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Master thesis

The development of a maturity model to support the assessment and evaluation of the purchasing department in the field of innovation

Ruben Kappert

S2520400

R.e.kappert@student.utwente.nl

1st Supervisor: Dr. K. Stek

2nd Supervisor: Prof. Dr. habil. H. Schiele

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Finally, I wish you much reading pleasure and hope that the developed maturity tool supports the literature within this exciting field.

Enschede, June 2022

Abstract

The strategic importance of purchasing increases, especially regarding innovation/New Product Development; the inclusion of the purchasing department in the NPD process results in a support of the process of innovation and the protection of cost over the entire product life cycle. Hence, Company X set up a new department in purchasing: NPD purchasing. Nevertheless, it seems that literature provides a surplus on why the inclusion of purchasing is beneficial/necessary in the innovation/NPD process of a company, but less is mentioned on how this should be done. Consequently, no established structure is available that serves as a tool to support the evaluation of the purchasing department in the field of innovation/NPD. Therefore, this thesis provides the first innovation/NPD-oriented maturity model to assess and evaluate the contribution of purchasing in this field. This is done by answering the following main research question: “How to develop a maturity model that supports the assessment and evaluation of the purchasing department in terms of innovation/NPD?” The model is based on an extensive literature review on innovation, NPD, ESI, early purchasing integration and interviews with purchasing experts of Company X. After which the model was demonstrated at the company, resulting in an overview of the current performance/sophistication of the newly formed department.

Keywords: innovation; new product development; NPD; purchasing; procurement; sourcing; early purchasing inclusion; maturity model

Management report

The maturity model is divided into five dimensions, each with its own set of sub-dimensions. The approach assesses the current state of the examined company on all important parts of the NPD purchasing literature using these five dimensions. The used dimensions are planning, organisational structure, process organisation, human resource & leading and controlling. Next to the dimensions that are assessed, the maturity phases must be constructed to provide a full assessment of NPD purchasing maturity. To do so, four maturity stages have been developed:

- Stage 1: Unsatisfying process description. Link with innovation only exists sporadically/occasionally. Hardly any engagement in fulfilling innovation potential.
- Stage 2: Rough process description. Purchasing is aware of the innovation link, some activities are implemented, however, are mainly employee-driven. Purchasing is a source of the company's innovation potential.
- Stage 3: Process is defined, fully documented and applied. Link with innovation is strongly established within purchasing. Purchasing leader in fulfilling the innovation potential of the company.
- Stage 4: Processes are cross-functionally documented and implemented. Purchasing drives continuous improvements in innovation. Innovation potential is harmonised cross-functionally. Process annually/continuously updated and improved according to relevant developments.

The planning dimension scores low in stage two, as it is not done proactively. The lack of written processes is another recurring theme. Furthermore, no clear strategy for NPD purchasing has been developed, thus there is little understanding of where decisions are based, aside from cost savings. However, because the cooperation between sales, (marketing) engineering and purchasing is reasonably solid, it can be claimed that communication between functions in the organisation is sophisticated. Conducting proactive market research to uncover innovations / new technologies and develop activities to implement them is the most effective way to improve.
The organisational structure dimensions scores also in stage two. NPD purchasing has a well-defined organisation with clearly defined roles and duties. The lack of an innovation committee, in which a cross-functional team assesses innovations and technologies, is the first major area for improvement. The strategic integration of procurement into top

management is another area for improvement. This is a key driver of innovation in procurement, and therefore very important to enhance.

The process organisation dimension scores below average in stage two. Company X lacks established processes that support actions over the entire dimension, which is a prevalent theme. Supplier satisfaction is the sub-dimension with the lowest score and so requires improvement. The project teams are cross-functionally integrated at an early stage in the new development process, implying that process participation with other functions and early purchasing involvement is quite sophisticated.

The human resource & leading dimension scores the highest of all with ten points. The purchasing department employs its own NPD buyers, who have different goals and responsibilities than normal buys. Targets and skill training, on the other hand, are mostly cost-cutting in nature and are not driven by innovation.

At last, the controlling dimension sores below average in stage two. The department lacks KPIs and targets related to innovation since top management is focused on cost-cutting. Furthermore, there is a lack of a systematic way of evaluating both suppliers and staff. This is due to the lack of a department-wide steering function, which is caused by understaffing. Risk management is ensured from the first interaction with suppliers through the required certifications, several studies, and the use of recognized suppliers, which also reduces unethical supplier issues.

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1. Introduction to the need for a supportive evaluation model for new product development purchasing

1.1. The contribution of the newly formed NPD purchasing department is unclear

Company X was recently acquired by an organisation consisting of a wide portfolio of copmanies. As a result of the acquisition, a new purchasing department was formed; New Product Development (NPD) sourcing/purchasing. However, they struggle to assess its contribution, leaving them unaware of where this department is lacking and where the department scores well. Hence, this department needs a closer look.

NPD is a business process through which a company develops new products or concepts, covering the process from initial ideation to production and finally to market.[1] The critical aspect of bringing new products to market for companies is to anticipate and predict the needs, wants and desires of customers.[2] Companies are aware that their survival depends on effectively managing a continuous stream of successful new products. Companies form strategic alliances with external partners and build cross-functional teams internally to achieve this. One of the business functions that can contribute to NPD is purchasing/sourcing.[3] In the NPD process, critical purchasing decisions are made about cost and profitability. A large part of the sourcing costs is incurred during the NPD process, making sourcing an increasingly important aspect of NPD.[4] Acquisition price used to be the main focus in purchasing decisions. However, there was a growing realisation that this is only a portion of the picture for the purchasing decision. Furthermore, a purchase price focus is not market-driven in the sense that a higher-priced alternative may result in greater performance of the firm's new product that its customers prefer, even at a higher price point.[5] So, cheaper is not always better. Besides cost reduction, purchasing plays another role in NPD: supplier collaboration. According to Johnsen (2009); Pöppelbuß and Röglinger (2011), involving suppliers in NPD is vital because suppliers have specific product and process capabilities, which become increasingly important as products become more complex.[6] In other words, the integration of suppliers in the NPD process allows for the development of competencies to incorporate knowledge obtained from innovative suppliers. However, several studies have shown that the results of early

[1] See Yu-Tien, Han-Hsin, and Ching-Hsue (2011), p. 10734.
[2] See Khurana and Rosenthal (1998), p. 60.
[3] See Nijssen, Biemans, and De Kort (2002), p. 281.
[4] See Wouters, Anderson, Narus, and Wynstra (2009) ,p. 64.
[5] See Wouters et al. (2009) ,p. 64.
[6] See Johnsen (2009), p. 193.

supplier integration (ESI) are ambiguous and therefore have positive and negative outcomes. This is where purchasing plays an important role, as the integration of the purchasing department into NPD is a prerequisite for enabling ESI.[7] As a matter of fact, Schiele, Hofman, Zunk, and Eggers (2020) state that: "(…) it is not only beneficial but clearly advised to involve purchasers early on in NPD in order to benefit from early supplier involvement. In the absence of professional purchasers, early supplier integration in NPD can even have detrimental effects."[8]

The newly formed department at Company X was created to incorporate purchasing in the innovation process, but there is no clear vision on how to do it. Hence, Company X does not know what activities are expected of purchasing regarding their contribution to innovation. As a result, how this department operates is immeasurable for management. In other words, when is an NPD-purchasing department a good one?

