data that was not suggested in the literature review.

Whenever one of the indicators was mentioned during the semi-structured interview, a 'node' has been attached to that specific sentence. Each indicator has been made up of arguments from the literature review to clarify what was understood for each driver or barrier. For the reported empirical data that could not be linked to literature, new nodes have been created. Additionally, several keywords have been formulated to help the researcher in identifying each driver or barrier from the transcripts.

Drivers to interdepartmental PSS development

Table 25: Node indicators drivers for interdepartmental PSS development

Node	Indicator *The interviewee indicated that a reason for involving/engaging with interdepartmental collaboration was...*	Source
Nodes for reported drivers adopted from the literature review		
Absorptive capacity	If a department is highly related to other departments, it will be relatively easy to gain new knowledge Key words: *Able to process knowledge from others; connecting department*	Tsai (2001)
Avoiding risks	Better manage risks within a company (business impediments, costs, relations with stakeholders)	Hansen (2013); Lozano (2013)
	Risk sharing Key words: *Manage risk; birds-eye view*	Camarinha-Matos et al. (2007)
Champions	Champions are at the forefront and embody the link between de innovator and the organisation. They can accelerate processes. Key words: *Individual leader; champion; proactively*	Lozano (2009; 2013)
Culture	Commitment to learn, tolerance of failure, openness to external ideas, continuous improvement Key words: *Progressive organisational culture*	Lozano (2013); Weymes (2004)
External best practices	Examples from Cross-Functional Teams or Communities of practice from other organisations Key words: *External best practices*	Dougherty (1992); Denison et al. (1996); Majchrzak et al. (2012)
History	Good experience with previous collaboration projects Key words: *History; success stories; previous successful projects; friends in the company*	Guimera et al. (2005)
Ideology	Believe in systems thinking Key words: *Holistic; systems perspective*	Senge (1999)
Innovation	To enhance competitiveness / Competitive advantages	Hansen (2002); Tsai (2001); Zhou & Li (2012)
	To develop new products, processes and services	Camarinha-Matos et al. (2007); Carnabuci &

	Key words: *Innovation; competitiveness*	Operti (2013); Fadeeva (2004); Hansen (1999); Kahn (1996); Love & Roper (2009); Tsai (2001); Stacey (2007)
Leadership	Management who developed and communicated corporate vision on collaboration	Denise (1999)
	Leadership	Lozano (2013)
	Management who motivated, involved and empowered employees	Carter et al. (2012); Gill (2002); Denise (1999)
	Management's use of personal power to organise success stories & joint advertisement	Camarinha-Matos et al. (2007)
	Management support Key words: *Vision/support management; organise success stories*	Denise (1999); Keegan & Turner (2002)
Market & Customers	To improve access to markets and customers by using your colleagues customer base	Camarinha-Matos et al. (2007); Fadeeva (2004); Lozano (2013)
	To better cope with market turbulence, by responding with greater agility, creativity and speed	Camarinha-Matos et al. (2007); Kotter (2012)
	To be able to process more customer information which makes it more likely that the innovation actually meets customer needs Key words: *Access; Cross-selling; resilient to market turbulence; process more customer information*	Cuijpers et al. (2011)
Network Position	To include a different department because that department is central in the network, which may lead to inclusion of more departments Key words: *Benefit from network others*	Tsai (2001)
Personal benefits for employees	Offering benefits to all players, easy access to complementary skills	Camarinha-Matos et al. (2007); Fadeeva (2004); Lozano (2013).
	The chance to learn from each other and benefit from novel knowledge developed by other departments Key words: *Personal development; benefit from others; learn*	Camarinha-Matos et al. (2007); Tsai (2001)
Productivity & Quality	Increase in employee morale and motivation leading to higher productivity	Stacey (2007)
	To reduce time for accomplishing objectives; better operations	Camarinha-Matos et al. (2007); Garcia et al. (2008); Hansen (2013); Zeller (2002)
	A shared bag of assets leads to higher productivity/quality (e.g. shared tools, lessons learnt, legal information, sample contracts)	Fadeeva (2004); Camarinha-Matos et al. (2007)
	To accomplish complex interdependent tasks beyond the ability of individuals working alone; optimise projects	Fadeeva (2004); Lozano (2013); Stacey (2007)
	Reuse of existing resources → use old resources to create something new; cheaper	Hansen (2013)
	Better operations → best practices in one part of the organisation can be used in different parts Key words: *Reduce time; higher productivity; shared bag of assets; reuse knowledge/resources*	Camarinha-Matos et al. (2007); Hansen (2013)

