Assessing maturity development of purchasing management in construction

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Received 22 July 2014
Revised 30 March 2015
Accepted 9 May 2015

Abstract

Purpose – Prime contractors spent a substantial part of their turnover on purchasing. The management of the purchasing function therefore has a large influence on the overall performance of a prime contractor. The more developed the purchasing function is, the greater its contribution to success of the companies. The purpose of this paper is to measure and explain the development in maturity of the purchasing function in construction firms.

Design/methodology/approach – Based on a literature review, a theoretical framework for the assessment of purchasing maturity is provided first. Then a longitudinal multiple case study is executed in order to assess the maturity development of the purchasing function in seven construction companies. Results are compared with a historical baseline assessment.

Findings – The results demonstrate an increase in the maturity of the purchasing function in general and in particular in the management of strategic relations. The case companies have reached a maturity in which they start to coordinate activities in their supply chains. Increased use of IT solutions enables a more integrated approach of the construction process.

Practical implications – IT and in particular Building Information Modelling pave the path towards an integrated supply chain, which in turn enables the reduction of waste in the processes. Nevertheless, companies still struggle with the tension between project-based flexibility and long-term relations with suppliers.

Originality/value – The development of purchasing maturity was measured in a baseline measurement and in a second assessment performed five years later by using the exact same model and exact same case companies.

Keywords Supply chain, Construction, Purchasing maturity

Paper type Research paper

1. Introduction

The construction industry is plagued by hardly any increase in efficiency over the last years, while in industries like automotive the productivity improved substantially (Khanzode *et al.*, 2006). Although developments in adoption of technology and tools have occurred, there were no big improvements in construction industry productivity (Fulford and Standing, 2014; Abdel-Wahab and Vogl, 2011). Many authors blame this lagging development in productivity to fragmentation, adversarial culture and lack of integration in the sector (Bresnen and Marshall, 2000; Aram *et al.*, 2013; Egan, 1998; Voordijk *et al.*, 2000; Saad *et al.*, 2002). Although contractors spent up to 90 per cent of the project turnover on buying goods or services (Hinze and Tracey, 1994; Nobbs, 1993; Vrijhoef and Koskela, 2000), they do not take full advantage of opportunities to make use of external resources through buyer-supplier cooperation (Dubois and Gadde, 2000).

Benchmarking: An International Journal
Vol. 22 No. 6, 2015
pp. 1033-1057

1463-5771
DOI 10.1108/BIJ-07-2014-0071

Development and management of long-term buyer-supplier relationships at the cross-project level still seems challenging for all parties (Bemelmans *et al.*, 2012; Bresnen and Marshall, 2000).

Literature suggests various approaches for the purpose of increasing the efficiency of construction, in terms of cost, time, quality, constructability, fitness for purpose and a whole range of other criteria. A substantial amount of the research is done to solve the problems that arise because of the aforementioned fragmentation. Not surprisingly, the major focus of a variety of initiatives in the construction industry is on finding a more integrated approach to construction. Another approach to these problems is studying productivity improvements in other industries (Khanzode *et al.*, 2006; Fulford and Standing, 2014; Xie *et al.*, 2010).

The purchasing volume in construction is substantial relative to turnover (Hartmann and Caerteling, 2010). Suppliers therefore have a large impact on (project) performance. The management of the prime contractor's purchasing function has a large influence on the overall performance of that prime contractor (Ellram *et al.*, 2002; Rozemeijer *et al.*, 2003; Schiele, 2007). This influence is not only limited to increasing the internal efficiency of organizations but also includes methods of reducing waste and adding value across the entire supply chain (Tan, 2001). However, until now the development of the purchasing function in the construction industry has so far hardly been measured (Bemelmans *et al.*, 2012, 2013). The objective of this paper therefore is to measure and explain the development in maturity of the purchasing function in construction firms.

Measuring the development over time requires a longitudinal study (Yin, 2014). To determine this development, it is needed to measure the maturity of the purchasing function of a construction firm over two points in time. A baseline assessment of the maturity of the purchasing function at 20 Dutch construction firms was conducted by Bemelmans *et al.* (2012). One year after this assessment, two companies were selected in order to evaluate changes in het level of purchasing maturity (Bemelmans *et al.*, 2013). In this study, by using the exact same model and seven of exact the same case companies as used for the baseline measurement a new assessment was performed five years later to assess the development of purchasing maturity.

The next section provides a theoretical framework on buyer-supplier relationship management in construction. Next, the research methodology is described along with the justification for the measurement tool used. The results are presented in the fourth section, where the growth of the maturity of the case companies has been analysed. In the fifth part we compare our findings with the theoretical framework to explain them. This paper ends with conclusions about the maturity development of the purchasing function in the case companies.

2. Theoretical framework

Intense competition forces organizations to offer low cost, high quality and reliable products with greater design flexibility. Manufacturers utilized just-in-time and other management initiatives in the 1980s to improve efficiency and cycle time (Tan, 2001). Companies needed to increase customer focus and required their suppliers to mature along with them. They started to form partnerships with their important suppliers to focus on long-term relationships. In this way suppliers could be motivated to invest into adapting their processes to those of the final production line. When manufacturers experimented with strategic partnerships the concept of Supply Chain Management (SCM) emerged (Vrijhoef and Koskela, 2000). The term SCM has multiple meanings (Tan, 2001), but for our research we will use the definition by Van Weele (2014),

defining SCM as: "The management of all activities, information, knowledge and financial resources associated with the flow and transformation of goods and services up from the raw materials suppliers, component suppliers and other suppliers in such a way that the expectations of the end users of the company are being met or surpassed".

In this paper the focus is on the inbound part of supply chains, being the responsibility of the purchasing function. It is assumed, albeit often implicitly, that the more developed (i.e. mature or professional) the purchasing function is, the greater its contribution to the overall company performance (Schiele, 2007). The level of purchasing maturity reflects the extent to which the purchasing function is integrated into the strategic management decision-making process (Pearson and Gritzmacher, 1990; Bemelmans *et al.*, 2013). If a company has a high level of purchasing maturity, it will have an integrated information system that enables the purchasing professionals to work on the tactical and strategic levels. Conversely, a low level of purchasing maturity means that the purchasing professionals remain on the operational level (Pearson and Gritzmacher, 1990). If a firms' purchasing function fulfils a "SCM" role instead of a traditional ordering role, this is an indication of a higher purchasing maturity (Rozemeijer *et al.*, 2003; Bemelmans *et al.*, 2013). More specifically, this broader SCM role for the purchasing function requires more sophisticated approaches to the management of buyer-supplier relationships.

2.1 Aspects in development of buyer-supplier relationship management

Maturity development of buyer-supplier management is closely dependent upon the ability to create, manage and reshape relationships between individuals, organizations and networks within the supply chain (Akintoye *et al.*, 2000; Saad *et al.*, 2002). Various aspects are important in determining the effectiveness of buyer-supplier relationship management. First, it is crucial for a buying company to optimize its supply base in terms of both the number and the quality of its suppliers. Second, attention should be given to activities related to managing a buying company's portfolio of suppliers. Third, buying companies need to decide to what extent suppliers have to be integrated into their own processes. This integration aspect can be split into two distinct parts: operational processes and value creation. Finally, effective buyer-supplier relationship management requires attention to be given to developing suppliers, based on an on-going monitoring of their performance (Bemelmans *et al.*, 2012).