1.2. The aim of the research is to develop a maturity model that supports the evaluation of the purchasing department in terms of innovation/NPD

There is a surplus of literature available on why purchasing should be involved in the innovation process of a company. However, less literature is available on how this should be done. In parallel with this study, Schiele and Spadoto (2022) developed a purchasing innovation process to ensure that a buyer can systematically and continuously access its supplier's power of innovation.[9] One of the conditions that, according to them, is conducive to the successful introduction and application of a purchasing innovation process is corporate maturity which can be considered a necessary condition.[10] Hence, the starting point for the research was the exploration of literature for a suitable model that supports the process of NPD purchasing. The literature provides maturity models that evaluate the influence of purchasing regarding strategic importance and supply chain orientation. However, the reviewed models do not assess and evaluate the purchasing department in terms of NPD/innovation.[11] Therefore, organisations cannot assess and evaluate their purchasing departments' maturity regarding innovation. Based on this, the aim of the research is to introduce a maturity model that supports the assessment and evaluation of the NPD purchasing department in terms of innovation/NPD. As a result, the

[7] See chapter 2.1.4.1.
[8] Schiele et al. (2020), p. 31.
[9] See chapter 2.2.1.-2.2.6.; Schiele and Spadoto (2022), p. 1.
[10] See Schiele and Spadoto (2022), p. 23.
[11] See chapter 2.3.2.

following main question is formulated: “How to develop a maturity model that supports the assessment and evaluation of the purchasing department in terms of innovation/NPD?” This main research question will be answered by elaboration of three sub-questions: 1) What characteristics define the influence of purchasing in NPD? 2) What does the NPD purchasing process look like? 3) What are the requirements to set up a maturity model?

To answer this in a structured manner, the study follows the design science research framework for the development of a new artefact of Peffers, Tuunanen, Rothenberger, and Chatterjee (2007).[12] In Chapter 2, a literature review is conducted to explore the innovation in purchasing. The literature review involves topics of innovation, NPD, ESI and early purchasing integration, after which a detailed NPD purchasing process is explained using the category sourcing year cycle of Schiele (2019).[13] This cycle can be seen in figure 1. The process includes the most relevant outcomes of the community of practice installed by Schiele and Spadoto (2022). The organisational structure and employees’ skills, however, are not involved in the category sourcing cycle of Schiele (2019) but are addressed in the purchasing department cycle of Schiele (2019) and will be elaborated on in this research as its goal is to assess the purchasing department. Therefore, the process contains eight steps: 1) demand planning, 2) category strategy, 3) supplier selection, 4) contracting, 5) executing, 6) controlling, 7) organisational structure, and 8) skills of employees.[14] After which Chapter 2 concludes with information on the principles of maturity models. Based on these steps, in Chapter 4, an innovation purchasing maturity model will be created. Several purchasing-related maturity models are already available in the literature. However, the only empirically tested purchasing maturity model that is based on theory and results in a matrix is the maturity model of Schiele (2007).[15] Therefore, the model that will be proposed in this research is an expansion of the model of Schiele (2007). Chapter 4 includes interviews with experts as part of the iterative development process to improve the maturity model. However, no contribution was made to the literature-based model. Next, in line with the approach of Peffers et al. (2007), the model has to be demonstrated, which verifies its usefulness in assessing the NPD purchasing department. Finally, the evaluation of the model is discussed in Chapter 6. The study concludes with the newly developed maturity model.

[12] See Peffers et al. (2007), p. 54.
[13] See Schiele (2019), p. 56.
[14] See chapter 2.2.1-2.2.8.
[15] See chapter 2.3.3.

This research makes relevant contributions to the literature and increases its practical relevance for procurement organisations. The results will increase the body of knowledge within the research area of innovation/NPD procurement, by providing the first maturity model within this research area.

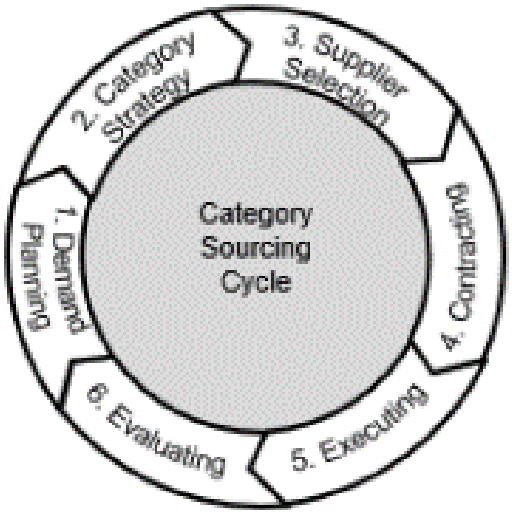

Figure 1: Category sourcing cycle by Schiele (2019)

2. Literature review about the innovation in purchasing, the process of NPD purchasing and the maturity model design that form the basis of the development of the model

2.1. Innovation in purchasing contains NPD, ESI and early purchasing inclusion

2.1.1. Innovation contains many different typologies and is not only about new products

Innovation is an extensive subject with much literature regarding the subject. The first literature on innovation emerged in the early 1970s, and with it the first definitions. Thompson (1965) defined innovation as: "the generation, acceptance, and implementation of new ideas, processes, products or services."[16] It is agreed that there are multiple sorts of dimensions that cover a variety of activities. Meaning that innovation is not just about a new product, but it can also be a new process in production, cheaper material, a reorganisation, lower costs or an improvement in instruments or methods.[17] Innovation can therefore benefit all economic activities through the implementation of projects.[18]

Garcia and Calantone (2002) state that although different working fields provide unique spins on the definition of innovation, the best capture of the definition of innovation from an overall perspective is: "Innovation is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention."[19] In this definition, two parts can be separated. First, the innovation process is iterative, which means it requires repetition. As a result, the first presentation of a new invention and the reintroduction of an enhanced innovation are automatically included.[20] Utterback and Abernathy (1975) describe the iterative process of innovation as the predictable development of products over time with an initial focus on performance, then diversity and later standardisation and cost reduction.[21] Second, the development of an invention occurs concurrently with its commercialization. This means that innovations do not only occur during the development phases of production (the iterative process) but can also take place during the diffusion process where a product or process can undergo continuous improvements and upgrades.[22]

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[16] Thompson (1965), p. 36 cited according to Hurley and Hult (1998), p. 44.
[17] See Kline and Rosenberg (2010), p. 180.
[18] See Kogabayev and Maziliauskas (2017), p. 70.
[19] Garcia and Calantone (2002), p. 112.
[20] See Garcia and Calantone (2002), p. 112.
[21] See Utterback and Abernathy (1975), p. 642.
[22] See Garcia and Calantone (2002), p. 112.

