

Information management in supply chain partnering: improving maintenance processes in Dutch housing associations

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Abstract

Maintenance processes of Dutch housing associations are often still organized in a traditional manner. Contracts are based on lowest price instead of 'best quality for lowest price' considering users' demands. Dutch housing associations acknowledge the need to improve their maintenance processes in order to lower maintenance cost, but are not sure how. In this research, this problem is addressed by investigating different supply chain partnering principles and the role of information management. The main question is "How can the organisation of maintenance processes of Dutch housing associations, in different supply chain partnering principles and the related information management, be improved?" The answer is sought through case study research.

Keywords: supply chain partnering, information management, building information model (BIM), maintenance, process innovation.

1 Introduction

The Netherlands has a strong tradition of social housing for lower income groups. Within this tradition, housing associations are a major player (Boelhouwer et al., 2014) something which dates back to the 1901 Housing Act. In the beginning, social housing was operated from the pillarization, the politico-denominational segregation. After World War II, the Dutch government managed and prescribed how, what and where to build. From the mid-1990s, the government withdrew itself and stimulated self-reliance (Van Gijssel, Gärtner, Bos, Van Dellen, & Minke, 2014). Today, the social housing system is failing, the decreasing support from society is a crucial threat to the future of the system (Boelhouwer et al., 2014). Therefore, innovation of the system, among other things by regaining commitment between the housing associations and their target population, is vital (Boelhouwer et al., 2014). A focus on core activities is, together with the first benchmark by Aedes in 2015 (the national organisation promoting the interests of social housing organisations in the Netherlands), the first step in the right direction.

With rental incomes that are just sufficient to cover the expenses for management and maintenance, more efficient cooperation with maintenance companies can lead to more

efficient maintenance processes and lower maintenance costs (Gruis, 2011). It is believed by both scholars and practitioners that more efficient cooperation can be achieved through supply chain partnering and the effective use of information systems. Especially for housing associations, where the organisation of maintenance occurs in a complex environment. The very diverse property portfolio of housing associations is one of the complexing aspects. The portfolio's consists of recently completed new built houses, post-war dwellings and houses completed in the intervening period. Furthermore, they lack unity regarding (i) construction quality, (ii) compliance with present living requirements, (iii) method of recording the construction and installation engineering information, and (iv) accessibility to and completeness of this information (Jak, 2016; Mans, 2016).

Supply chain partnering (SCP) has become a prominent phenomenon among academics and professionals working in the construction sector (Briscoe & Dainty, 2005; Eriksson, 2015; Gruis, 2011; Segerstedt et al., 2010; Tennant & Fernie, 2014; Venselaar, Gruis, & Verhoeven, 2015; Vrijhoef & Ridder, 2007). Several benefits are ascribed to better coordinated cooperation between supply chain partners, including cost reduction, increase of quality, shorter execution times, and more opportunities for innovation and learning (Eriksson, 2015; Gruis, 2011; Segerstedt et al., 2010; Tennant & Fernie, 2014; Vrijhoef & Ridder, 2007). And although information management is a prerequisite for successful implementation of SCP, there is little attention for the relation between the implementation of SCP and information management. Furthermore, most research on information management in construction focuses on building information modelling (BIM) for new construction (A. Adriaanse, Voordijk, & Dewulf, 2010; Almarshad & Motawa, 2012; Azhar, 2011; Fox & Hietanen, 2007; Love, Matthews, Simpson, Hill, & Olatunji, 2014; Miettinen & Paavola, 2014; Motawa & Almarshad, 2013) while benefits of BIM could also apply to maintenance. BIM use facilitates the integration of stakeholders thereby reducing fragmentation, improves knowledge management and communication, cooperation, decision-making, and performance of maintenance, and reduces maintenance costs (A. Adriaanse et al., 2010; Almarshad & Motawa, 2012; Azhar, 2011; Deshpande, Azhar, & Amireddy, 2014; Fox & Hietanen, 2007; Love, Simpson, Hill, & Standing, 2013; Van der Vlist, Arno J, Vrolijk, & Dewulf, 2014). However, to fully benefit from BIM coordination of stakeholders and stakeholders' actions is required (Van der Vlist, Arno J et al., 2014). Research on SCP also focuses mostly on new construction, which is surprising since new construction is still mostly about one-time projects while maintenance is an ongoing series of activities. It is the latter that generates opportunities for a more structural cooperation between supply chain partners and also a more structural coordination of activities, resources, and benefits and risks. This research addresses these opportunities and identifies the coordination mechanisms that help improve information management as well as the implementation of SCP.