Profits & growth	Better sales: it is cheaper to sell more to current customers than to acquire new customers. E.g. Sell products with different existing customers: cross selling	Hansen (2013)
	Shifting focus from short-term profit to long-term profit- and/or value maximisation through strategic collaboration	Camarinha-Matos et al. (2007)
	Acknowledging the business case; Costs for change outweighed by benefits	Garcia et al. (2008); Lozano (2013)
	Market opportunity for supplying a total offer: product plus lease service, plus insurance, plus ingredients, plus product upgrading, plus repair, plus call centre, plus take-back, plus refurbishing Key words: *Better sales; long-term thinking; more benefits than costs for change*	Goedkoop et al. (1999)
Rewards	Rewards for cross-functional cooperation	Song et al. (1997)
	Rewards, incentives, compensations Key words: *Bonus; price; appreciation for interdepartmental behaviour*	Lozano (2013)
Nodes for reported drivers that had not been distinguished in the literature review		
Challenge	When employees want to act differently because of an interesting challenge they foresee. They want to prove that they can manage the challenge. Key words: *Challenge; tackle a problem*	
Champion (department)	If one department connects enthuses others departments and connects them. Similar to a champion on individual level, with the difference that a department champion operates out of the department's needs Key words: *One department connecting everyone; frontrunner department*	
Combining disciplines	Doing the project for it is a good way to collaborate with other disciplines. Key words: *Opportunity to combine knowledge/disciplines/departments*	
Competitions (internal or external)	A competition or game enabled the beginning the collaboration. Key words: *Competition; company game; engineering firm challenge*	
(Informal) gathering of employees	A reason why people from different departments come together, to discuss content that could be relevant for the company. Key words: *Informal meeting to discuss interesting topics. Share knowledge from employee-to-employee. Engage each other in working on innovations.*	
Logical to get involved	When someone has joined the collaboration because this was mot 'logical'. It was known that his/her department or that his/her qualities were required for developing the PSS. Key words: *Fitting for the job; logical to get involved; needed my specific capacities*	
Tender	A market actor that has sent a tender request to different engineering firms. This market player provides the demand and this demand can lead to interdepartmental collaboration for PSS development. Key words: *Tender offer*	

Barriers to interdepartmental PSS development

Table 26: Node indicators barriers to interdepartmental PSS development

Node	Indicator	Source
	The interviewee indicated that a reason for interdepartmental collaboration to be hindered was...	

Barriers to interdepartmental collaboration that were distinguished in the literature review		
Conflicts	Conflicts arising from incompatible or conflicting needs	Lozano (2007), from Lozano et al. (2014)
	Dysfunctional conflicts because of differences between departments	Cuijpers et al. (2011)
	Conflict between collective responsibilities and responsibilities at own department Key words: *Conflicting needs; differences between departments; conflict with own responsibilities*	Schilling & Kluge (2009); Thomson & Perry (2006)
Extra costs and/or time	'Wasted' time for mobilising information from other departments	Cuijpers et al. (2011); Hartmann (2006); Keegan & Turner (2002); West (2000)
	Effective collaboration involves considerable preparation and operational costs / time	Camarinha-Matos et al. (2007)
	Fear of less Return On Investment	Camarinha-Matos et al. (2007)
	Project delays, because departments set different task priorities and pursue incongruent objectives or because of differences in educational backgrounds of employees Key words: *Too expensive; not billable; les ROI; takes time to get info from other department; project delays; language barrier between different departments;*	Hansen (2009); Mishra and Shah (2009); West (2000); Cuijpers et al. (2011)
Extra work load	High commitment level/extra work Key words: *extra work*	Camarinha-Matos et al. (2007); Dent & Galloway Goldberg (1999); Lozano (2013); Thomson & Perry (2006)
History	Unsuccessful previous incorporation attempts Key words: *Bad experiences*	Lozano (2013)
Institutionalised organisational memory	Change of the status quo is difficult. People are used to business as usual. Working in own silos/departments. Key words: *Silos; culture; change is difficult*	Dent & Galloway Goldberg (1999); Schilling & Kluge (2009)
Insular thinking	Having the idea that all departments are very different Key words: *Idea of big differences between departments*	Pieterse et al. (2012); Lozano (2013)
Interdepartmental competition	How to split the gains? Competition with other teams/units leads to departments not wanting to share equally Key words: *Intra-firm competition; departmental goals conflict with organisational goals*	Lozano et al. (2014); Singendonk (2015); Schilling & Kluge (2009)
Lack of confidence in the concept/unclear business case	No confidence that collaboration will create a better situation/higher chances of success	Dent & Galloway Goldberg (1999); Lozano (2013); Kawano (2000); Silva et al. (2014)
	Cynism of change Key words: *Don't see advantages*	Kotter & Cohen (2012)
Lack of interest from actors	Unwillingness to change for an organisation	Lozano (2013); Schilling & Kluge (2009) Cuijpers et al. (2011)