Managing buyer-supplier relationships. In this research, managing supplier relationships is defined as the way to give substance to the different types of supplier relationships and to allocate the appropriate amount of effort to different types of suppliers. In addition, relationships with suppliers of critical products can be managed more effectively.

The most collaborative relationship is a partnership. An approach like partnering requires considerable commitment and resources, and takes time to develop (Saad *et al.*, 2002; Schiele, 2007). When strategic partners are identified, company policies between the contractor and supplier can be aligned; information and knowledge can be shared. These new relationships incorporate continuous improvement targets to reduce costs, enhance quality and focus on the whole-life cost and functional performance of buildings (Kraljic, 1983; Tan, 2001). It could have a negative impact on the team communications if proper procedures have not been put in place (Xie *et al.*, 2010). Further challenges in developing partnership relationships include a lack of common purpose, multiple and often hidden goals, power imbalances, different cultures and

procedures, incompatible collaborative capability, the tension between autonomy and accountability, over dependence, and continuing lack of openness and the threat of opportunistic behaviour (Saad *et al.*, 2002).

Improving supplier performance. The process of looking at reactive and pro-active strategic activities of the buyer (the construction company) is part of developing quality. It focuses on the identification of possibilities for improvement and it facilitates performance improvements of suppliers and buyers. Vonderembse and Tracey (1999) concluded that a positive correlation exists between "manufacturing performance and supplier performance/involvement".

Literature provides various strategies and models for the process of improving supplier performance. For example, Monczka *et al.* (1993) suggest that the supply base can be optimized by "setting higher performance expectations and direct supply development". This is in line with Cousins (1999) who advocates that improvements of suppliers' performance should be measured and documented. In this way, companies can get more insights of the capabilities of suppliers and whether they fit with the company's strategies and policies (Bemelmans *et al.*, 2012). Also the extent to which subcontractors have performed with respect to quality, technical know-how and cooperation in the past can be the base for trust (Hartmann and Caerteling, 2010).

Optimizing supply base. In this research, optimizing a company's supply base is defined as the way to select and contract the most suitable suppliers in order to identify critical products and linking them to potential strategic partners. The selection is executed by measuring the performances of current and characteristics of new suppliers to provide a systematic approach for reducing the supply base. As a result the number of suppliers can also be monitored more efficiently, kept up-to-date and potential strategic partners can be identified (Bemelmans *et al.*, 2012; Kraljic, 1983). It has been claimed that this portfolio approach can make the difference between an unfocused, ineffective purchasing organization and a focused, effective one (Hadeler and Evans, 1994). This implies that optimizing the supply base is one of the main drivers of purchasing maturity (Bemelmans *et al.*, 2013). Especially for the strategic suppliers within a portfolio approach, collaboration is an important subject.

Integrating the supplier in the value creation process. Integrating suppliers into a company's value creation process is defined as using the knowledge of suppliers to develop new products, process or services that are aimed at maximizing the performance of one's own company (in terms of costs, time, quality, etc.). As stated by Bemelmans *et al.* (2012), integrating suppliers in the value creation process is the most preferable situation, but also the hardest to reach. This especially holds for the construction industry with its project-oriented way of working associated with predominantly project-based relations between contractors and suppliers. By adopting long-term relationships suppliers could be motivated to integrate their knowledge in the value creation process. Utilization of suppliers' knowledge can be maximized in developing new products, processes or services, albeit that in the construction industry suppliers are often not involved in component design and usually manufacture to a buyer's specifications (Bensaou, 1999).

2.2 Stages in the development of the purchasing function

The development of the purchasing function can be seen as an example of evolutionary and cumulative innovation process (Vrijhoef and Koskela, 2000; Saad *et al.*, 2002). This implies that companies develop their purchasing maturity through various sequential stages. Van Weele (2014) divides this development process in six stages

(Bemelmans *et al.*, 2013). These six stages in essence describe the development from a transaction-orientated organization to an organization focused on value chain integration (Van Weele, 2014, pp. 67-71).

Stage 1: transactional orientation. In this first stage, the primary task of purchasing is to find appropriate suppliers and ensure that the company's operational processes do not run out of raw materials and components. There is no explicit purchasing strategy in place. The organizational structure can be characterized as a decentralized sub-department at the business unit level. The purchasing function is strongly orientated towards operational and administrative activities. The culture is "reactive". Information systems, if in place, are also very much administratively oriented. The purchasing staff usually consists of operational and administrative buyers, with only limited professional education.

Stage 2: commercial orientation. At this stage, a more pro-active purchasing manager can be found, someone who can negotiate credibly with suppliers for lower prices. The purchasing strategy is characterized by a sharp focus on low prices. Buyers concentrate on negotiating and contracting "good deals". Management monitors low prices and savings. Performance measurement is focused primarily on price (variance), cost savings and the delivery performance of the suppliers.

Stage 3: purchasing coordination. At this stage, some form of strategy formulation appears, aimed at capturing the benefits of internal coordination, collaboration and synergy among business units. Apart from price and costs, the purchasing function is now seen as having an important influence on the quality of purchased products. Formalization of the purchasing process and procedures is a priority. The focus is on improving communication between the central purchasing unit and the decentralized business units.

Stage 4: internal integration. At this stage, the emphasis turns to cross-functional problem solving with the objective of reducing total life-cycle costs and not just the unit cost of purchased components. These cross-functional efforts often involve key suppliers as joint problem solvers, implying a move from confrontational to a more partnership form of sourcing. The culture is characterized by many cross-functional buying teams. Improvement actions are aimed at integrating and harmonizing the purchasing processes across the various business units. Information systems are integrated with those of other departments/functions and divisions, but not yet with those of the most important suppliers.

Stage 5: external integration. Having reached this stage, suppliers are actively involved in new product development, process improvement and preproduction planning, and often have a base within the company. Users themselves order goods, against corporate contracts, through advanced, web-enabled catalogue systems. Companies invest heavily to truly involve supply partners in a range of business processes, rather than simply buying goods and services from them as efficiently and as effectively as possible. Responsibility for initial purchasing resides with cross-functional teams. Information systems are integrated not only internally, but also with those of the partner suppliers.

Stage 6: value chain integration. In this stage, suppliers are consistently challenged to support the company's product/market strategies and to actively participate in product development. The goal is to design the most efficient and effective value chain possible to satisfy the needs of the end customers. The orientation is both upstream and downstream. The culture is entrepreneurial. Information systems are integrated as much as possible.

In analysing the development of purchasing maturity for each of the six stages, basic characteristics have to be assessed. These characteristics are linked to at least one of the developmental stages. The underlying connections between the characteristics are identified in Figure 1. Some of the characteristics overlap stages while others do not. Characteristics that share an underlying connection are displayed at the same vertical position. The vertical displacements do not reflect the importance or relevance of specific characteristics, they are merely used for the purpose of graphical presentation.

3. Research design

In this research on purchasing maturity development, a multiple case study has been conducted in the Dutch construction industry. In this section, the rationale of this multiple case research design is explained. Next, a description of the tool measuring the change of purchasing maturity and its characteristics is provided. Finally, the methods for data collection and analysis are presented.