This research proposal has the following structure, hereafter the problem definition and formulated research question are discussed. Subsequently section three describes the research methodology while section four elaborates on the expected results. Future development of this research is discussed in section five.

2 Problem definition

Opportunities for implementation of SCP are particularly evident in the social housing sector in Northwest Europe, including the Netherlands. In Northwest Europe, the social

housing sector is managed by professional property managers, who are capable of building professional partnerships with their contractors. In general, the housing sector is under increased financial pressure, which triggers social landlords to look for more efficient ways of working. According to the Housing Act 2015, Dutch housing associations must focus on building, renting out, and managing and maintaining social housing, and invest in the livability of the neighbourhood. The Housing Act 2015 also allows for commercial activities (such as private sector dwellings in a neighbourhood where houses are being demolished to provide a better mix of lower and higher income groups within the neighbourhood) but only when commercial parties have no interest (Rijksoverheid, 2015). This is executed within a framework of (i) less (governmental) subsidies (Gruis, 2011); (ii) various organisational structures; and (iii) a differentiated property portfolio. In addition, the internal business operations of Dutch housing associations are neither transparent nor efficient. An understanding of the activity-based costs is often imperfect (Boelhouwer et al., 2014), while the necessity to manage costs forces housing associations to develop structures of strategic stock management (Bouw Research, 2013) and a housing stock with sufficient flexibility to anticipate to future developments. In addition, the social rent that is actually paid to the housing association is often lower than the (economic or market) value of the housing services generated by the houses (Gruis, 2002). The internal management of housing associations is often neither transparent nor functional (Boelhouwer et al., 2014). Potentially, about 80% of all housing associations could improve their processes regarding maintenance (Aedes, 2015). Koolma & Allers (2013) also indicate there is ample room for efficiency gains in the Dutch housing association sector.

In the current organisational structure of maintenance, housing associations still tend to do a lot of maintenance activities themselves. This is costing them a lot of time and money, therefore revenues from rent are just sufficient to cover management expenses (Gruis, 2011). Both scholars and practice recommend that housing associations change their maintenance processes in order to lower the costs involved (Dreimüller, Gruis, & Snoeijjs, 2013). This starts with changing the type of contract. Traditionally, parties rely on formal, dyadic contracts that specify each party's financial and other rights, responsibilities, and duties (Lavikka, Smeds, & Jaatinen, 2015). And traditional approaches to maintenance lead to more management time, unnecessary costs, and poor maintenance decision-making (Alshawhi, Goulding, Sharp, & Jones, 2012). In addition, in construction projects, the relationship between firms typically last for the duration of the project (Vrijhoef & Ridder, 2007), meaning that learning across and between projects to improve processes hardly ever occurs. Also, construction projects are often criticised because of the performance of contractors, with lower than expected performance in time, costs, quality, and satisfaction levels of clients (Ferrada & Serpell, 2014). Kempton (2009) identified a significant problem with communication and a lack of coordination between the corporate goals of the development, management, and maintenance departments. This is illustrated by three employees of a medium sized Dutch housing association who point out that the new building projects department is an independent entity within the housing association. As a result, one of the key challenges is to have sufficient information available for maintenance work, such as specifications, information on previous maintenance work, a list of specialist professionals to conduct work, etc. (Motawa & Almarshad, 2013). Information is often not available and available information is often not complete or up-to-date nor easily shared among supply chain

members. Maintenance processes could be improved through improving coordination and information management processes. This is not provided by a dyadic contract since this type of contract neither provides a shared goal for all project partners, nor specifies the organisational or technological mechanisms to align information and knowledge flows between the project partners (Lavikka et al., 2015). A dyadic contract will more likely lead to fear of opportunism, to an experienced lack of trust in the beginning of the project, which in turn leads to more procedural coordination mechanisms to benefit project outcomes and to reduce project risks (Lavikka et al., 2015). Here, a transition towards integrative supply chain processes appears desirable, because maintenance projects require an approach with a clear and integral set of requirements, where all involved parties cooperate as a well-oiled team (Vijverberg, Van der Krogt, & Keus, 2013). Furthermore, transparency and an increase in efficiency are necessary for the legitimacy of housing associations in society (Aedes, 2015).