		from Tushman & Nadler (1978)
	Loosing decision making power; less managerial control Key words: *Don't want to change; losing power*	Cuijpers et al. (2011) from Tushman & Nadler (1978); Camarinha-Matos et al. (2007)
Lack of leadership	Lack of support by top management	Lozano (2009; 2013); Schilling & Kluge (2009)
	Middle management short-term constraint	Lozano (2009)
	Management's fear for change Key words: *Don't dare to change; no management support*	Kotter & Cohen (2012)
Lack of resources	No budget and/or other resources Key words: *No budget; no resources*	Lozano (2009)
Language/culture barrier	Slow information processing since departments adhere to different operating principles, have different goals and technical jargon; low absorptive capacity Key words: *Language barrier; adapt to culture.*	Cuijpers et al. (2011) from Dougherty (1992); Song et al. (1997); Schilling & Kluge (2009)
Linear thinking	Lack of systems thinking Key words: *Narrow focus; linear behaviour; do not see the bigger picture*	Lozano (2013)
Markets & Customers	Spatial separation with independent markets restricts interdepartmental collaboration to a minimum Key words: *Different market*	Hartmann (2006)
Nature of change	Change is difficult Key words: *Not ready to change; difficulty of change*	Lozano (2009)
No clear goals	Lack of precise planning towards concrete goals Key words: *No clear goals; deadlines; targets*	Schilling & Kluge (2009); Thomson & Perry (2006)
Not-invented-here barrier	Departments should fix their own problems. Why can others do things better than we can? Key words: *We do not need help; different focus*	Hansen (2013); Schilling & Kluge (2009)
Organisational structure	Hierarchical settings are risk-aversive	Blayse & Manley (2004); Davila et al. (2012); Dent & Galloway Goldberg (1999); Dubois & Gadde (2002); Hartmann (2006);
	Rigid and conservative organisation	Kotter (2012); Schilling & Kluge (2009); Shaw (2010); Xue et al. (2014)
	Failing to alter cultural traits	Lozano (2013)
	Focus on planning & control Key words: *Hierarchy; tradition; risk-avoiding; culture; control*	Keegan & Turner (2002)
Perceived lack of relevance	Employees do not have understanding of the benefits that the new situation implies	Dent & Galloway Goldberg (1999); Lozano (2013)
	Short-term thinking	Lozano (2013)

	Key words: *Don't know benefits; short-term thinking*	
Physical distance	The greater the distance between colleagues, the greater the chance of flawed communication. People miss out on brainstorming, decision making and socialising that leads to positive outcomes. Key words: *Distance; not in same office; phone calls*	Geisler (2008)
Pragmatic concerns	Free riding (those who choose not to participate but still get the benefits)	Chilosi (2003), from Lozano et al. (2014)
	Coordination problems	Lozano et al. (2014)
	A lack of systems, tools and instruments for operationalisation, implementation and review of progress Key words: *No rooms available; no method to contact each other; lack of available tools; departments get benefit but put no effort in it; coordination problems*	Lozano (2009); Schilling & Kluge (2009)
Responsibility	Lack of clear responsibilities Key words: *Responsibilities not clear*	Schilling & Kluge (2009)
Risk	The business unit with the initial idea has to take the risks whereas other units are not willing to bear part of that risk	Hartmann (2006)
	Avoiding risks Key words: *1 department bears (financial) risk*	Lozano (2009)
Status	Low status of innovator makes that people do not listen Key words: *Status; lack of influence; junior*	Schilling & Kluge (2009)
Transfer barrier	People are not able to work with people they do not know well Key words: *Cannot work with other departments*	Hansen (2013)
Reported barriers that were not distinguished in the literature review		
Communication / not involved enough	That there was no clear communication. They were not asked for their opinion as often as expected. Key words: *Lack of communication; lack of involvement; no dialogue*	
Conflict due to billing	Employees have to be billable (on the customer) for a certain percentage of their time. This percentage usually lies above 80%. Working on a PSS project is not billable, and is therefore mostly done in someone's spare time. Key words: *Have to reach billing; spare time; project does not make money; conflict with other work because of billing*	
Lack of knowledge on how to approach	The people involved in the PSS development did not know how to approach. What should be the first step, and the steps hereafter? Who should we include? Key words: *No plan*; *do not know how to approach*	
Lack of ownership	No one took ownership of the project. Or very little ownership for people's own specific parts in each project. Key words: *No ownership*	
Time to get finance	Getting finance took longer than expected. This hindered the process; delayed the project. Key words: *It took long to get finance*; *expected finance at an earlier stage*	
Too ambitious	On or more people involved in the project had too ambitious goals. Those goals could not be reached. Focus should be on smaller targets. Key words: *Too ambitious; goals did not match reality*	
Top-down	There was too much of a top-down hierarchy. This hindered bottom-up engagement and	

approach	initiative. Key words: *Too much top-down; no bottom-up influence*
Unequal contribution	Not everyone contributed equally to the project. Difference in hours, effort etc. Key words: *Unequal time distribution; effort or resources.*
Wrong people involved	One or more people involved in the project were not suitable. They did not fulfil their jobs the way that was expected. Key words: *Incapable colleague; need for other skills*