Because no two innovations are alike, they are grouped into typologies to define their innovative features or degree of inventiveness. However, because there are so many typologies, the same word is used for multiple sorts of innovations, and the same innovation is classed differently.[23]

To make it easier to understand the complexity of the concept of 'innovation', Rowley, Baregheh, and Sambrook (2011), based on Francis and Bessant (2005), proposed a framework for the types of innovation and the relationships between them.[24] Four innovation types were found, namely: 1) Product innovation, 2) Process innovation, 3) Position innovation, and 4) Paradigm innovation.[25] These can be found in figure 2.

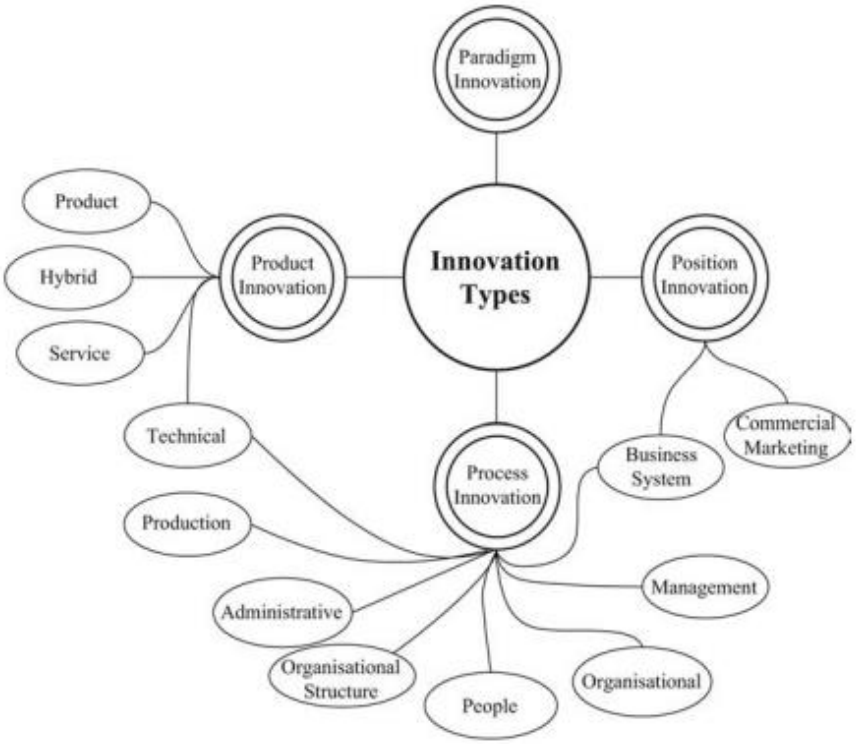

Figure 2: Innovation-type mapping tool by Rowley et al. (2011)

For product innovation, product and service innovation are grouped. Also, a hybrid innovation is possible as it is a mix of product and service innovation.[26]

Innovations in the Process Innovation category seem to be either technical are organisational, with many different terms implying the same process innovation. an overlap can be seen between administrative, organisational, management (process

[23] See Garcia and Calantone (2002), p. 117.
[24] See Rowley et al. (2011), p. 81-83; as well as Francis and Bessant (2005), p. 18.
[25] See Francis and Bessant (2005), p. 3
[26] See Rowley et al. (2011), p 82.

innovation) and business system innovations (position innovation), as they all relate to innovations in the administration and management of business operations.[27]

Positioning innovation is also described as commercial or marketing innovation. When business system innovation encompasses both the administrative and marketing sides of business operations, these two groups overlap.[28]

Changes in the fundamental mental models that frame what the organisation accomplishes are known as paradigm innovations. In other words, it is about the way people look at things, and how this can change through innovation.[29]

2.1.2. New Product Development is considered to be the lifeblood of companies

As previously mentioned, innovation is not just about the creation of new products. Innovation can also take place in production or marketing activities. New product development (NPD) is a more specific type of innovation and is considered to be the lifeblood of companies large and small.[30] Krishnan and Ulrich (2001) define it as: "the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale."[31] Yu-Tien et al. (2011) see NPD as a business process through which a company develops new products or concepts, covering the process from initial ideation to production and finally to market.[32] The critical aspect of bringing new products to market for companies is to anticipate and predict the needs, wants and desires of customers.[33] In other words, NPD is the interface between the customer and the organisation. The customer with its needs, and the organisation with its capabilities. All this is to create value for its customers. The success of NPD is measured through 1) customer measures, such as market share and customer satisfaction, 2) financial measures, such as margin level, 3) firm-level measures, such as the percentage of sales, and 4) product-related measures, such as performance, speed to market and technical success rates.[34]

Cooper and Kleinschmidt (1986) proposed a new product process activity model that is used and quoted by multiple researchers in the field. According to this activity model,

[27] See Rowley et al. (2011), p. 82-83.
[28] See Rowley et al. (2011), p. 83.
[29] See Rowley et al. (2011), p. 80.
[30] See Lynn, Abel, Valentine, and Wright (1999), p. 320.
[31] Krishnan and Ulrich (2001), p. 1.
[32] See Yu-Tien et al. (2011), p. 10734.
[33] See Khurana and Rosenthal (1998), p. 60.
[34] See Griffin and Page (1993), p. 299.

firms are advised to follow several steps in the NPD process. Usually, the whole process starts with an initial idea that was taken from the market, i.e., from customers or competitors. Alternatively, the idea could have been prompted by technology from internal R&D, laboratories or a supplier source. The process begins with an initial screening with a go/no go decision and allocation of funds. Then a quick market and technical assessment are proposed to note the technical advantages and potential difficulties of the product. Despite the quick market assessment, detailed market research and data collection are effective to get the reactions of customers, followed by a business and financial analysis before proceeding with the actual product development. If the result of the previous steps was positive, the product development process begins with a design, prototype or pilot product, internal testing and customer testing. Before trial production, a test market phase for customers is recommended to be included in the process. Between pilot production and the start of full-scale production, another business and financial analysis is advisable to see if any changes have occurred during product development. Finally, the market launch of the product can be prepared and implemented. Successful new product development projects, for the most part, follow these steps. However, Kahn, Barczak, Nicolas, Ledwith, and Perks (2012) state that there is no one best way to perform well, but rather different routes that lead to the same end goal. This leaves room for the manager to come up with a customized solution that fits the resources and characteristics of the company.[35]

Furthermore, Evanschitzky, Eisend, Calantone, and Jiang (2012) conducted a literature review regarding the success factors of product innovation within firms. They found five categories of characteristics that can be predictive of NPD success. These are 1) Product characteristics, 2) strategy characteristics, 3) process characteristics, 4) marketplace characteristics, and 5) organisational characteristics.[36] Finally, it was discovered that the importance of success factors decreases over time, meaning that the ability to gain competitive advantages through an awareness of NPD success factors reduces as management knowledge of these characteristics rises.[37] In other words, managers and companies must continue to innovate, because the competition will follow.