The idea of a shift from a fragmented (dyadic) into an integrative way of construction is also a generalised technological promise of building information modelling (BIM) technologies (Miettinen & Paavola, 2014). However, this does not provide a realistic conception of the complexity of the conditions of the implementation of BIM (Miettinen & Paavola, 2014). According to Love et al. (2014) BIM technology in itself has no inherent value; having BIM technology in place will not necessarily provide benefits or create value for a housing association, benefits only arise from its effective use. This asks for coordination of stakeholders' actions (Van der Vlist, Arno J et al., 2014). And learning to cooperate as partners is a social accomplishment, rather than a technical feature (Bresnen, 2010). Partnering must involve the production of new working practices at a local (supply chain) level (Bresnen, 2010). The implementation of BIM could help as it facilitates the integration of the roles of all stakeholders (Azhar, 2011). In 2014 Nobakht stated in *Cobouw*, a daily (online) magazine for construction professionals, that despite the changes and challenges housing associations are facing, structural innovations of the current business models were still omitted. He believes that the barrier for structural innovations lies in the originating small scale building sector, with a traditional way of thinking, a monoculture, and a lack of knowledge regarding strategic business problems (Nobakht, 2014). Construction clients appear to distrust their main contractors who, in turn, distrust their subcontractors and suppliers, and individual players have very little stake in the long-term success of, and therefore no commitment to resulting structure. (Briscoe & Dainty, 2005). The core of the problem is that fragmentation (A. M. Adriaanse, 2014; Behera, Mohanty, & Prakash, 2015) is thought to be of interest to all involved parties although it leads to loss of information, misunderstandings, pointing at each other, sub-optimizations, and additional work (Vijverberg et al., 2013). Although it is believed that supply chain integration must lead to improvement by developing a more stable environment (Vrijhoef & Ridder, 2007), several barriers prevent this integration. The traditional fragmentation leads to resistance towards supply chain integration due to perceived extra costs, partners are unaccustomed to share knowledge across project phases and are unaware of potential benefits (Nam & Tatum, 1992). Successful integration of the construction supply chain is possible. For instance through a multi-party contract which aligns financial interests and builds trust between supply chain partners in the beginning of the project; the contract aligns information and knowledge flow between the project partners by specifying organisational and technological mechanisms (Lavikka et al., 2015). Long term supply chain partnerships (i) make it easier to be vulnerable and communicate freely and thus to establish common norms and good team practices, and

(ii) are also positively associated with improved working practices and an increased level of trust (Buvik & Rolfsen, 2015). In high trust groups, coordination is more effective leading to greater efficiency and hence better performance (Dirks, 1999).