3.1 A multiple case-study design

The multiple case-study design encompasses seven Dutch construction firms active in civil and utility building or in infrastructure. To measure the change of purchasing maturity over time, the so-called Michigan State University (MSU) model is used for a baseline measurement executed at these seven case firms. After five years, the same model was used to perform a second assessment at the same firms to measure the development of purchasing maturity.

This multiple case-study approach was chosen for two main reasons. The first reason is the importance of studying purchasing maturity development in the real-life context, using multiple sources of evidence (Yin, 2014). The second reason is based on the structure of the Dutch construction industry. Given the great diversity of

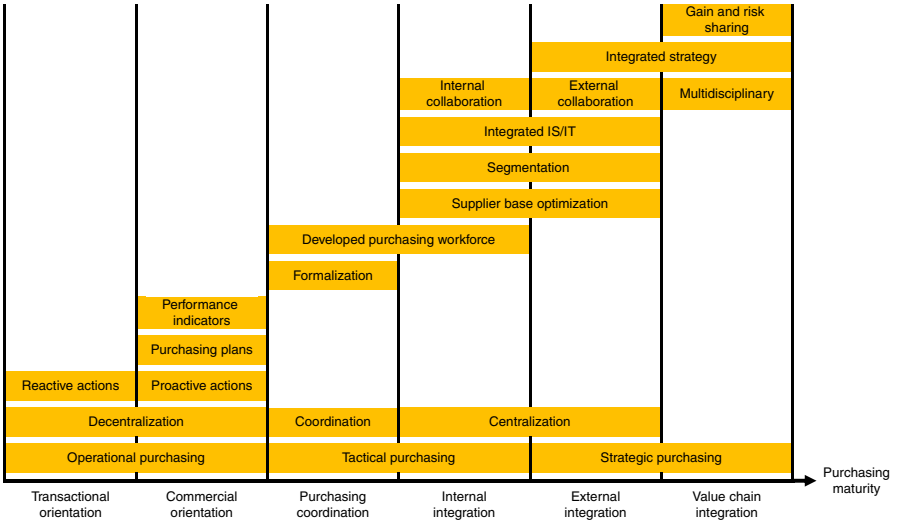

Figure 1.
Development stages of purchasing maturity

Source: Adapted from Bemelmans *et al*. (2013)

companies active in this industry, companies with different sizes and business focus were selected, although their willingness to cooperate also played a major part in the selection process. The Dutch construction industry has two main subsectors, the civil and utility building subsector and the infrastructure subsector, and companies from both subsectors were included. The selected companies also differed in size, with both SMEs and large companies involved. An overview of the case companies based on these characteristics is provided in Table I. The work portfolios of companies active in the civil and utility building subsector consist mainly of residential housing and office or health care building projects. Companies active in the infrastructure subsector mainly focus on road construction and data infrastructure projects.

3.2 Selection of measurement tool

Purchasing maturity has been defined as "the level of professionalism in the purchasing function" (Rozemeijer *et al.*, 2003). To measure purchasing maturity multiple models have been developed (Schiele, 2007). All these models have a different view but they all have comparable subjects in the model like planning, structural organization, process organization, human resources, controlling and collaborative supply relation (Schiele, 2007). Bemelmans *et al.* (2012) used an adapted MSU model to assess the purchasing maturity level of Dutch construction firms. Their model is derived from the MSU model, developed by Monczka in 1993 (Van Weele, 2014, pp. 158-162). This general model was adapted for usage in the Dutch construction sector.

The MSU-building model was selected for this research also for several reasons.

First and most important is the validity of this model for the Dutch construction industry. In designing the MSU-building model the input of various chief purchasing officers of large Dutch construction firms proved to be instrumental to assure the suitability of the model for the project-based construction industry (Bemelmans *et al.*, 2012). The MSU-building model has also been tested at 19 Dutch contractors after an extensive review of the model in multiple departments of a leading contractor.

Second, in comparison to other purchasing maturity models analysed by Schiele (2007), the MSU model is more comprehensive by measuring maturity of purchasing processes in ten levels (Bemelmans *et al.*, 2012). This comprehensiveness is needed to distinguish different kinds of purchasing capabilities, like the identification of different products, suppliers, technology necessities, etc.

Third, data and results of the research performed were available for use in the present research as a baseline maturity assessment. By applying the same model to the same sample of case companies the reliability of the comparison is ensured.

No.	Case company	Sector	Number of employees	Annual turnover € mln.	Purchasing volume of turnover (%)
1.	Black Civil	Civil building	132	70	60
2.	Green Infra	Infrastructure	2,600	452	80
3.	Brown Civil	Civil and utility building	250	73	75
4.	Red Civil	Civil and utility building	1,500	630	n/a
5.	Blue Infra	Infrastructure	1,800	300	52
6.	Orange Civil	Civil and utility building	200	90	75
7.	Yellow Civil	Civil and utility building	250	173	n/a

Note: The names of the case companies studied in this paper are fictitious

Table I.
Overview of the case companies

3.3 Characteristics of the MSU-building model

The MSU-building model assesses purchasing maturity based on eight strategic and six enabling processes. In Figure 2 and Table II the strategic processes, and in Figure 3 and Table III the enabling processes of the MSU-building model and their relations are described.

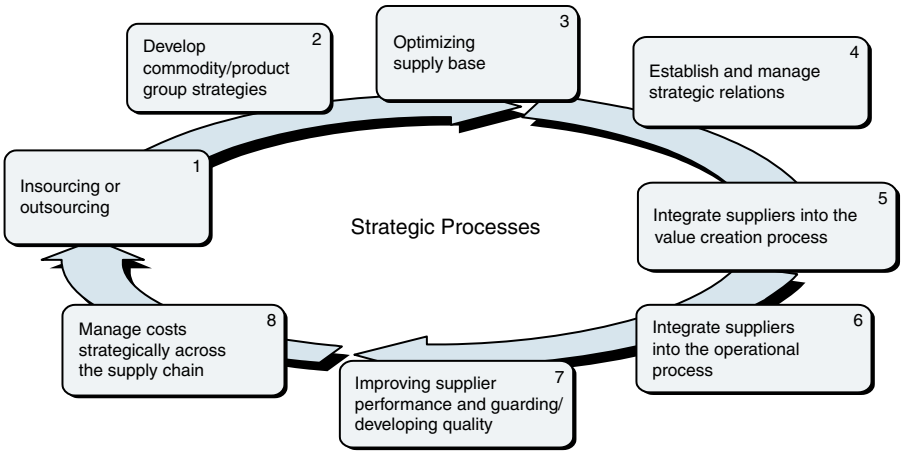

Figure 2.
The eight strategic processes of the MSU-construction model

Strategic processes	Description
SP1: insourcing or outsourcing	Making a strategic choice between insourcing and outsourcing
SP2: develop commodity/ product group strategies	Determining the needs of the company and formulate the strategy needed with a commodity
SP3: optimizing supply base	Optimization of the supply base is the process to determine the amount and most suitable suppliers for the company
SP4: establish and manage strategic relations	Developing, managing and optimizing the relation with strategic suppliers
SP5: integrate suppliers into the value creation process	Integration of suppliers in the value creation process is probably the most profitable long-term process, but also the hardest to realize in practice. Knowledge of suppliers is utilized at a maximum level in favour of developing new products, process or services for the own company to maximize the results of (costs, functionality, time, quality)
SP6: integrate suppliers into the operational process	Integrating suppliers in the operational process consists of strategies and activities which help simplify, standardize and synchronize the operational processes of the company
SP7: improving supplier performance and guarding/developing quality	The process of improving the supplier performance and quality management is the process that looks at reactive and pro-active strategic activities of the buyer (the construction company). It focuses on the identification of possibilities for improvement and it facilitates performance improvements of suppliers
SP8: manage costs strategically across the supply chain	Strategic cost management leads to activities of the buyer and supplier to identifying and prioritizing the costs and cost creators to suggest improvement strategies. These strategies have impact on the costs and the cost creator and will lead to cost reduction. The goal is to eliminate costs for the whole value chain