To drive and ensure innovation, companies have traditionally invested heavily in big research and development divisions. This has decreased as firms know that not all

[35] See Kahn et al. (2012), p. 182.
[36] See Evanschitzky et al. (2012), p. 30.
[37] See Evanschitzky et al. (2012), p. 30.

innovations will emerge from within the organisation and that not all good ideas will be successfully marketed internally. Hence, companies have had to change their NPD process from an exclusively internal one to a more open process.[38]

2.1.3. When correctly implemented, early supplier involvement is vital to remain competitive

2.1.3.1. Early supplier involvement is about sharing responsibility with a supplier for the development and design of a new product

Companies started to operate more globally due to the more open NPD process. This resulted in more competition and thus made it necessary for companies to collaborate with external partners, as well as to outsource tasks and commodities.[39] In other words, partnerships are established with suppliers to benefit from their technical expertise in design and manufacturing.[40] Hence, involving suppliers early and closely in the NPD process is vital to remain competitive.[41]

In 1989, the Japanese car manufacturers enjoyed better lead times and cost advantages compared to the European or American car manufacturers. This was because the Japanese worked closely with their suppliers, unlike the European or American who did not work closely with their suppliers or involved their suppliers early in the NPD process.[42] At that time, outsourcing services that were formerly conducted in-house became more popular. As a result, corporations focused more on their main business and outsourced operations like accounting, computer services, and R&D to their suppliers. As a result, conventional huge, vertically integrated corporations have evolved into complex networks of collaborating firms within a supply chain of customers and suppliers.[43] For this reason, the concept of early supplier involvement (ESI) in NPD was proposed.

One of the activities being shifted to supply chain partners in this new industrial structure is the design and development of complicated products. The degree to which this occurs varies; some manufacturers outsource the majority of engineering design and development to outside vendors. In some circumstances, a hybrid situation exists, with suppliers designing sub-assemblies and components or in-house designers working closely with their

[38] See Chesbrough and Crowther (2006), p 229.
[39] See Schiele (2010), p. 138.
[40] See Dowlatshahi (1998), p. 143.
[41] See Johnsen (2009), p. 187.
[42] See Clark (1989), p. 1258.
[43] See McIvor and Humphreys (2004), p. 179.

suppliers to guarantee that components are developed with the appropriate performance and quality. As a result, design and development are controlled not only within one major organisation but also across multiple buyers and suppliers.[44]

There are many different definitions for ESI. Bonaccorsi and Lipparini (1994) stated that ESI "is a strategy for appropriating supplier-originated innovations alternative to the traditional procurement of improved devices developed autonomously by suppliers and then offered in the open market."[45] Likewise, Hoegl and Wagner (2005) defined ESI in NPD as "the extent to which a buyer organisation shares responsibility with a supplier organisation for the development and design of the subsystems (or components) of a new product."[46] Fundamentally, ESI is concerned with the integration of supplier capabilities into NPD projects.[47]

2.1.3.2. Challenges of early supplier involvement can be associated with the supplier, the manufacturer and/or the relationship between them

Collaborating with a supplier by involving them in NPD projects goes beyond the level of regular purchasing activities, and can therefore present challenges, pitfalls and risks. Wynstra, van Weele, and Weggemann (2001) state that the problems in managing supplier involvement in NPD activities can be associated with the supplier, the manufacturer and/or the relationship between the two parties.[48] First, problems could occur in the relationship between buyer and supplier. A major detriment to the relationship here is the lack of trust and commitment, which can negatively affect cooperation performance in terms of efficiency and effectiveness. When this is the case, both parties see the relationship as unstable and as a potential risk. Moreover, communication with suppliers may become a problem if the purchasing company does not communicate its expectations regarding the sharing of responsibility in the development process of the new product.[49] In other words, problems occur through the absence of clearly identified and consistent contact persons and from delayed responses. Therefore, insufficient or misleading information was often exchanged, resulting in limited access to relevant information and delays due to the time spent searching for the right contact person to provide the information.[50] Problems can also

[44] See McIvor and Humphreys (2004), p. 179.
[45] Bonaccorsi and Lipparini (1994), p. 139.
[46] Hoegl and Wagner (2005), p. 531.
[47] See Dowlatshahi (1998), p. 143.
[48] See Wynstra et al. (2001), p. 159.
[49] See Cataldo and Ehrlich (2012), p. 2.
[50] See Flankegård, Granlund, and Johansson (2021), p. 6.

occur that originate from the suppliers. One of the main drawbacks of successful product development collaboration is a lack of in-house technical capabilities. In addition, suppliers may lack experience in cooperating on product development, as the selection criteria for suppliers focus only on low prices. It is also possible that suppliers will not be able or ready to commit the time, labour, or the capital required. Moreover, people in the supplier organisation can be a problem in two ways. First of all, cross-functional collaboration challenges appear when there is insufficient dialogue, unclear agreements or different understanding of responsibilities. Second, project management challenges are related to poor planning, unclear responsibilities or insufficient exchange of information.[51] Last, problems could occur at the manufacturer, who may not have a clearly defined product development process.[52] As a result, no clear concepts exist about what areas, when, or how suppliers can be involved. This may lead to the wrong suppliers being involved in the process; for example, suppliers whose innovative capabilities are limited.[53] Also, issues were raised as a result of the lack of a complete or acceptable process model. It was discovered that a lack of formal procedures, such as decision criteria and procedures for decision-making, frequently resulted in ineffective decision-making and confusion. Because the project organisation thought the receiving organisation had taken over responsibility for certain aspects of the project, while the receiving organisation thought the project organisation still had responsibility. Thus, the lack of a comprehensive or appropriate model could lead to confusion about who is/was responsible for what.[54]

Another issue is that development engineers build barriers out of fear of losing their employment, also purchasers are hesitant because they do not have a finished product to validate their judgments. Engineers say that in addition to the quality discrepancies they notice between themselves and the supplier's level, engaging with the supplier during the NPD process would add another layer of complexity to their work.[55] Meaning that the entire organisation must be willing to collaborate. Moreover, culture can make it difficult for suppliers to accept suggestions, and corporate designers and engineers may be hesitant to relinquish influence over design decisions. Finally, internal opposition may exist inside the supplier's organisation due to concerns about disclosing private information or

[51] See Flankegård et al. (2021), p. 7.
[52] See Flankegård et al. (2021), p. 8.
[53] See Wynstra et al. (2001), p. 160.
[54] See Flankegård et al. (2021), p. 8.
[55] See Wynstra et al. (2001), p. 160.

technologies. A supplier may be apprehensive about unfair treatment, especially when dealing with a more powerful buyer.[56] In the same way, Zolghadri, Amrani, Zouggar, and Girard (2011) discovered that the stronger partner often forces the weaker one to accept challenging points against its will and abuses its power in the partnership. This abuse of power leads to mistrust and frustration so the power difference on both sides must be known before cooperation between the two parties.[57]

2.1.3.3 Benefits of early supplier involvement can be distinguished between long- and short-term goals

On the other hand, despite the challenges and risks of involving a supplier in a company's NPD activities, there are also benefits. Wynstra et al. (2001) made a distinction between long-term goals and short-term goals, regarding the benefits of supplier involvement.[58] Van Echtelt, Wynstra, Van Weele, and Duysters (2008) added that it is vital for firms to understand the short-term and the long-term benefits simultaneously and focus on both perspectives to implement the process successfully.[59]

The short-term objectives are linked to specific development projects in two areas: efficiency and effectiveness. Efficient involvement of suppliers can bring benefits such as a reduction in development costs and time. This can be achieved by regulating design changes with early communication with the supplier at each step of the process with the same perception and level. In addition, the development tasks can be separated so that either the manufacturer or the supplier is responsible, depending on who is more qualified for the implementation. Alternatively, both parties can develop the components at the same time to avoid bottlenecks in the engineering or R&D department. In terms of the effectiveness of the short-term benefits, there is evidence that this leads to a reduction in product costs and an increase in product value. These improvements can be acquired by supporting supplier expertise in design manufacturing, component quality and reliability, alternative materials and component standardisation capabilities.[60] Oinonen and Jalkala (2015) agree with this and state that the main goal of the buyer is to achieve process efficiency through collaboration with the supplier.[61]

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[56] See Ragatz, Handfield, and Scannell (1997), p. 199.
[57] See Zolghadri et al. (2011), p. 312.
[58] See Wynstra et al. (2001), p. 158.
[59] See Van Echtelt et al. (2008), p. 180.
[60] See Wynstra et al. (2001), p. 160.
[61] See Oinonen and Jalkala (2015), p. 291.