Coordination theory is relevant for improving the cooperation in supply chains (Kanda & Deshmukh, 2008; Li & Wang, 2007), especially in combination with the concept of boundary objects (Bresnen, 2010). However, thus far this theory has not been applied to supply chains in the construction industry. Coordination theory has been defined by Malone and Crowston (1990) as “a body of principles about how activities can be coordinated, that is, how actors can work together harmoniously”. Li and Wang (2007) distinguish two supply chain types, centralised and decentralised. They state that construction supply chains are decentralised supply chains, which are more difficult to coordinate because this requires a scheme to allocate the benefits of coordination throughout the supply chain to maintain the interest and participation of all dependent supply chain partners (Li & Wang, 2007). For this agency theory “offers a unique, realistic, and empirically testable perspective on problems of cooperative effort” (Eisenhardt, 1989). It analyses the relationship that develops in an economic exchange when an individual (the principal) concedes authority to another (the agent) to act in his or her name (Cuevas-Rodríguez, Gomez-Mejia, & Wiseman, 2012). The exercise of coercive and legal power has a strong negative effect on collaborative behaviour, while rewards have a positive effect (Nyaga, Lynch, Marshall, & Ambrose, 2013). The central goal of agency theory is to stop opportunistic behaviour in a situation where parties have different goals and the information supply is incomplete (i.e. the traditional maintenance practice at Dutch housing associations). Coordination theory and agency theory are complementary because where the latter theory presents a partial view of the world that ignores a good bit of the complexity of organisations (Eisenhardt, 1989), the former theory fills this gap by looking at the complexity of cooperation between organisations. Because supply chains are complex with many activities usually spread over multiple organisations and sometimes over lengthy time horizons, it is necessary to overlay a coordinated system (Kanda & Deshmukh, 2008). This coordinated system may include an explicit definition of processes, responsibilities, and structures aligned with overall objectives of the whole supply chain to bring together multiple functions and organisations (Kanda & Deshmukh, 2008). This implies that all these organisations and the people within the organisations have to face, and preferably employ, one of the four dialogical learning mechanisms of boundaries (Akkerman & Bakker, 2011):

- Identification, which is about coming to know what the diverse practices are about in relation to one another;
- Coordination, which is about creating cooperative and routinized exchanges between practices;
- Reflection, which is about expanding one's perspectives on the practices;
- Transformation, which is about collaboration and co-development of (new) practices.

The results of this research are specifically aimed at realising recommendations for improving maintenance processes at Dutch housing associations by improving the collaboration (and coordination) of the supply chain processes. Based on the discussion as described above the results should provide an answer to the following main research question:

How can the organisation of maintenance processes at Dutch housing associations in different supply chain partnering principles and the related information management be improved?

Related sub-questions are:

- What coordination methods are used to align goals and objectives, to align decision-making, to share information, and to align cooperation?
- Do supply chain partners experience the benefits of SCP (improved performance, reduced project costs, reduced project risks)?
- To what extent does BIM support the coordination method of sharing information?
- What are other IT systems used in the cooperation?
- What problems occur in using the coordination mechanisms, and how can these problems be improved?

3 Methodology

This research follows the applied research perspective as described by Kumar (2014). The chosen perspective for the objectives of the research is that of explanatory research since little is known about the research topic (Kumar, 2014). This is combined with descriptive research in order to describe systematically the situation (Kumar, 2014). The mode of enquiry perspective is that of a qualitative approach (Kumar, 2014) and therefore the form of case studies is chosen to retain a holistic and real-world perspective (Yin, 2013). A case study is interpretive and descriptive because it attempts to understand and portray results-oriented planned maintenance through the participants' interpretation of their context (Runeson & Höst, 2009). The case study design is also chosen because (i) the main research question is a 'how' question, (ii) the researcher has no control over actual behavioural events, and (iii) the degree of focus is on contemporary events (Yin, 2013). The research aims to discover which coordination mechanisms are used (i) to align goals and objectives in the supply chain, (ii) to align decision-making by the supply chain partners, (iii) to share information within the supply chain, and (iv) to align cooperation in the supply chain. But also to discover whether the benefits of SCP (e.g. (i) improved project performance (e.g. project coordination, work processes, problem solving processes, organizational learning, quality of project results), (ii) reduced project costs (e.g. less redundant work and wastage), and (iii) reduced project risks (project delay, over-budget, poor quality) (Arvitrida, Robinson, & Tako, 2015; Bresnen, 2007; Challender, Farrell, & Sherratt, 2014; Love, Irani, Cheng, & Li, 2002; Soosay & Hyland, 2015; Vrijhoef & de Ridder, 2007; Wong & Cheung, 2004) are present in the cases. Further objectives are to investigate what ICT systems are used, the problems that occur in using the coordination mechanisms, and how these problems can be improved.