Strategies to induce interdepartmental PSS development

Table 27: Node indicators strategies to overcome barriers to interdepartmental PSS development

Node	Indicator *The interviewee indicated that a strategy used to increase interdepartmental collaboration efforts is...*	Source
Strategies to overcome barriers to change that were distinguished in the literature review		
Awareness building	Build awareness that the new situation is important	Lozano (2009)
	Use of fear: the current situation won't last Key words: *flyers; use of fear as communication*	Lozano (2009)
Communicating success stories	Harnessing results	Denise (1999)
	Building success stories Key words: *celebrate wins; share successes of own and other organisations*	Camarinha-Matos et al. (2007)
Create the space	Reserve office space for employees who want to collaborate Key words: *office space; innovation room; secondary conditions*	Denise (1999)
Empowerment	Empowerment of employees	Lozano (2009)
	Different levels of membership Key words: *Give employees responsibility; collaboration forms that do not cost too much time*	Camarinha-Matos et al. (2007)
Force changes	Using power and authority Key words: *mandatory; obligation; fines*	Lozano (2009)
Knowledge sharing	Better information sharing through the company Key words: *opportunities for knowledge sharing; transparency*	Lozano (2009)
Rewards	Financial benefits	Lozano (2009)
	Incentives, rewards and compensations Key words: *Winning a price, salary increase, pubic acknowledgement, rewards, compensations, incentives.*	Lozano (2009); Song et al. (1997)
Top-Bottom approach	Set direction from the top and engage the people below (both top-down & bottom-up) Key words: *joint approach; management involvement; short lines between top and bottom*	Beer & Noriah (2000)
Groups of strategies that were not distinguished in the literature review		

Competitions	Internal or external competitions that require expertise from different departments Key words: *competition; winning*
Decrease distance	Efforts to decrease the physical distance between employees Key words: *fewer offices; bigger offices; re-organisation*
Digital communication	Changes that enable distant contact between employees. Key words: *web calls; online chat*
Digital knowledge share platforms	Platforms where knowledge can be shared that are available to anyone in the organisation Key words: *online knowledge sharing; communicate successes online*
Formal groups	Groups or communities within the organisation that are officially acknowledged and that include members from different departments Key words: *formal group; company boards*
Formal meetings	Meetings that were formally arranged, which are meant to share knowledge with different departments and look for opportunities to work together Key words: *team discussions; networking days*
Informal meetings	Groups that have been created by employees and do not have an official strategic purpose Key words: *Underground meetings; after work drinks*
Other	Random practices that could lead to interdepartmental PSS development

Appendix E: Product-service categorisation of the five investigated projects

In this section, the degree of PSS in the five studied projects is compared and it is discussed whether the five examined projects are in accordance with one or more PSS elements as distinguished by Mont (2004). The section starts with an illustration[15] of secondary and primary data that helped categorising the projects on a product (1) to service (5) scale.

Smart City

Primary data: Interviewee A: *"It is more like a cocoon in which many practices can be formulated. First, it would be a service, as we would give advice. In a later stadium we could develop more products."*

Secondary data: 'Smart Cities provide a new, sexy casing and exposure of our services' (Concept version working document Smart Cities, 2015).

IMBY

Primary data: Interviewee D: *"It is a product, but can help to provide services."*

Secondary data: The tool (product) '[...] offers a platform for citizens to share their concerns (service), which provides the opportunity to solve resistance and complaints in order to minimise costs of failure' (Grontmij, 2015).

Obsurv

[15] Each of the interviewees was asked to categorise the project on a product-service scale; hence, three explanations per project have been obtained. Many of the explanations showed overlap, which is why mostly on quote per project is included in this section.

Primary data: Interviewee H: *"It was intended as a product, but it is very much used as a service. Customers, such as municipalities, do not want a software product, rather they want the functionalities."*
Secondary data: 'Obsurv is a web based solution [...], which enables managers and administrators of public space to check and control the state of their assets, day and night' (Grontmij, 2015).