Table II.
Strategic processes of the MSU-building model

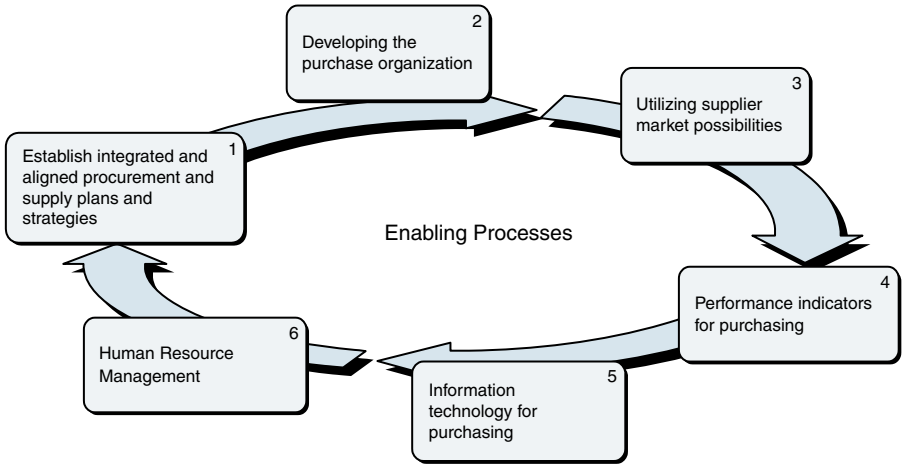

Figure 3.
The six enabling processes of the MSU-construction model

Enabling processes	Description
EP1: establish integrated and aligned procurement and supply chain plans and strategies	The process handles the plans and policies for purchase, the company strategy and aligns them
EP2: developing the purchase organization	By developing the organization and teaming strategies, the purchasing and other disciplines are aligned, so the goals of the company (and with that the purchasing targets) are realized at their maximum level
EP3: utilizing supplier market possibilities	Utilizing the possibilities of the supplier market is the organization of purchasing activities on a local, regional, national and international level to optimize the purchasing possibilities
EP4: performance indicators for purchasing	Performance indicators are important when determining the maximum results in relation with the targets. These targets can be internally settled, or focused on supplier relations or the purchasing portfolio
EP5: information technology for purchasing	Developing and implementing supporting electronic information systems are important for controlling the value chain
EP6: human resource management	Identifying the necessary competences for realizing and implementing the organizational and purchasing goals and targets. Aspects such as rewarding, training, recruiting and selection integrity principles and knowledge retaining (succession planning) are incorporated in this enabling process

Table III.
Enabling processes of the MSU-building model

In this model, for each of these processes, maturity levels and assessment criteria are described. A detailed description of the ten maturity levels for the five most relevant strategic processes in this context, SP3 till SP7, can be found in Appendix 1. The measurement tool uses the "strict step" principle when determining the maturity level for each construct, i.e. all criteria for a certain level have to be satisfied before the criteria of the next maturity level are considered. In the reassessments, researchers have explicitly looked for fulfilment of the criteria left open in previous assessments. Only if all criteria of a next level were fulfilled, a higher maturity level (for that particularly process) was assigned. For example, a company scores a

maturity level of 3 for a construct when not all aspects of level 4 are met (whereas all the aspects of the first three levels are met), even if all the criteria at levels 5 and 6 were also met.

3.4 Data collection and analysis

The same data collection and analysis procedure was followed in each baseline assessment and re-assessment. First, the researchers reviewed documentation provided by the case company that offered insights into their daily routines and strategies. The documentation included internal reports such as minutes of meetings and memos, company policies, annual reports and internal process descriptions. Having read all this documentation, one or more researchers visited the company and interviewed representatives using the developed measurement tool as a reference. The following functions within the company were approached in identifying representatives:

- responsibility for purchasing (manager of the purchasing department/CPO);
- their superior (usually a board member); and
- internal customer of purchasing (usually project managers).

These functions were chosen to enable assessment of the maturity levels of the purchasing function using multiple sources. In the interviews, the interviewer essentially followed the questions derived from the measurement tool. To assess the maturity level of the purchasing function, the interview format was partly open ended, allowing the interviewer to explore areas that came to light during the course of the discussion. When required, the researchers would ask the interviewees to provide additional documentation to support the given answers.

To measure the development in purchasing maturity a re-assessment was executed at the case companies, in the following procedure. The researchers would read the available data from the audits performed with the baseline assessment. Following the MSU tool and the baseline audit report, the team of researchers performed interviews with the representative responsible for purchasing.

Following the set of interviews, data analysis was performed in three steps. First, after the visit, the researcher prepared a case report on the company. Second, to achieve construct validity, these draft reports were submitted to the respondents for verification. After the verification and integration of comments, the final case report was written. Finally, when all seven re-assessments were completed, the overall results were analysed and compared with the results from the baseline assessment.

4. Case findings

In this section, the main case findings are presented. Table IV summarizes the change in maturity levels for each process obtained from the seven case companies. The eight strategic processes and the six enabling processes of the MSU-building model are presented on the horizontal axis. The numbers on the vertical axis of Table IV represent the maturity change per process as determined via the strict step method. For instance, Red Civil has grown from a level 3 into a level 4 maturity level on SP1, so the number 1 is presented in this box.

The results show that all seven firms manage to develop their purchasing maturity. However, it is also observed that the case-study companies adopted different approaches in developing their purchasing function. The results are discussed in more detail in the following subsections, making a distinction between high, moderate and low-developed strategic and enabling processes.

Difference per company	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	EP1	EP2	EP3	EP4	EP5	EP6
Red Civil	1	0	0	0	0	0	1	2	0	0	-2	0	0	0
Yellow Civil	-1	0	0	1	2	0	0	3	0	2	0	0	0	0
Orange Civil	0	0	0	2	0	0	3	0	0	0	3	0	0	0
Black Civil	0	2	0	0	0	0	0	1	1	0	1	0	5	1
Brown Civil	3	0	2	5	0	3	2	1	4	3	0	0	1	0
Green Infra	0	0	0	4	0	2	0	2	2	3	3	3	2	3
Blue Infra	2	0	2	5	0	1	0	5	3	4	6	0	1	0
Average	***0.7***	***0.3***	***0.6***	***2.4***	***0.3***	***0.9***	***0.9***	***2.0***	***1.4***	***1.7***	***1.6***	***0.4***	***1.3***	***0.6***

Table IV.
Growth in maturity per case company

4.1 Highly developed strategic processes

SP4: establish and manage strategic relations. In this research, managing supplier relationships is defined as the way to give substance to the different types of supplier relationships and to allocate the appropriate amount of effort to different types of suppliers.