This research consists of two (replicable) cases. For these cases, a two-case case study design (Yin, 2013) is chosen in order to describe and explain SCP in planned maintenance at Dutch housing associations. The findings from these cases are assessed in a wider context through a survey. Research results are published four times during the research. The first paper is a literature review, the second paper is based on the results of the first case study, the third paper is based on the results of the second case study, and the fourth

paper is based on the survey results. The final thesis is composed based on the published papers (see also figure 1).

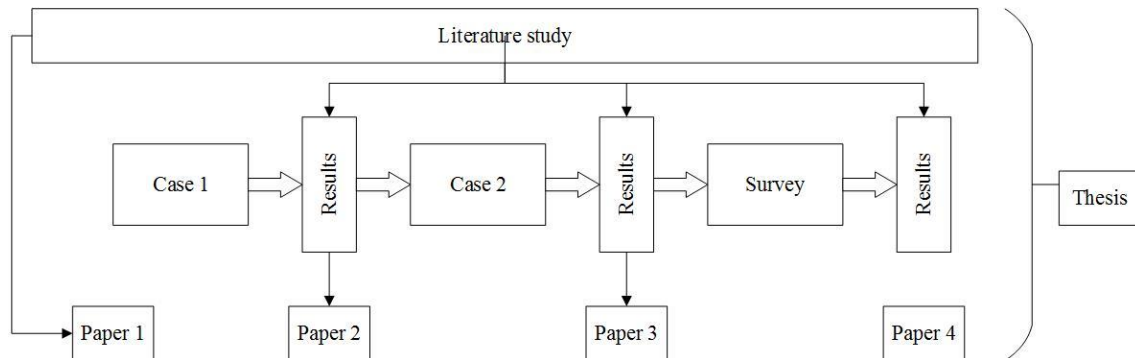


Figure 1: Research method (Goedknecht, 2017)

The coordination processes of supply chain integration at Dutch housing associations are described through a literature study. This is supported by literature on coordination theory, agency theory, boundary crossing, and information management. Literature is found through desk research and snowballing using scientific databases such as Science Direct and scholar.google.com. Results of this literature review will be used in the case studies. Case study evidence may come from six sources: documents, archival records, interviews, direct observations, participant observations, and physical artefacts (Yin, 2013). And because in case study research it is important to use multiple sources of evidence (Yin, 2013), this research makes use of the following sources: documents, archival records, interviews, and direct observations. The researcher will not participate in the maintenance process, therefore participant observation is not used. The researcher remains “a passive observer, watching and listening to activities and drawing conclusions from this” (Kumar, 2014). Also, physical artefacts are not used because processes are researched, not technical operations (Yin, 2013). Furthermore, two types of interviews will be used: prolonged case study interviews (“in which interviewees can be asked about their interpretations and opinions about people and events or their insights, explanations, and meanings related to certain occurrences”) and survey interviews (Yin, 2013). The direct observations will contain observations of meetings and maintenance activities (Yin, 2013).

Both case studies are organised to the same theory in order to strive for generalizable findings (analytic generalisations) that go beyond the specific cases (Yin, 2013). This means that this research adopts the holistic multiple-case design and is a literal replication of two cases as described by Yin (2013). In all cases (i) maintenance must be executed within a supply chain; (ii) within the supply chain all partners commit to predetermined results; (iii) maintenance is described by the housing association (in consultation with tenants and the contractor) as technical performance demands; and (iv) the contractor assures both housing association and tenants that the technical performances are achieved. Results from both case studies will be validated (or rejected) through a survey amongst other Dutch housing associations and their maintenance contractors.

The first object of study is a maintenance supply chain at a local Dutch housing association, founded in 1913. For this housing association, supply chain partnering is an

important feature since 2011. They believe in the benefits of SCP and execute 80% of their maintenance work through SCP. In this case study, the main contractor is a new supply chain partner who has proven his reliability and skills in a small project. The following roles are included in the study: the project manager of the housing association, the foreman of the main contractor, the project manager of the most important subcontractor(s) and the project manager of the (main) supplier(s). It is important to point out that the project that is researched is the first of this particular main contractor. Aspects of study are the sub-questions as stated in section two. In more detail, it is researched what mechanisms are in place to establish supply chain integration for the maintenance activities using coordination mechanisms and boundary crossing mechanisms (see table 1). The first column in table 1 shows the supply chain integration mechanisms (after Briscoe & Dainty, 2005). The second and third column show matching coordination and boundary crossing mechanisms for each of the supply chain integration mechanisms. In the fourth column, the matching maintenance activities are added. In other words, the table shows what maintenance activities contribute to supply chain integration.