N211
Primary data: Interviewee L: *"I would grant it a 4. It is mostly a service; we provide the customer with advice. However, the plan can be seen as a product."* Interviewee J reasoned differently: *"I would grant it a 2. The end result is a road, which is a product. However, it must be a road with very limited maintenance for which we provide advice; this is the service part."*
Secondary data: Ambitions in the tender request by the Province of South-Holland (2015, *translated*). Ambition 1: '[…] only 12 years after completion of the project, large maintenance will have to take place.' Since maintenance would normally be required sooner, this ambition can be interpreted as a 'service' of higher quality and endurance. Ambition 2: 'Innovations are visible and scalable and therefore future oriented' (products).

RTO
Primary data: Interviewee O: *"We will be the knowledge and consulting party, which is why it is more of a service. However, when the stadiums are actually going to be built, the product part will become clearer."*
Secondary data: Design a plan to built what is necessary for the Olympics, only to place these elements on a predetermined location after the event' (Doe en Durf, 2015, *translated*).

A comparison of the product-service categorisations based on secondary data and afterwards on primary data did not result in large alterations for any of the projects. IMBY and Smart City remained in position after conducting primary data, whereas the other three never changed by more than 0,75 on the product (1) to service (5) scale (Figure 9). Obsurv moved towards the centre of the scale and thereby showed to be more of a service than initially expected. A reason for this is that once the interviewees were challenged to think about the PSS ratio, they realised that the 'product' Obsurv simply has a bigger service component than expected. Based on secondary data, RTO was expected to be closest to the centre of the scale; the best example of a PSS. Nevertheless, after consulting the interviewees, the project has moved more towards the service side. The major reason for this is that Grontmij's role in RTO would be providing services. Other parties would have to be included to perform the product parts. N211 is most central on the scale, which seems to imply that this project is the best example of a PSS in which the product and services sides are equally represented. Nevertheless, the reason that it is placed so central is that two interviewees categorised it as more of a service whereas one interviewee argued the N211-project to be mostly product development. The average of the three interviewees therefore lies rather central, albeit more on the service side.

Furthermore, none of the projects were categorised as solely products (1) or services (5). This could be because people tend to choose the 'safe' option and thereby ignoring the ultimate numbers (Colman et al., 1997), in this case 1 and 5. Number 2 till 4 might hence be overemphasised. Another explanation could be that all of the investigated cases indeed have service as well as product characteristics.

In short, as primary data turned out to provide approximately the same product-service classification as secondary data on the five projects, it seems that secondary data served as an appropriate indicator. Yet, using both data sources is a good method to verify findings from another source (Andrews et al., 2012). Also, because primary and secondary data provided evidence that each project had both service and product characteristics, the five projects seem to have been suitable for the purpose of this thesis. The description of the placements and shifts of all five projects due to primary and secondary data is visualised in figure 9.