The long-term benefits are achieved by integrating the supplier into the NPD process. Since they are only important for long-term success, they often cannot be measured directly regarding NPD success. One of the long-term benefits is a closer, more open, and trusting long-term relationship with the supplier.[62] Notably, when the short-term goals' efficiency and effectiveness increase, the maintenance of the relationship is enhanced.[63] According to Handfield, Ragatz, Petersen, and Monczka (1999), the closer the relationship between buyer and supplier, the more willing the supplier is to share its technology for the benefit of the buying company. Building a long-term relationship is therefore a vital factor for cooperation and exchange of information and technology.[64] It is rare that a single company will master all necessary technologies, especially in industries that use sophisticated product and/or process technologies. The ability to tap into suppliers' knowledge and skills will likely result in better technological choices and, in the long run, better designs.[65]

Moreover, a significant part of the cost of a product is determined very early in the design cycle, when technological decisions are made. Decisions made early in the process are vital and become more expensive and difficult as the process progresses, since the engineering and product design phase generates five to eight per cent of total product development costs, but accounts for 80% of total product costs. This is because early decisions in the design process affect the quality, cost and cycle time of the product. Hence, early cooperation with suppliers leads to better decision-making in the early stages of product development, which in turn leads to cost reduction.[66] Next to cost reduction, product quality in NPD is vital, and one way to increase quality is to allow suppliers the freedom to share information about their product concept early in the production cycles, ensuring that the final product meets the quality criteria. Next to that, cycle time is also seen as a key performance indicator for organisations and early inclusion of the knowledge and expertise of suppliers enables time savings.[67]

[62] See Ragatz et al. (1997), p. 194.
[63] See Patrucco, Luzzini, and Ronchi (2017), p. 1276.
[64] See Handfield et al. (1999), p. 79.
[65] See Ragatz et al. (1997), p. 199.
[66] See Ragatz, Handfield, and Petersen (2002), p. 398.
[67] See Ragatz et al. (2002), p. 398.

2.1.4. Purchasing's relevance increases and encompasses purchasing early integration

2.1.4.1. Purchasing early integration is a prerequisite for enabling ESI

Companies are aware that their survival depends on effectively managing a continuous stream of successful new products. Companies form strategic alliances with external partners and build cross-functional teams internally to achieve this. Purchasing/sourcing is an example of a business function that can help with NPD.[68] Moreover, several studies have shown that the results of ESI are ambiguous, and therefore have positive and negative outcomes. This is where purchasing plays an important role, as the integration of the purchasing department into NPD is a prerequisite for enabling successful ESI.[69] As a matter of fact, Schiele et al. (2020) state that: "(…) it is not only beneficial but clearly advised to involve purchasers early on in NPD in order to benefit from early supplier involvement. In the absence of professional purchasers, early supplier integration in NPD can even have detrimental effects."[70]

Since the 1980s, purchasing functions are no longer working as a cost-saving function, and their strategic fit into an organisation's strategy has been catching greater attention of top management. In other words, purchasing has more and more evolved into a strategic business function, that comes with a higher level of professionalism within a firm.[71] Narasimhan and Das (2001) referred to this as purchasing integration which they defined as "the integration and alignment of strategic purchasing and goals with that of the firm."[72] This means that purchasing activities must be aligned with the strategic plans of the company, which require purchasing to participate in the strategic planning process, have access to strategic information and that major procurement decisions are made in coordination with other strategic decisions of the company.[73] In other words, purchasing integration relates purchasing plans and practices to business objectives and shapes senior management's perception of the strategic role of purchasing in the organisation. Therefore, Narasimhan and Das (2001) distinct purchasing integration from procurement activities in two ways. First, purchasing integration has an internal orientation, whereby purchasing must play a significant role in developing the company's product and technology-oriented strategies. This differs from procurement practices as this consists of actions affecting the

[68] See Nijssen et al. (2002), p. 281.
[69] See Hillebrand and Biemans (2004), p. 118-119.
[70] Schiele et al. (2020), p. 31.
[71] See Nijssen et al. (2002) p. 282.
[72] Narasimhan and Das (2001), p. 593.
[73] See Narasimhan and Das (2001), p. 594.

supply base. Second, purchasing integration necessitates organisational changes; the establishment of strong internal relationships through participation in strategy development teams, information exchange, and shared decision-making activities that can be launched without major upfront costs. This differs from procurement practices as this may require significant investment, such as supplier quality training.[74]

According to Wynstra, Weggeman, and van Weele (2003), the purchasing function has three strategic roles: rationalisation, structure, and development. The rationalisation role involves tasks to minimise overall production costs. The structural role of purchasing concerns the management of the enterprise's supplier network by influencing its structure. An important task for example is giving support to newly established suppliers that may play a critical role for the company. Finally, the development role of purchasing entails systematically aligning the enterprise's technological development with the development of suppliers and the supplier network, ensuring that suppliers' technical skills are utilized in R&D processes, and increasing suppliers' interest in developing products that the firm requires and desires.[75] Wynstra et al. (2003) conclude that the integration of purchasing into the NPD should be based on a combination of all three roles. The unique attributes and motivations of the development project or the organisation's longer-term goals influence the relative importance of the various roles, as well as the extent to which potential conflicts and overlaps exist.[76]

2.1.4.2. Top-management support and an adequate organisational structure are the main drivers of purchasing early integration

In terms of the factors determining the need for involvement of purchasing, Wynstra, Axelsson, and Weele (2000) identified four drivers, namely: size of the company, production type or technology, the dependence on suppliers, and the importance of product development.[77]

First, company size is measured in the number of employees and acts as an indicator of the complexity of the organisation. The larger the company, the more important the involvement of purchasing and suppliers becomes. When an organisation is more complex, communication is more difficult to coordinate and establishing communication guidelines

[74] See Narasimhan and Das (2001), p. 596.
[75] See Wynstra et al. (2003), p. 69.
[76] See Wynstra et al. (2003), p. 69-70
[77] See Wynstra et al. (2000), p. 130.