Supply chain integration (Briscoe & Dainty, 2005)	Coordination mechanisms (Kanda & Deshmukh, 2008; Koolwijk et al., 2015; Li & Wang, 2007; Malone & Crowston, 1990; Malone & Crowston, 1994)	Boundary crossing (Akkerman & Bakker, 2011)	Maintenance (construction) activities (Lavikka et al., 2015; Tucker et al., 2014)
Develop effective communication systems throughout the phases of the supply chain, Ensure good and reliable flows of information, Establish mechanisms for problem resolution.	Align decision-making (e.g. through (electronic) meeting and communication tools). Establish standardisation of outputs.	Identification (othering, legitimating co-existence). Coordination (communicative connection, increase boundary permeability, routinization) Reflection (perspective making and taking).	Establish maintenance service standards. Set up collaborative decision-making. Use building information modelling (BIM). Use project management software and techniques.
Ensure that all supply chain partners have knowledge of each other's processes Ensure that all supply chain partners are able to align their processes.	Align goals and objectives within the supply chain.	Transformation (confrontation, recognising shared problem space, hybridization).	Establish a procurement strategy. Establish a joint financial incentive. Set up an organisational design. Agree on a process for collaborative working. Agree on common definitions. Use the pull technique of Lean construction

Supply chain integration (Briscoe & Dainty, 2005)	Coordination mechanisms (Kanda & Deshmukh, 2008; Koolwijk et al., 2015; Li & Wang, 2007; Malone & Crowston, 1990; Malone & Crowston, 1994)	Boundary crossing (Akkerman & Bakker, 2011)	Maintenance (construction) activities (Lavikka et al., 2015; Tucker et al., 2014)
Focus on coordinated working through (i) project management techniques, and (ii) alignment of ICT-systems (e.g. BIM).	Structure joint working sharing of resources. Establish an ICT-system to transfer information and knowledge (e.g. BIM). Set up SC contracts. Planning project phases together.		Establish efficient work practices. Align work practices. Establish quality control procedures. Key project partners work co-located. Use building information modelling (BIM). Use and project management software and techniques.

Table 1: Conceptual model (Goedknecht, 2017)

4 Expected results

Based on our study of the literature, the following elements are a prerequisite for the improvement of the maintenance processes (see figure 2) (Goedknecht & Ravesteijn, 2016): (i) supply chain partners have a joint understanding of the mutual (inter)dependencies between all supply chain partners; (ii) supply chain partners align their goals and objectives; (iii) supply chain partners agree on the coordination of decision-making; and (iv) supply chain partners agree on the exchange and availability of information and knowledge (regarding the maintenance processes). The assumption is that by identifying and applying the coordination mechanisms (see figure 2), information management (through implementing BIM) and supply chain partnering, and thus maintenance processes will improve. This will lead to all previously mentioned benefits (e.g. improved project performance, reduced costs, and reduced project risks).

Preliminary case study observations (of the first case study) show a difference in the approach to SCP. The property managers ambition is results-oriented cooperation with a permanent network of supply chain partners based on affordability, availability, and quality. He believes that data must be secured and available and knowledge must be assured, for example by using BIM. The project manager, however, does not talk about results-oriented cooperation but about performance oriented cooperation with responsible supply chain partners. He also draws up performance oriented contracts per project which contravenes to both the literature on trust and SCP and the housing association's own supply chain principles. The main contractor has aligned his goals with those of the housing association regarding the project, he puts the quality of living of the tenants during and after the maintenance activities first. Further research must give more insight into the actual cooperation process and its effects.