From Table IV it is visible that three firms gave SP4 a lot of attention while others did only marginally develop these purchasing skills. The high growth in maturity was reached because the case companies already had taken the first steps towards partnerships. High growth was measured because at this point case companies have formalized their policy on partnerships or strategic relations and have taken the first steps towards mutual development or cost management programmes.

Brown Civil has created a memorandum of understanding for potential partners to mutually improve control of cost and quality. This company currently works with Building Information Modelling (BIM) tools in over half of its projects. BIM is a set of interacting policies, processes and technologies aiming to manage building design and project data in a digital format throughout the building's life cycle (Succar, 2009). Brown Civil uses it among others for "clash checking". Where necessary they invite their partners to come to the clash session and discus the problems. In order for this to result in usable data and pragmatic solutions, potential partners need to offer their input. Therefore Brown Civil is developing a selection system for critical parties on "BIM-readiness". In this way, Brown Civil can use the input from suppliers as valuable data in decision making. The definition BIM-ready is under constant debate, both within the company as with their suppliers.

SP8: manage costs across supply chain. Strategic cost management leads to activities of the buyer and supplier to identifying and prioritizing the costs and to suggest improvement strategies (Bemelmans *et al.*, 2012). These strategies aim to reduce costs in the entire value chain. Managing costs across the supply chain had attention in the case companies. In the monitored period, a financial crisis has occurred, causing a dramatic drop in turnover for some of the case companies, especially in the building sector. Long-term contracts have been adapted accordingly by the addition of cost efficiency targets. Some companies even use or are planning to use the concept of total cost of ownership in their purchasing.

4.2 Moderately developed strategic processes

SP6: integrate suppliers into the operational process. In this research, integrating suppliers into the operational process is defined as "the set of strategies and activities directed at simplification, standardization and synchronization with the operational processes of the company" (Bemelmans *et al.*, 2012). This is important because only standardized processes can be improved (Khanzode *et al.*, 2006).

Case companies have shown much progress in managing supplier relations, so it could be expected that the involvement of suppliers in the operational processes is enhanced as well. The highly developed companies have seen an increase of their maturity to level 5. Brown Civil has set targets for reducing the number of invoices and digitally handling them. Blue Infra already had targets and an action plan to reduce inventories and lead times. In the second assessment it was found they also regularly perform evaluations with the suppliers. Other companies did not show significant development on SP6. The main reason is the lack of capacity to invest time, because of the reduced staff on the purchasing departments. A second reason is the lack of formal communication structures, both internal and with suppliers. Because of the unique and dynamic character of projects, communication on operational level is usually ad hoc. Suppliers are only called for when needed.

SP7: improving supplier performance and guarding/developing quality. Most case companies are in a process of developing partnerships with main suppliers. Part of this development is also the evaluation and improvement of suppliers. Especially the housing firms have put more effort in this process. Four civil building companies had a programme with a standardized house, which was developed jointly with specialist partners. The infrastructure companies Green Infra and Blue Infra have shown also developments in this process, even though this is not visible in the numerical maturity. They plan audits at strategic suppliers, and have put an internal communication tool in place to communicate results to internal staff. Green Infra however has no formal complaint procedure in place to communicate internal complaints towards suppliers and stays at maturity level 3.

A more general observation is that none of the case companies reviewed the (potential) strategic partners on relevant process aspects before contracting. Moreover, most companies did not have the capacity to perform audits at all key (strategic) suppliers, because of a lack capacity at the purchasing department. The result is that none of the case companies has a SP7 maturity level higher than 5.

SP1: strategic choice between insourcing and outsourcing. In this research insourcing is defined as making investments in resources which are needed to carry out activities. Outsourcing is defined as renouncing all resources (assets, infrastructure, people and competences), subsequently to let all activities be carried out by another company (outside the legal entity). According to this definition, outsourcing is only the appropriate term if the company once was capable of carrying out the activities by itself (own people and resources) but by means of de-investing now is not capable of carrying out the activities any longer (Bemelmans *et al.*, 2013).

Case companies have put effort in making their labour workforce flexible, and have therefore made some strategic decisions on outsourcing some of these works. For example Red Civil fired their masons and now hires them on a project basis. Most of the case companies however decide on a project level what part of the work will be outsourced and what can be done internally. Hence only small developments were identified in the re-assessment.

SP3: optimizing supply base. In this research, optimize supply base is defined as the way to select and contract the most suitable suppliers in order to identify critical products and linking them to potential strategic partners. The selection is executed by measuring the performance of current and characteristics of new suppliers to provide a systematic approach for reducing the supply base. As a result, the number of suppliers can also be monitored more efficiently, kept up-to-date and potential strategic partners can be identified (Bemelmans *et al.*, 2012).

Brown Civil established a purchasing policy based on the model of Kraljic (1983). From the model different approaching strategies are predetermined in a procedure. The more mature companies were already using purchasing models and differentiate in the attention suppliers get. In higher maturity levels, companies show care of their supply base and are initiating mutual development or cost management programmes.

Other firms are still lacking purchasing models. They measure the performance of suppliers as is demanded by their quality management system, but do not put in additional effort. The selection of (potential) partners is done based on experience. There is however no explicit rationale to label these suppliers as critical or strategic in projects. As a result most case companies stay in maturity level 3 on SP3.

4.3 Low-developed strategic processes

SP2: develop commodity/product group strategies. This process is about determining the needs of the company and formulating the purchasing strategy needed with every product group. Product groups are in all case companies standardised by the standard contract terms codes that are used in Dutch contracts. Most of the case companies determine their purchasing needs and corresponding strategy on project level. This results in the operational purchasing being done on a project level as well.

As mentioned before, the building companies that offer a standardised house have developed some long-term strategies in the customer needs and matching their supply chain to those requirements. For this purpose they are developing product group strategies but do it very specific for the products that they need in their own developed houses. For other customer specific project they are tied to project-based purchasing.

The re-assessment data also reveal that none of the companies organized multi-disciplinary teams to develop commodity/product group strategies.

SP5: integrate suppliers in the value creation process. Strategic process 5 measures the utilization of the knowledge of suppliers for developing new products and processes. In this process, the least progression in maturity is observed. Three companies claimed to have policies in product and process development. After five years, we can conclude, however, that there is no significant change. Firms are still very anxious to lose their flexibility if they formalize their partnerships. So despite of firms jointly developing standardized houses, they do not feel the need to secure the agreed conditions. Yellow Civil does have an official policy, but does not use contracts or clauses with partnerships. Other companies like Brown Civil, Orange Civil and Red Civil do not have a policy, but they do have a limited pool of subcontractors for critical works. Green Infra lacks a formal policy, but does have dedicated offices for subcontractors that are involved in tender processes. So practically, it is facilitating integration into the value creation process.

Companies that already indicated to have actions planned in the re-assessment also have a documented policy and could therefore grow in purchasing maturity. For example Orange Civil does not have documents or policy on value creation, but it is

active in mutual developments with suppliers. At the baseline assessment Orange Civil did not have a purchasing policy, but it did have a structured and documented process to identify, assess and select potential (strategic) suppliers. Now that the policy was established they could grow to level 3.

4.4 Enabling processes

In order to establish an internal professional purchasing organization, the case companies have put effort in the enabling processes. Four enabling processes show a growth in maturity whereas the other two processes were not developed by most case companies.