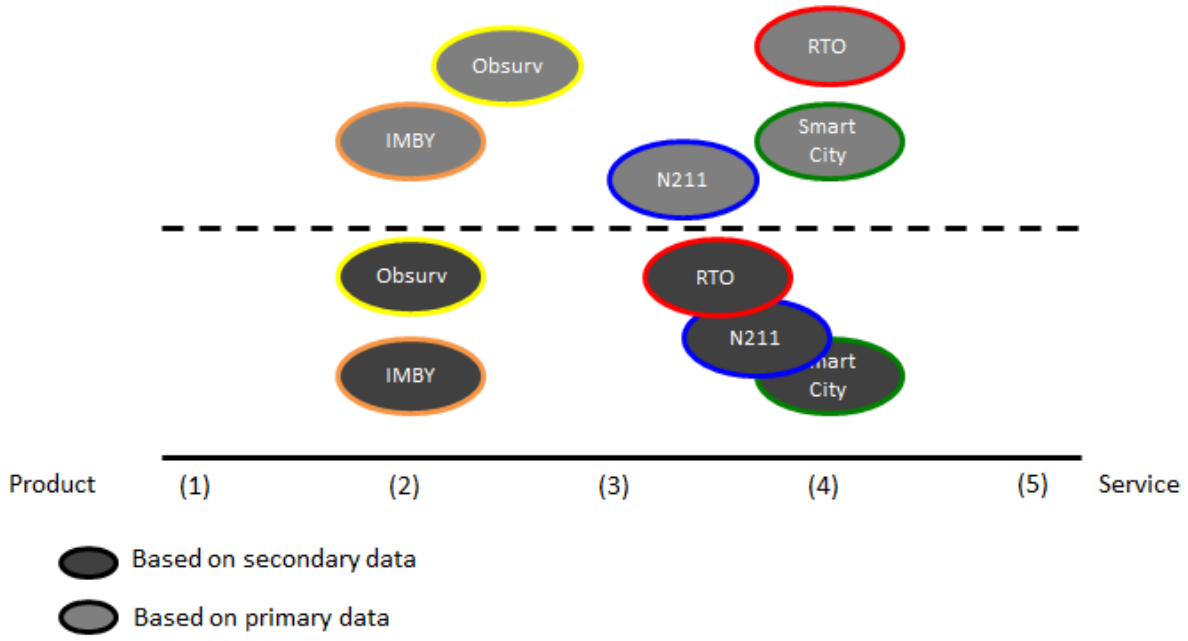

Figure 9: Categorisation of 5 investigated projects on a product-service scale

In the literature review (section 3.1, p. 16) it became apparent that out of Mont's (2004) five key elements, only element 2, for it comprises service at the point of sale (such as treatment of customers in a show), does not seem relevant for interdepartmental collaboration and PSS development at an engineering firm. The remaining four elements are now discussed in relation to the five projects. The elements are explained in the way Lozano (2013) summarised Mont's (2004) elements.

Element one addressed product/service combinations/substitutions. Projects involving combinations of different products or services seem to fit this element. In essence, all of the investigated projects do to some degree make use of this element since knowledge from different departments is used (service combinations). However, from the five projects,

especially Smart City and the N211-project seem to have interfaces with this element. Smart City is a project so overarching that it requires knowledge on and smart solutions/new combinations with conventional materials, products and service provision; product/service combinations. The N211 is a project in which a new combination of two very different products/services has to be realised: a road and power generating elements. Merging these two is a new product/service combination.

Element three considers different concepts of product use, encompassing both use-oriented and result-oriented phases. The use-oriented phase seems mostly applicable to IMBY and Obsurv. Both projects have led to software that customers do not necessarily want to own. Rather they aim to use the functionalities it offers and, depending on their needs, they like to choose a selection of the functionalities. When considering the result-oriented part of this element, one only buys a service and does not purchase the actual project as with Obsurv and IMBY. The project that seems to fit the result-oriented phase best is RTO; one only buys the service of stadium, however third parties own all of the stadium's material. The party that requested the stadium does not control what happens with the stadium once its' purpose is fulfilled.

The fourth element comprises resilient planning and therefore the possibility of maintaining and upgrading PSS in order to extend the PSS' lifetime. Several of the investigated projects might be applicable to this element. For instance IMBY and Obsurv, as they comprise software that every now and then launches a new version. The new versions are meant to upgrade the old version and therefore better serve customer's demands. Although the Smart City-project did not produce concrete examples of to-be-developed products, one can expect that they would comprise future-oriented and modifiable 'smart' solutions. Moreover, perhaps the most straightforward project that can be related to element four is the N211. This project's end result should ensure minimal maintenance and include the possibility of installing future climate positive inventions (Province of South-Holland, 2015).

Element five, revalorisation services, could be relevant for the N211, Smart City and RTO-projects since they will likely all make use of materials that have proven to be recyclable. However, neither primary nor secondary data showed considerations as to closing the material cycle.

In short, all of the investigated projects have service as well as product elements. In addition, all of the projects fit to some extent Mont's (2004) definition of PSS. Thus, it seems that the projects can indeed be categorised as PSS.

Appendix F: Semi-Structured Interview & Topic list

Certain background conversations were held in order for the researcher to gain familiarity with general thoughts on interdepartmental collaboration and PSS development at Grontmij. Those conversations have not been transcribed for the purpose of analysis. People who provided these first insights on how included Wouter Truffino, Annemarijn Jelsma, Rob van Hout, Remco Hofstede and Bas vd Bijl.

Semi-structured interview

The semi-structured interviews have been conducted according to the following setup:

1) Introduction by the researcher on the purpose of this thesis, basically explaining this story:

As mentioned in the email prior to this interview, the topic of this interview is collaboration between departments. The goal of the interview is to learn from previous collaboration projects within Grontmij that have led to new products/services.

2) Next, the actual questions of the semi-structured interview were treated. The first questions comprised general information (function, years in function etc.). The following questions involved relatively easy questions and concerned the content of the PSS they developed. Those questions were mainly meant for the interviewees to remember what they did and feel confident that they could answer all questions. Slowly, more focused questions towards the interdepartmental collaboration process were asked.

Interview #

Name:.....
Location:.....
Date:.....
Male/female
Age:.....

General

1. What is your function within Grontmij?
2. How long have you been working at Grontmij?
3. How long have you been working at Grontmij in this specific function?
4. What functions have you had prior to this one (both within Grontmij & at previous employers?