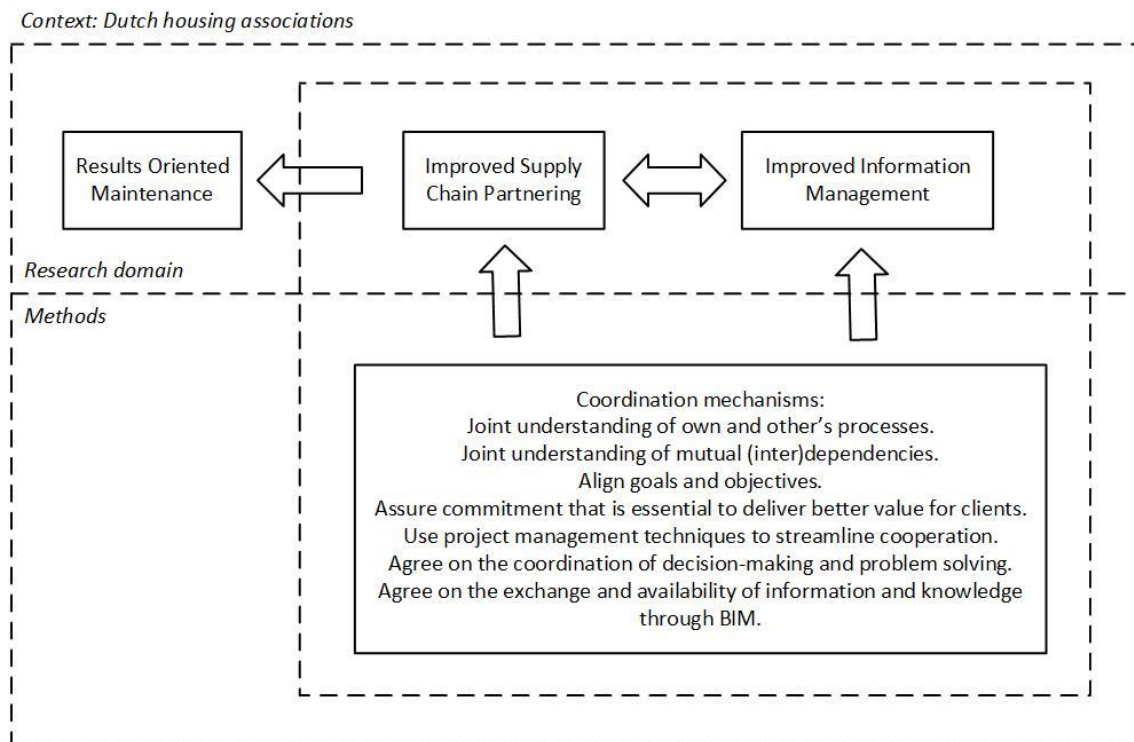


Figure 2: Conceptual model (Goedknecht, 2017)

5 Future Development

The literature study is the rationale for subsequent future research. Although more scientific and practical research can be incorporated, this study has already shown that research regarding improving maintenance processes at Dutch housing associations is missing. Therefore, research will be executed through case studies at two Dutch housing associations currently implementing results-oriented maintenance processes. These case studies aim to reveal how the different constructs in our conceptual model help improve the information management, supply chain management and thus the maintenance processes. These results will then be tested via a qualitative survey with relevant stakeholders (e.g. housing associations, main contractors, subcontractors). This will contribute to the implementation of SCP in the construction industry. According to Van der Boon (manager R&D, innovation, business development) at Leertouwer (a technical service provider in electrical engineering, climate control and ICT) many housing associations are still stuck in the previous century, steering at lowest cost based on Excel documents, sometimes even lacking the knowledge and skills to see the bigger picture (Van der Boon, 2016). Van der Boon (2016) also stresses that although SCP is very relevant, construction is still an industry where phases are viewed as stand-alone, and learning across phases is still not common. When one phase is finished, information is not well nurtured, and cooperation and coordination are not common. Communication is key, and a change in culture is necessary. It is important to understand the role, responsibilities and processes of all actors. Wolf (managing director of Vines Building Engineers) states that BIM, as a vehicle for improving the coordination of information of maintenance processes, can be used to change the current maintenance processes into

processes based on sharing knowledge and information and empowering process stakeholders (Wolf, 2014).

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