becomes an important part of successful projects. The second driver is production type or technology, where products with a high degree of complexity and multiple components often involve multiple suppliers. Purchasing departments should act as coordinators of development activities between the company and the (multiple) suppliers. The third driver is supplier dependency which is measured through the share of purchasing in turnover. This driver is characterised by the influence the supplier has on the development of a final product, the greater the influence, the greater the dependency. The final driver is the importance of product development in an enterprise. If a company has a high R&D expenditure, product development is considered important. The greater the importance of product development, the more important the involvement of purchasing in the process.[78]

Moreover, Nijssen et al. (2002) conducted regression analyses on drivers of early purchasing involvement and came to two main drivers: top management's support and the firm's NPD strategy. Accordingly, the more top management encourages purchasing, the more purchasing is involved in NPD. Furthermore, the more a company concentrates on generating innovative products, the more likely purchasing will be included in the NPD process. Purchase value and firm size were found not to be significant. However, Nijssen et al. (2002) claim that this can be explained by the support of top management and its strategic decisions. Finally, two personal characteristics of purchasing managers were also found to be significant; purchasing managers with more experience and higher education had a higher involvement in NPD.[79]

In line with Nijssen et al. (2002), Schiele (2010) found top-management support as well as an adequate organisational structure to be the most influential factors facilitating early purchasing inclusion. In total, Schiele (2010) found four main drivers for early purchasing involvement, namely: top management support, structural differentiation, processes, and culture. First, top management support goes in line with a dedicated strategy for innovation, including the desired vision and the steps needed to achieve this.[80] Second, structural differentiation is about making a clear distinction between 'advanced sourcing' and 'strategic sourcing', where the 'advanced sourcing' team is integrated into NPD-related projects and activities, whereas the 'strategic sourcing' team takes control of the supplier management during production. Engineers and/or purchasers with a technical

[78] See Wynstra et al. (2000), p .131.
[79] See Nijssen et al. (2002), p. 286.
[80] See Schiele (2010), p. 145-146.

background make up the 'advanced sourcing' team, whilst members of the 'strategic sourcing' team have a more commercial focus.[81] Third, a well-documented and detailed NPD process must be set up, including clearly defined steps, milestones, go/no-go decisions, tasks and responsibilities. The process has four phases: 1) a concept phase, 2) a design phase, 3) a piloting/testing phase, and 4) a transition to the operations phase.[82] Lastly, culture is found to be a driver as an innovation-oriented company culture supports NPD activities. This is in addition to cross-functional collaboration inside the company, as well as the involvement of suppliers and top management in the process. NPD projects cannot begin without purchasing knowledge in an innovation-oriented culture where purchasing managers are members of the board.[83] To conclude, the inclusion of the purchasing department in the NPD process results in a support of the process of innovation and the protection of cost over the entire product life cycle. Hence, it is highly beneficial to include the purchasing department in NPD activities.[84]

2.2. Purchasing activities in NPD along the year cycle of Schiele (2019)

2.2.1. Cross-functional planning is vital to excel at innovation sourcing

The year cycle of Schiele (2019) starts with demand planning, which is the combining of the expected number of inputs from the supplier with the expected sales of the company and is required at the beginning of the purchasing year cycle. For this purpose, an analysis of the past is coupled with a projection of the future. Past information is extracted from the software. A sales forecast can be used as a basis for breaking down expected sales into required purchasing in the future.[85] Schiele and Spadoto (2022) found in a community of practice that innovation-oriented purchasing activities in the demand planning process are derived from either financial planning, marketing & sales or R&D planning.[86]

The annual budget process determines the available budget for each purchasing category. If, as proposed by Hesping and Schiele (2016), classical cost-oriented instruments, such as price negotiations, global sourcing or pooling, do not yield sufficient savings, innovation-oriented instruments, such as product and process innovations, may be needed to realise the objective.[87]

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[81] See Schiele (2010), p. 146-147.
[82] See Schiele (2010), p. 147-148.
[83] See Schiele (2010), p. 148.
[84] See Schiele (2010), p. 149.
[85] See Schiele (2019), p. 56.
[86] See Schiele and Spadoto (2022), p. 10.
[87] See Schiele and Spadoto (2022), p. 10.

Next to that, purchasing's increasingly important role in NPD demands the integration between marketing and purchasing. Because of the role marketing plays in communication with the customers, and the more demanding customer preferences, marketing has a crucial role in extending this knowledge to NPD. Hence, purchasing and marketing must continuously exchange information to ensure an optimal match between consumer preferences and supplier resources and capabilities during NPD.[88] Beforehand, the purchasing-marketing linkage allows purchasing to collect customer-focused specs and utilize them to communicate with suppliers, allowing suppliers to focus on designing and developing their components while contributing their experience and ideas to NPD. Afterwards, when a new product is in stores, the purchasing-marketing integration helps to better adjust marketing promises and actions to the capabilities of the supplier. This requires constant exchange of information and coordinated decision-making between buyers and suppliers. Overall, the inclusion of marketing in the demand planning contributes to the consistency of NPD throughout the supply chain, from product specification to market launch.[89]

At last, in innovation sourcing demand planning it is critical that sourcing understands the needs of Research & Development (R&D). Purchasing should look beyond present demands and consider opportunities that could give them a competitive advantage in the future.[90] These needs are made up of expectations, constraints, and issues that arise in the R&D department and are felt or anticipated by both internal and external clients. To gather these unmet needs, purchasers must engage in cross-departmental contacts, demonstrating that buyers contribute to overall corporate performance beyond cost savings. Purchasers may respond quickly, enhance their awareness of what makes a difference, and anticipate future innovation and transformation by participating in cross-functional activities.[91] In other words, innovation purchasers need to understand the end product and integrate customer needs as a guide for innovation purchasing decisions, to excel at innovation sourcing.

According to Schiele (2010), technology roadmaps play an important role in successful cross-functional integration between departments, as collective and cross-functional

[88] See Gonzalez-Zapatero, Gonzalez-Benito, and Lannelongue (2016), p. 48.
[89] See Gonzalez-Zapatero et al. (2016), p. 50.
[90] See Legenvre and Gualandris (2018), p. 97.
[91] See Legenvre and Gualandris (2018), p. 98.

technology roadmaps usually reflect market expectations and technological trends.[92] In addition, technology roadmaps also help to link the purchasing strategy with the innovation strategy of the firm. Therefore, technology roadmaps are vital for demand planning, as it links cross-functional strategies.[93]

Overall, the demand planning in NPD purchasing is derived from either budget planning, market or/and R&D. A great tool for this is the technology roadmap, as it facilitates cross-functional integration and reflects market expectations and trends. Understanding the need of each other is vital for gaining competitive advantage.