Collaboration in project X

5. How has product/service X originated?
    i. Was this a top-down or bottom-up process?
6. How would you rate X on a scale of (1) product till (5) service?
7. Which departments have contributed to the development of product/service X?
    i. Which people within these departments?
8. What has driven the collaboration between departments in project X?
    i. Which department initiated the collaboration?
    ii. What drove you to engage with this collaboration?
    iii. Why did people from different departments get involved in this project?
9. What was the intensity of collaborating; how often did the different departments meet?
10. Could you exemplify some of the key strengths of this collaboration?
11. Could you also give examples of some weaker points that you can distinguish?
12. To what extent was the top level/higher management at Grontmij supporting collaboration between different departments in this project?
13. To what extent was the top level/higher management at Grontmij hindering collaboration between different departments in this project?
14. To what extent was your department management supporting collaboration between different departments in this project?
15. To what extent was your department management hindering collaboration between different departments in this project?
16. How have financial costs been divided among departments?

17. How have profits been divided among departments?
18. What was the biggest challenge in the process of collaboration?
19. Overall, how have you experienced the collaboration between different departments?
20. Could you say that this project has been (dis)advantaged by the fact that collaboration between employees from different departments has taken place?
21. Would you have wanted to engage even more departments?
    i. Why has this not happened?
22. Could you explain whether the goals of the project have been reached?
23. Could you explain whether your personal project goals have been reached?
24. Would you arrange the collaboration differently if the project would start over again?
25. What is the current stage of product/service X?

Interdepartmental collaboration general

26. How important do you think that collaboration between different departments for Grontmij is?
    i. Could you elaborate on reasons why collaboration between different departments does not always happen naturally?
    ii. Could you give examples of how this form of collaboration has been stimulated at Grontmij?
    iii. Which of these examples are the best practices?
27. Could you give examples of how interdepartmental collaboration can be fostered further within Grontmij?
28. Which departments within the division of Transport & Mobility can be considered as most involved regarding interdepartmental collaboration efforts?
    i. Could you illustrate why they are most involved?
29. Could you distinguish departments within the division of Transport & Mobility that are least involved regarding interdepartmental collaboration practices?
    i. Could you illustrate why they are least involved?

Additional/challenging questions

30. If a project regarding the development of a new product-service system was to start, what would you do to facilitate collaboration between departments?
    i. What challenges would you foresee?
    ii. How would you overcome them?
31. Can you recommend any other innovative products/services for me to look into?
32. Can you recommend any other colleagues from within Grontmij whom I should try to conduct an interview with?
33. Are there any subjects that are not discussed within this interview but you value to share?

Topic list

General
Function, time, prior functions

Name:.....
Location:.....
Date:.....
Male/female
Age:.....

Collaboration project X
Origination. Top-down / bottom-up

(1) product - (5) service

Which departments / people

Drivers collaboration / who initiated

What drove you to engage

Intensity

Strengths / weaknesses

Conflicting responsibilities

Higher management

Department management

Financial costs / revenue

Biggest challenge

How did you experience ?

Advantage / disadvantage because of interdepartmental

More departments desired?

Project goals reached?

Personal goals?

Stadium project X

Arrange the collaboration differently if you would do it again? How?

Interdepartmental collaboration general
How important / why happens so little / why so little PSS development

What is being done to stimulate it

Which practices are best / worst

Examples of how interdepartmental collaboration can be stimulated

Most involved

Less involved

Additional/challenging questions
New PSS, how would you facilitate the collaboration
What challenges / how to overcome them

Other people / projects

Other topics

Additional
Example of project where interdepartmental collaboration could have helped

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Appendix G: Visualisation of drivers and barriers in respect to different study areas

'Yes' means that the reported driver/barrier was also mentioned in at least one of the consulted articles from the specific literature cluster.
'No' means that no consulted articles in the scientific clusters mentioned the driver/barrier.

Table 28: Comparison of drivers for interdepartmental collaboration for PSS development to 7 different scientific clusters

	Organisational change	*Intra-organisational collaboration*	*Interdepartmental collaboration*	*Collaboration for sustainability*	*Corporate Sustainability*	*Innovation*	*Construction industry*
Internal drivers (project)							
Avoiding Risk	No	No	Yes	Yes	Yes	No	No
Innovation	Yes	Yes	Yes	No	Yes	Yes	No
Profits & Growth	No	Yes	Yes	Yes	Yes	Yes	No
Internal drivers (collaboration)							
Champions (employee)	No	No	No	No	Yes	No	No
Personal benefit for employees	No	Yes	No	Yes	Yes	No	No
Productivity & Quality	Yes	Yes	Yes	Yes	Yes	Yes	No
External drivers (project)							
External best practice	No	No	Yes	No	No	Yes	No
Leadership*	Yes	Yes	Yes	No	No	Yes	No
Markets & Customers	Yes	Yes	Yes	No	Yes	Yes	No
Profits & Growth	No	Yes	Yes	No	No	Yes	No
External drivers (collaboration)							