Developed enabling processes. The case companies have implemented limited upgrades in their policy making and quality control processes as is demanded in their certified quality management systems. Part of these efforts are composing and managing the policies and plans for purchasing as part of the company strategy. The more professional companies indicated that the process of making plans is essential for developing SCM. This is visible in EP1 establish integrated and aligned procurement and supply chain plans and strategies.

Enabling Process 2 is developing the purchase organization. Clear differences are seen here between the companies that had the opportunity to invest in developing the organization and companies that had to narrow their organization due to revenue declines. For example, Brown Civil used the retirement of various purchasing employees as an opportunity to set up a completely new purchasing organization. A new purchasing officer took up his role in a more strategic manner, decentralizing the tactical purchasing function to the project teams. By developing the organization and team strategies, the purchasing and other disciplines are aligned, so the goals of the company (and with that the purchasing targets) are realized at their maximum level. At Red Civil and Yellow Civil, this development of decentralizing was also noticed. This, however, seemed to be going at a slower pace.

EP3 utilizing supplier market possibilities has received the most attention in the case companies. Main contractors are looking for cost savings or added value and look closely into their networks and supply base. They are often striving for a locally represented supplier network. In this way emissions from transportation are reduced and local knowledge can be used in the projects.

Red Civil did not perform active and structured market analysis to identify potential new suppliers but used the so-called "gut feeling" and project-based requests for proposal. In the baseline assessment there was a structured market analysis found, but in the recent assessment we could not validate this.

The case companies are also rated at the project-oriented maturity level on EP5 information technology for purchasing. An Enterprise Resource Planning system is used to integrate and manage internal information by these companies. However, it does not bring the expected added value to the case companies. Some of the case companies have implemented a web-based purchasing dashboard that is able to produce insight in the operational purchasing behaviour of the internal staff. Also evaluations can be shown to all internal employees to help in future selection of suppliers.

Stagnated enabling processes. Companies are putting effort in developing, implementing and maintaining elaborate quality management systems. Major part in these management systems is continuous improvement of client satisfaction. This improvement can be measured with help of performance indicators. Benchmarking the performance gives

insight into the progress of the improvement efforts. The companies seem to be putting little effort into developing and measuring performance indicators. Only a few companies use a basic set of supplier performance indicators over time. No significant change could be identified over the last five years.

Another process with no remarkable increase in maturity is EP6 human resource management. The case companies claimed to put some effort in developing improved appreciating and waging systems. This was however not measurable with the applied measurement tool.

5. Discussion

First, changes in purchasing maturity in general are discussed by using the van Weele (2014) model on the development of the purchasing function. Second, using the same model the focus is on the role of IT/IS and BIM technologies as trigger for increasing purchasing maturity.

5.1 Development of the purchasing function

Following the six stages in the development of the purchasing function of van Weele (2014) it can be concluded that the construction companies participating in this research have reached a stage of purchasing coordination (Stage 3). This coordination is based on supplier segmentation, relationship management and exchanging best practices inside the company and across departments. Improvement actions are aimed at integrating and harmonizing the purchasing processes across the various business units, besides the ever important cost reductions. Most companies have passed the commercial stage (Stage 2), where prices dominate the purchasing function. Internal integration (Stage 4) by involving key suppliers and cross-function problem solving is still in its infancy. Companies are putting effort in optimizing supplier base; some companies clearly apply segmentation in suppliers.

In order to reach Stage 4 (see Figure 1), companies are required to enhance their long-term vision, enhance team-building skills and will need to consolidate their partnerships. As is visible in the results companies seemed not inclined to develop the process of integrating suppliers into the value creation process (SP5). Having a flexible supply base still seems more important than integration of suppliers into the value creation process. Moreover, internal and external collaboration remains challenging for most companies because they appear to be reluctant to trust other companies. This keeps the companies from reaching higher stages in the van Weele (2014) model. First steps however are taken, and it could be a start in the direction of an integrated process with major suppliers. The main reasons to form partnerships mentioned by the respondents were cost benefits and increased and steadier quality of service. Some case companies also named the extent to which the relationship will lead to simplification or reduce the waste in the construction process. This is closely linked to lean construction, which has received increasing popularity in recent years (Sacks *et al.*, 2010; Khanzode *et al.*, 2006).

5.2 The role of IT/IS and BIM technologies

Our results indicate that the case companies have a significant awareness of the importance of the purchasing function in general. More specifically, all case companies have professionalized the management of buyer-supplier relationships and associated processes. In most of the cases a movement towards decentralization of the purchasing function was identified. The data suggests that the availability for information through

IT/IS and BIM technologies has further increased, both inside a project and on corporate or regional level. Reporting structures have been adjusted so that a movement towards decentralized project organizations could be realized without losing scaling advantages at a corporate level. This has cleared the way for purchasing officers to carry out more tactical and strategic functions. Their function has grown towards coordinator of the operational purchasing process, which is now mostly carried out by the project teams themselves. Some of the participating building companies seemed to have had trouble in coping with the decrease of turnover in times of crisis. In these companies the movement of decentralization seemed to be going at a slower pace, because there was very limited capacity available at the purchasing departments. Interestingly, the development towards a more professionalized management of buyer-supplier relationships does not necessary mean more centralization of the organization of purchasing processes.

Case companies mention they are examining methods to stimulate the involvement of suppliers in the operational and value creation process. BIM is often mentioned as a tool to help in communication, design and management of the interfacing processes of both main contractor and their suppliers. By adding relevant data of construction components, the contractors are able to make early decisions and assess design and execution strategies. When companies develop their BIM capabilities the BIM implementation develops from internal towards external orientation. In other words, BIM may be an enabler of an increasing purchasing maturity by stimulating the move from Stage 3 (purchasing coordination) and Stage 4 (internal integration) to Stage 5 (external integration). Because the building companies are developing their BIM maturity, they are also required to develop the maturity of their buyer-supplier relation management. Most noticeable example in this research was Brown Civil, which selects suppliers based on "BIM-readiness". The way this company is managing its supply chain integrally with its BIM processes could be seen as a look into the future.

6. Conclusion

The objective of this paper is to measure and analyse the development in maturity of the purchasing function in the construction industry. In order to assess the development a multiple case study was executed. Seven Dutch construction companies were assessed with use of the MSU-building model. To measure the development in maturity an assessment was performed which was compared with a baseline assessment.

6.1 SCM maturity development

Based on the baseline assessments, Bemelmans *et al.* (2012) concluded that there were at the same time major factors impeding and positive developments and opportunities stimulating improved management of buyer-supplier relationships in Dutch construction firms. The impeding factors were summarized as the lack of formalization, documentation and communication (both internally and with suppliers) linked to the various policies, plans, processes and measurement systems that form part of the management of buyer-supplier relationships. On the positive side, it was seen that companies had made a start with the optimization of the supply base, the management of supplier relationships, the integration of suppliers into the operational and value creation processes and the development of suppliers (Bemelmans *et al.*, 2012).