2.2.2. The type and number of suppliers are typical ESI elements in the NPD strategy

After the demand planning, a strategy is defined relating to the planning. A strategy is defined for each sourcing category, which reflects the objectives of the corporate budget planning and defines the reflection of this strategy in the category. Schiele and Spadoto (2022) state that a particular challenge for the formulation of category strategies, regarding sourcing innovation, is to design the strategic approach in such a way that sufficient suppliers that can contribute to innovation are present and willing to commit resources to the innovation process of the purchasing enterprise. This requires three main activities: 1) The inclusion of innovation requirements in the concrete category sourcing strategy, which can be done using the Kraljic matrix. Whereby buyer and supplier call for a collaborative strategy, including joint innovation in the so-called "strategic quadrant", in which buyer and supplier are important to each other. 2) The monitoring of supplier markets for innovation and the identification of company needs. This can be done through pull and push instruments, like scouting activities, supplier days, workshops and an online web interface where innovative ideas can be pitched. 3) The motivation of suppliers to share innovations or participate in joint development projects by ensuring the attractiveness of a company to its suppliers.[94]

In line, typical ESI elements that benefit the strategy are proposed by Servajean-Hilst and Calvi (2018) in a supplier interface consisting of five steps. First, monitoring supplier markets and current suppliers for relevant developments is critical. Second, suppliers for future involvement in NPD must be pre-selected. Third, the skills and capabilities of current suppliers must be exploited. After that, these suppliers must be motivated to

[92] See Schiele (2010), p. 145.
[93] See Schiele (2010), p. 139.
[94] See Schiele and Spadoto (2022), p. 11.

develop products and/or knowledge. Ultimately, these actions are evaluated on their performance.[95]

According to Mikkelsen and Johnsen (2019), innovation sourcing strategy includes decisions about the number of suppliers employed for a certain item or category, the sort of supplier relationship to pursue, contract term, and the type and location of sourcing decisions. Thus, for innovation sourcing, in the strategy phase, the potential for supplier innovation is created. However, Mikkelsen and Johnsen (2019) are primarily concerned with decisions about the type of supplier relationship to pursue, as this is critical to purchasing's role in regulating supplier participation in NPD initiatives.[96] What was identified is that competencies need to be developed within purchasing to enable cooperation with, and understanding of, the technical requirements of R&D.[97] In other words, purchasing does contribute to the determination of the type of suppliers and which relationship should be pursued, however, purchasing maturity is essential to ensure that the purchasing function is strategically aligned with the company's entire strategy.[98]

Next to the type and amount of suppliers, Pihlajamaa, Kaipia, Aminoff, and Tanskanen (2019) introduce the concept of stimulation of suppliers to encompass the various approaches that buyers can take to promote the innovativeness and capabilities of their suppliers.[99] Pihlajamaa et al. (2019) define stimulation as: “Stimulation of supplier innovation refers to the buyer company's actions which aim to enhance its suppliers' innovativeness, and/or guide its suppliers' innovation processes, and/or encourage its suppliers to share their innovations.”[100] Before suppliers can be stimulated, three necessary conditions were found for buyers to benefit from the innovativeness of their suppliers: 1) they must generate innovations that are relevant to the customer, 2) they must share their innovations with the buyer, and 3) they must share their inventions with the consumer. Supplier innovation stimulation is defined as a set of measures aimed at meeting these conditions.[101] Stimulation comprises a combination of knowledge-sharing routines and effective governance and can be direct or indirect. The majority of stimulation activities are based on indirect knowledge exchange, which means that innovation outcomes are

[95] See Servajean-Hilst and Calvi (2018), p. 7.
[96] See Mikkelsen and Johnsen (2019), p. 4.
[97] See Mikkelsen and Johnsen (2019), p. 9.
[98] See Mikkelsen and Johnsen (2019), p. 11.
[99] See Pihlajamaa et al. (2019), p. 1
[100] Pihlajamaa et al. (2019), p. 3.
[101] See Pihlajamaa et al. (2019), p. 3.

highly dependent on the voluntary actions of suppliers. This includes frequent communication and meetings with suppliers to discuss long-term strategies. It also involves setting joint development goals by communicating with suppliers and getting to know their innovation capabilities and interests. Also, direct forms of knowledge sharing were identified. This includes buyers that organise meetings and workshops to stimulate suppliers to innovate. The most prolific stimulation through effective governance is in line with Mikkelsen and Johnsen (2019): supplier selection. Above all, the foundation of stimulation is to make suppliers aware of the buyer's innovation needs; suppliers should be made aware of any changes in behaviour that are desired.[102]

Overall, the difficulty for category strategy formation in terms of sourcing innovation is to build the strategic approach in such a way that enough suppliers who can contribute to innovation are present and prepared to devote resources to the purchasing enterprise's innovation process. Thus, the potential for supplier innovation is developed in the strategy phase. Vital aspects for this are the type of supplier, number of suppliers, stimulation of suppliers and the evaluation of their actions.

2.2.3. Technical, strategic and relational characteristics explain an important part of a supplier’s contribution to innovation

Once the planning and the strategy are defined, the next step is to identify and select the best supplier(s). To do so, the buyer sends out a request for a quotation or proposal (RFQ), which contains all necessary information for the potential suppliers.[103] However, innovation sourcing has additional challenges, as suppliers must be innovative and relevant to the buyer.[104] According to Servajean-Hilst and Calvi (2018), supplier selection takes place through a series of exchanges between R&D and the potential supplier. Afterwards, purchasing directors check for innovation opportunities and include them in the innovation project system.[105]

Legenvre and Gualandris (2018) found activities in which purchasing was involved in exploring new supply opportunities. The research shows that purchasing teams tend to find innovation in their existing supplier network through innovation days and roadmap-sharing activities. Other purchasing teams engage with suppliers further down the supplier

[102] See Pihlajamaa et al. (2019), p. 10-11
[103] See Schiele (2019), p. 56.
[104] See Pihlajamaa et al. (2019), p. 21-22.
[105] See Servajean-Hilst and Calvi (2018), p. 15.

network, to improve long-term performance. The most advanced purchasing teams, on the other hand, work with start-ups, as well as third parties and universities.[106]

When identifying NPD partners, Emden, Calantone, and Droge (2006) found three phases purchasing managers go through. The first phase is technological alignment and is characterized by developing a mutual understanding of unique competencies and their implication in the market. These unique competencies are technical ability, resource complementarity, and overlapping knowledge.[107] The second phase is strategic alignment and consists of motivation correspondence and goal correspondence. The correspondence of motivations indicates mutually beneficial intentions and determines the probability of partners engaging in opportunistic behaviour. Goal correspondence emerges when the potential partners have non-competitive goals. A high degree of goal alignment was a necessary prerequisite since it guaranteed consistency in expectations and reciprocal benefits.[108] The third and last phase is relational alignment, which is about compatible cultures, willingness to change, and long-term orientation. Because efficient communication and knowledge exchange require a certain level of agreement in norms and processes, or how things are done, culture is vital. Willingness to change refers to partners who are willing to adjust as collaboration requirements change. Lastly, long-term orientation is about sacrificing short-term results for the long-term.[109]

In addition, relational alignment/capabilities have a major influence on the decision process between totally new suppliers and already existing suppliers.[110] Long-term and trusted exchange relationships may need time to establish to benefit from the innovative input of suppliers. Hence, establishing innovative relationships with new suppliers may be limited in the short term.[111]

In addition, Pulles, Veldman, and Schiele (2014) found that being a preferred customer appears to be the best predictor of supplier innovativeness.[112] If a buyer is a preferred customer, the supplier will allocate resources more efficiently, therefore, it is more likely that the supplier will deploy its best staff for co-development or offer innovations that the

[106] See Legenvre and Gualandris (2018), p. 99.
[107] See Emden et al. (2006), p. 334-336.
[108] See Emden et al. (2006), p. 337.
[109] See Emden et al. (2006), p. 338.
[110] See Croom (2001), p. 32
[111] See Schiele (2006), p. 8.
[112] See Pulles et al. (2014), p. 414-415.