***Leadership is used as an overarching term to include higher management en department management support**

Table 29: Comparison of barriers to interdepartmental collaboration for PSS development with 7 different scientific clusters

	Organisational change	*Intra-organisational collaboration*	*Interdepartmental collaboration*	*Collaboration for sustainability*	*Corporate Sustainability*	*Innovation*	*Construction industry*
Individual							
Conflict in time	**Yes**	**No**	**No**	**No**	**No**	**No**	**No**
Extra work load	**Yes**	**Yes**	**No**	**No**	**Yes**	**No**	**No**
Lack of interest from actors	**Yes**	**No**	**Yes**	**No**	**Yes**	**Yes**	**No**
Group							
Extra costs and/or time	**No**	**Yes**	**Yes**	**No**	**No**	**Yes**	**Yes**
Interdepartmental competition	**Yes**	**No**	**No**	**Yes**	**Yes**	**No**	**No**
Lack of confidence in the concept	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Lack of leadership / management support	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Language/culture differences	**Yes**	**No**	**Yes**	**No**	**No**	**Yes**	**No**
No clear goal / vision	**Yes**	**No**	**No**	**No**	**No**	**No**	**No**
No clear responsibilities	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Physical distance	**No**	**No**	**Yes**	**No**	**No**	**No**	**No**
Pragmatic concerns	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Risk	**No**	**No**	**No**	**No**	**No**	**Yes**	**Yes**
Organisational							
Institutionalised organisational memory	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Lack of leadership / management support	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Organisational structure	**Yes**	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**

Appendix H: Strategies to foster drivers and overcome barriers to interdepartmental PSS development

Existing strategies at Grontmij, complemented with strategies to overcome barriers to change from literature.

Table 30: Overview of potential drivers that can be fostered and barriers that can be overcome with existing strategies at Grontmij, complemented with strategies to overcome barriers to change from literature

Strategy at Grontmij	Related to this strategy in literature	Potential to foster the following reported drivers	Potential to overcome the following reported barriers
Insite; Knowledge platforms/team sites; Newsletters; Yammer; PROUD-sheets Webinars; Conference calls; Lunch readings/knowledge share sessions; Weekly team discussions; GUP; ALV (general staff meeting); Boards (energy, water, roads); LPV (Staff association); and, Young Grontmij.	Knowledge-sharing / sharing best practices (Camarinha-Matos et al., 2007; Denise, 1999; Kegan & Laskow. 2001; and Lozano, 2009).	Innovation; Productivity & quality; Personal benefit for employees; profits & growth; Market & customers; Avoiding risk; and, The possibility to combine disciplines	A lack of confidence in the concept; Extra costs and/or time; and, A lack of interest from actors
Company Boards (energy, water or roads).	Short-term (one-month) cross-department committee (Kegan & Laskow, 2001).	X	Organisational structure; Institutionalised organisational memory; Lack of interest from actors; and Language/culture barrier
Enabling Lync-calls; Fewer offices; and, Abolition of different business units.	Reduce number of offices (Waber et al. 2014).	X	Physical distance
Top-bottom approach	Top-bottom approach (Beer & Noriah, 2000)	Higher management; and Department management	Lack of leadership/management support; Conflict due to billing; Conflict in time; Extra costs and/or time; Extra work; Time to get finance; Too ambitious; and Top-down approach

Internal and external competitions	Rewards, compensations, incentives (Beer & Noriah, 2000; Kotter & Cohen, 2002; Lozano, 2009; Song et al., 1997)	Competition (internal/external); Champion; and Champion (department).	Extra costs/time; and A lack of interest from actors
After work drinks; Education of regional teams; and Networking days	Strategically place coffee machines so that people meet (Waber et al., 2014)	Innovation; Profits & growth; and Personal benefit for employees.	X
Team projects	X	Logical to get involved	Interdepartmental competition
Engaging in Big tender projects	X	Tender; innovation; and challenge	
X	Co-opting approach (Lozano, 2007)	X	Lack of interest from actors
X	Set clear course and clear goals (Denise, 1999)	X	Communication / not involved enough; Lack of knowledge on how to approach; Lack of ownership; Language/culture differences; No clear goal / vision; No clear responsibilities; Too ambitious; and Unequal contribution

* A box marked with 'X' means that the box is empty. This implies that within this row there was no strategy at Grontmij, no strategy in literature, no driver to be potentially fostered or no barrier to be potentially overcome.
** *Pragmatic concerns & Wrong people involved* are reported barriers to interdepartmental PSS development to which no specific strategies at Grontmij or in the literature review could offer a solution. Nevertheless, quick anticipation if pragmatic concerns occur (such as a lack of available equipment) and substitution of the person concerned can reduce the impact of the barriers to interdepartmental PSS development.