Based on the re-assessment findings it can be concluded that the case companies have developed their purchasing skills, albeit in different degrees. More specifically, the acquirement, use, control and sharing of information has increased in the relation

between buyers and suppliers. A substantial increase in efficiency in the use of information systems was seen in all case companies. The adoption of IT/IS and BIM technologies-enabled project teams to increase the management and flow of information. In terms of the van Weele (2014) model BIM may stimulate the move from Stage 3 (purchasing coordination) and Stage 4 (internal integration) to Stage 5 (external integration). IT/IS and BIM technologies made it possible to efficiently execute the operational purchasing in a more decentralized purchasing system. Using the 3D modelling techniques makes it possible to speed up the process of estimation; quantity-take offs and therefore the requests for quotation. Where the purchaser used to do this centrally for all project teams, the project teams now have the (digital) tools to manage this themselves. This cleared the way for the purchasing manages to focus on more strategic purchasing activities, such as managing relationships, assessing supplier performance and developing suppliers. In other words, the development towards higher maturity does not necessary mean more centralization of the organization of purchasing processes. This is not in line with the model of van Weele (2014) where a move from Stage 3 towards Stage 4 and 5 requires not only a centrally determined purchasing policy but also a centrally determined organization of the purchasing processes.

Most case companies still purchase at project level and continue to appreciate the flexibility that can be used. Still, it is also observed that this prevents them from establishing partnerships and integrating the suppliers in the value creation processes. Ultimately it prevents them from fully exploiting the potential benefits of BIM-based design and construction. The building of trust and enhancing the inter-company collaboration, exceeding the project level, will be one of the key issues if companies want to improve their purchasing maturity.

Finally, most development was seen in two processes; management of strategic relationships and cost management. It is interesting to observe that the integration of suppliers in the operational and the value creation process has not been developed as fast. So despite the fact that case companies are putting effort in forming relationships, they are not putting much effort in using these relationships for developing new innovations and sharing technology. This implies that companies that are setting up partnerships are mainly doing this for cost reduction purposes rather than to focus on structural process improvements.

6.2 Limitations and further research

This research has some limitations. First, the multiple case-study design included seven companies that were able and willing to cooperate both in the baseline and recent assessment. Companies that were willing to cooperate could have been companies that put a lot of effort in their development process and wanted their effort to be assessed. Conversely the companies that did not want to participate could have had no mentionable developments in purchasing maturity and therefore did not see advantages in participating.

Second, the baseline maturity assessment conducted five years ago was not conducted by exactly the same researchers as this research. A difference in interpretation of the maturity could be of influence on the results.

Third, as for the MSU-building model it is important to keep it up to date with respect to new developments in the construction sector as well as those in the field of buyer-supplier relation management. We discovered a gap between the model and the actual developments in information technology within the construction sector and the rapidly advancing technologies in combination with, e.g. internet, the use of tablets on site combined with GPS.

In order to increase the benefits of BIM integration of the multiple disciplines will be one of the major prerequisites. Professionalizing buyer-supplier relation management will play a major role in this process. Next step to increase the adoption of BIM and lean construction principles is to increase the level of cooperation between contractors and subcontractors (or partners as the case companies prefer to call them). By trying to increase the level of partnering, increasing the level of trust between partners, the way can be cleared to increase the degree of interaction, communication and technical collaboration. Only when the level of trust is high, added value can be achieved in using BIM and lean construction. BIM can be a starting point for efforts to involve key suppliers as joint problem solvers, which implies a move from adversarial relations towards a long term, partnership relationship orientation.

Collaboration with suppliers is a dominant criterion in determining purchasing maturity. Collaboration between suppliers and the prime contractor determines the achieved success of a project. Differences in the maturity level of managing relationships by prime contractors may also effect the relation between supplier and contractor. In further research, it is interesting to explore to what extent the satisfaction of a contractor related to the collaboration with a supplier influences the relationship itself. It is also interesting to take the perspective of the supplier into account by analysing the potential impact of a contractors' maturity level of managing supplier relationships on the behaviour and performance of *t* suppliers.

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Appendix. Maturity levels and assessment criteria for five strategic processes

Level	Assessment criteria
1.	Supplier selection is based on price and availability. There are no initiatives to optimize the current supplier base (e.g. supplier reduction plan available), supplier assessment based on qualitative perception of performance and basic evaluation of costs and risks. Basic differentiation is made between key and non-key suppliers
2.	As per 1, and ad hoc (work) instructions are applied for supplier selection. To a limited extent there are initiatives for optimization of the supplier base. No or little evidence of a policy for differentiation in strategic and non-strategic suppliers. Ad hoc supplier market research takes place with the objective to learn more about potential suppliers
3.	As per 2, and basic supplier rating system in place: at least quality and delivery performance of key suppliers are measured. There is a multi-disciplinary involvement within a project. Little evidence of formal communication towards key stakeholders and no improvement actions planned
4.	Formal and documented supplier selection process in place, focused on current needs and capabilities of the company, with a supplier raring system completed with a basic supplier categorization system which supports a supply base optimization plan
5.	As per 4, but supplier list is extensively analysed based on turnover and risk. Documented evidence of analysis based on purchasing models (e.g. the Pareto (80-20) Analysis and Portfolio Analysis, etc.). There is little evidence of differentiated actions in line with these analyses
6.	As per 5, but there is clear evidence of differentiated supply base management on the basis of purchasing models. Documented evidence of differentiated strategy/actions towards suppliers. Also, an advanced supplier rating system in place: covering on-going production and product creation, criteria are weighted (aligned with business objectives), multi-disciplinary involvement, objective measurement. Communication concerning results used internal concerning the assessment of repetitive effort of the suppliers. There is the possibility to spend time and resources on structural supplier market research
7.	As per 6, but evidence of improving results and achieved targets. Information is communicated towards suppliers, and discussed in regular improvement meetings/improvement programmes. Following information is available for all key suppliers and communicated towards stakeholders based on current requirements and skills: current status of the supply base, supplier performance and improvement actions
8.	As per 7, but there is a formal documented supplier selection process based on future needs. Also, regular assessments take place for all key (strategic) suppliers (e.g. process capability studies and profile update processes) in order to clearly understand and communicate current and future capabilities of suppliers (in relation to current and future needs of the business)
9.	As per 8, and time and resources are available for fundamental market research, based on full understanding of business requirements and supplier base. Documented evidence of market research planning and execution
10.	Differentiated commodity/product group strategies in place (at least score 7 in strategy process 2) in order to optimize the supplier base and to maximize performance with the correct number and correct suppliers

Table AI.
SP3 Optimizing supply base

Table AII.
SP4 Establish and manage strategic relations

Level	Assessment criteria
1.	In the purchasing policy a formal definition identifies for which categories of suppliers to establish strategic supplier partnerships and comprises long-term relationships, interdependency and trust development. Formal process in place to identify the criteria and objectives for alliances within a project, in line with the project purchasing plan. Documented and structured process in place to identify, assess and select potential partners against alliance criteria on a project level
2.	As per 1, but little evidence of formal communication framework and common project exceeding goal setting
3.	As per 2, but a documented and structured process is present to identify, asses and select potential (strategic) suppliers on corporate level, based on defined pre-criteria
4.	As per 3, and a formal process is in place to identify the criteria and objectives for each alliance, in line with the project exceeding purchasing plan and the business objectives. And, if relevant, for the most strategic supplier there are partnerships agreements available, including documented evidence that they work on a partnership programme (improving supplier relations). Supplier relationships are sometimes discussed as a separated agenda point in meetings of the management team. Multiple-level communication in all functions is established, including a formal communication framework
5.	As per 4, and executive focal point (senior management) at both companies to lead and manage the relationship
6.	As per 5, at which (if applicable) the strategic supplier relation is integrated in value creation process. Shared objectives (with supplier) are set for current projects
7.	As per 6, and shared project exceeding objectives are set with suppliers. There is a joint objective setting and joint planning process in place. Little evidence of alignment of future strategies and objectives
8.	As per 7, and value chain cost and processes are jointly analysed. Open book policy to share cost calculations and cost breakdowns for the whole value chain and exceeding multiple projects
9.	As per 8, and clear evidence of a joint ambitious and continuous improvement agenda (with the supplier). Continuous assessment of the partnership against objectives. Evidence of achieved targets and improving results
10.	As per 9, and there is a formal alignment of mutual future plans on technologies, objectives and strategies. Complete openness to share future product and technology information

Table AIII.
SP5 Integrate suppliers into the value creation process

Level	Assessment criteria
1.	No or little evidence of a value creation process (VCP) policy/procedure available, including role of purchasing and determining tasks and responsibilities at every milestone for purchasing and suppliers. No or little evidence of supplier integration in VCP
2.	As per 1, but there is a VCP policy/procedure and formal (make/buy) decision-making process in place to identify project needs for external technologies and capabilities. Evidence of purchasing involvement in the VCP from early start (in pre-concept phase)
3.	As per 2, and selection of suppliers is based on clear understanding of (development and process) capabilities against those needs identified per 2. Further (process) assessments if necessary
4.	As per 3, and formal decision-making process to determine moment of supplier involvement, based on degree of development responsibility and development risk. Some evidence of target setting and contracting (at least non-disclosure and intellectual property agreement)
5.	As per 4, and project objectives are clearly set (including timing, quality and costs), and translated into purchasing and supplier objectives. Development contracts available in which supplier objectives are defined
6.	As per 5, and regular meetings are scheduled. Cross-functional multiple-level communication established to address project objectives (more than product functionalities)
7.	As per 6, and supplier performance is measured and reviewed against expectations. Corrective actions are planned and implemented if necessary. There is a formal advanced supplier rating system for supplier performance in VCP. There is evidence of improving results and achieved targets
8.	As per 7, and an open book policy of sharing appropriate technology roadmaps, costs and customer information is practiced. Evidence of key supplier involvement in (pre-concept) stages of development
9.	As per 8, and internally/externally linked information systems (e.g. extranet, EDI, CAD/CAM, databases) facilitate information exchange in order to reduce throughput time and development costs. There is a formal evaluation process in place to evaluate development projects with the supplier and to determine future improvement programmes
10.	As per 9, and preferred supplier lists are available per product group, supported by worldwide searches, continuous industry monitoring and joint technology roadmap discussions

Table AIV.
SP6 Integrate suppliers into the operational process

Level	Assessment criteria
1.	No evidence of supplier integration in the operational process. No requirement planning and scheduling process, this mainly happens ad hoc and/or based on gut feeling
2.	As per 1, but there is little evidence for integration of suppliers in the operational process. There is a limited requirements planning and scheduling process on a project level
3.	As per 2, and there is evidence of targets for reduction of lead times and throughput times as part of the purchasing improvement plan (only internally discussed). There is evidence of internal optimization of the requirement planning and scheduling process on a project level
4.	As per 3, and there is a formal internal communication structure and internal multi-disciplinary teams are organized involving marketing, manufacturing/logistics, and purchasing to align market demand, production capacity and supply. Suppliers are involved in the process to optimize operational purchasing
5.	As per 4, and there is evidence of an active process resulting in less process steps, less invoices and lower inventory levels. There is an internal optimization of the requirement planning and scheduling process on a regional/divisional level
6.	As per 5, and there is evidence of cross-organizational teams (buyer and supplier) to reduce inventories, lead times and throughput times. Evidence of an action plan, implementation of actions and review of targets
7.	As per 6, and there is an automated integrated scheduling and order processing system (production planning system) in place to optimize internal information exchange. There is evidence of a documented evaluation process. There is an internal optimization of the requirement planning and scheduling process on a corporate level
8.	As per 7, and there is a comprehensive alignment and integration over the full supply chain with both multiple tier suppliers and customers for planning, inventory reduction, invoicing, etc. and there is evidence that key first tier suppliers are involved in the requirement planning and scheduling process. Automated forecasts are shared with those suppliers
9.	As per 8, and there is evidence that supply chain capabilities are maximized through optimal design of systems and procedures and the use of among other things e-tools (ERP) and other innovative systems
10.	As per 9, and information systems allow information sharing across the full supply chain (externally) with multiple tier suppliers and customers. Cross-organizational supply chain benchmarking resulting in permanent improvement programmes

Level	Assessment criteria
1.	No evidence of a supplier improvement programme. Ad hoc supplier improvement actions, without structured follow-up. Important suppliers are on the process side, before contracting, marginal examined on legally necessary aspects. All key suppliers are externally certified and/or went through a formal qualification process
2.	As per 1, and limited evidence of a formal system in place for basic measurement of supplier performance (e.g. supplier rating). A simple checklist is present for basic measurement of supplier performance. Little evidence of communication of these results (towards suppliers) with appropriate analysis and corrective action planning (towards internal organization). Important suppliers are marginally reviewed before contracting
3.	As per 2, and ad hoc response to supplier problems (e.g. poor quality or late delivery) communicated towards suppliers: reactive supplier development. Measurement is aligned with the internal organization and there is a further development of the supplier improvement programme. All suppliers are marginally reviewed before contracting
4.	As per 3, and formal complaint procedure in place in order to communicate efficiently internal complaints towards suppliers. The general supplier performance is communicated towards suppliers. Evidence of follow-up of suppliers' corrective actions based on these complaints and the supplier rating results. All suppliers marginally reviewed before contracting, on legally necessary and relevant aspects
5.	As per 4, and supplier visits and/or days are organized for supplier recognition/evaluation and to communicate structurally business strategy and purchasing objectives. The strategic suppliers are reviewed at the process side before contracting on relevant aspects. Several formal supplier audits have taken place
6.	As per 5, and there is evidence of process studies and audits at all key (strategic) suppliers in order to fully understand all suppliers' current and future capabilities. This information is documented, regularly updated and effectively communicated towards key stakeholder and is internal accessible for all personnel
7.	As per 6, and process control systems have been agreed with all appropriate (strategic) suppliers. There is statistical evidence of stability and capability from those suppliers or there is evidence that corrective actions are planned
8.	As per 7, and there is evidence of strategic supplier development: pro-active response, concentrating efforts to most important commodities/product groups and suppliers. On site supplier assessments have been organized (e.g. industrial supplier scans, quick scans)
9.	As per 8, and advanced quality measures are in place: cost of non-quality (i.e. problems in supplying construction site) is measured and targets are set and communicated towards suppliers and key stakeholders. Evidence of a zero defect/error programme for critical delivery (including incentives). Evidence of improving results and achieved targets
10.	As per 9, and supplier assessment and joint/mutual trainings are organized to learn in two directions and to establish common improvement programmes (with targets and follow-up). Trained and dedicated personnel are accessible for supplier quality and development

Table AV.
SP7 Improving supplier performance and guarding/developing quality

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