buyer's competitors don't have.[113] Next to suppliers, start-ups or new venture suppliers are also considered attractive innovation partners. Kurpjuweit, Wagner, and Choi (2021) define new venture suppliers as: “young and innovative start-ups that can bring radical benefits to buying firms through sourcing or co-developing new technologies, products, or services.”[114] In line with Emden et al. (2006), Kurpjuweit et al. (2021) found that potential new venture suppliers must also be evaluated and aligned in the field of technological fit, strategic fit, resource & capabilities fit, and market fit.[115]

Overall, most of the literature reported in this chapter has recently been presented in a framework by Liu, Fan, Tu, and Wang (2021). This framework allows structuring criteria for the selection of innovative suppliers along three dimensions; 1) Supplier capability, which is about the ability (technological, service, specialisation) of a supplier to create innovative value for buyers with its complex skills and knowledge base. 2) Supplier willingness, which is about involving a supplier that has the confidence, commitment and motivation to make an innovative contribution to the buying company. Last 3), risk, which entails geographical distance and lack of social capital.[116] Meaning that the selection process must continuously be adjusted to the latest requirements of NPD purchasing.

2.2.4. A ‘light’ contract can be beneficial for innovation purposes

The fourth step in the year cycle is about contracting. Contracting happens after the potential suppliers are defined, and consists of an (intensive) negotiating process, after which one or more contracts are signed (depending on the number of suppliers).[117] Contract negotiations ensure the long-term commitment and motivation of internal and external actors by setting out their respective expectations, rights and obligations.[118] A crucial role of purchasing in the innovation process is the contract design with suppliers involved in co-development processes. Purchasing's role in the innovation process is to ensure professional development contracts with suppliers, including confidentiality agreements, management of intellectual property rights and assisting suppliers in managing the administrative requests of the purchasing company.[119]

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[113] See Hüttinger, Schiele, and Veldman (2012), p. 1194.
[114] Kurpjuweit et al. (2021), p. 26.
[115] See Kurpjuweit et al. (2021), p. 41.
[116] See Liu et al. (2021), p. 5.
[117] See Schiele (2019), p. 57.
[118] See Servajean-Hilst and Calvi (2018), p. 21.
[119] See Schiele and Spadoto (2022), p. 13.

Co-development contracts have two important functions in the purchasing of innovation: to reduce the risk of opportunistic behaviour and to promote and structure cooperation.[120] However, innovation is characterised by a potential for unexpected outcomes.[121] This requires more flexible contracts that involve more upfront work to ensure flexible terms and clauses that allow for continuous adjustment, preservation of the relationship and mutual benefit, also called 'preventative contracting'.[122] Moreover, cost-plus contracts, fixed-price contracts and incentive contracts have been proposed as explicit contracts for innovation situations. The cost-plus contract allows the supplier to charge for all costs incurred, which may be efficient if a solution must be found urgently. The fixed price, on the other hand, encourages suppliers to try to achieve a desired result at the lowest possible in-house cost, while the incentive contract tries to reach a mutually agreed compromise between the two extremes.[123]

Sustained cost savings are usually the sole responsibility of purchasing, even if extensive supplier qualification audits or technical tests are required to confirm or otherwise validate usability. However, there is an underlying contradiction between purchasing's function in enabling NPD at the lowest cost and purchasing's duty in attaining substantial and long-term cost savings. As a result, it is critical to link the NPD team's goals with ongoing cost savings. This is an important aspect when setting up contracts.[124] Especially in the transition from NPD to production, it is vital to achieve target costs, as the new product is more appealing to potential customers at the lowest price. A low production cost can also deter competitors since they believe it will be more difficult to match that pricing. Different team members may interact with suppliers in NPD teams, but purchasing is regarded as the cost and performance management specialist for suppliers, having the lead or only position in negotiations. Having a cost specialist on the NPD team or evaluating expenses is an essential strategy to prevent passive opportunism in purchasing.[125] When an individual does not actively pursue a conclusion that is favourable for the other party to the relationship but only for himself or his department, this is known as passive opportunism.[126] As a result, without a cost specialist, purchasing can take advantage of its

[120] See Hofman, Faems, and Schleimer (2017), p. 739-740.
[121] See Tracey and Neuhaus (2013), p. 99.
[122] See Tracey and Neuhaus (2013), p. 100.
[123] See Schiele and Spadoto (2022), p. 13.
[124] See Ellram, Tate, and Choi (2020), p. 4.
[125] See Ellram et al. (2020), p. 20.
[126] See Ellram et al. (2020), p. 18.

hidden cost information and postpone NPD cost reduction until it counts as ongoing cost reduction to meet measurable purchasing department targets.

The community of practice that was installed by Schiele and Spadoto (2022) ran a workshop to set up an innovation contract. In this way, they found five elements essential to an innovative contract, or a so-called ‘light contract’. 1) Contract details, containing specifications about output, time, resources and quality standards, 2) intellectual property, containing the definition of certain information as confidential information, regulation of its use, patents and agreements on the production phase, 3) agility, which concerns the way of dealing with unexpected results, periodic contract review and update procedure, possible sequencing of contracts, 4) coordination/monitoring of exchange commitments and forms, information requirements, and last 5) penalties and safeguarding with agreements on termination (gradual termination), penalties for breach and non-compliance.[127]

Overall, the possibility for unexpected outcomes is what characterises innovation. Therefore, in innovation purchasing, co-development contracts serve two purposes: to decrease the danger of opportunistic behaviour and to promote and structure cooperation.

2.2.5. Project execution in innovation projects is about the management of the co-development process and the supplier integration

The execution part in a purchasing process usually refers to operative procurement, because, once a supplier is contracted, orders can be placed. However, in the case of innovation projects, execution starts at the beginning of the development project, includes the ramp-up and then connects to the "normal" execution process. Here, the particular emphasis is on the management of the co-development process and the activities performed by procurement.[128] In other words, purchasing needs to support supplier integration. The goal is to acquire a structured innovation ecosystem in which purchasing enhances connectivity with and between internal and external partners.[129] The dual role of procurement proposed by Schiele (2010): promoting innovation while keeping costs under control and taking into account the requirements of the whole enterprise, e.g. in pooling and throughout the life cycle, applies.[130]

[127] See Schiele and Spadoto (2022), p. 14.
[128] See Schiele and Spadoto (2022), p. 15.
[129] See Legenvre and Gualandris (2018), p. 102.
[130] See Schiele (2010), p. 138.

The community of practice that was installed by Schiele and Spadoto (2022) classified the procurement activities during the implementation phase of the project into three main groups: 1) project management, in which the amount of supplier involvement is determined, alternative technologies or suppliers are discussed, developing or buying project-specific solutions is discussed and targets are determined and evaluated. 2) Supplier involvement, which relates to formulating and implementing secure supplier involvement guidelines, creating a communication interface with the supplier and coordinating development activities at the supplier (black box involvement) or with the supplier (grey box). 3) Support and business integration, which is about finding a balance between supply orientation (category management) and product orientation (engineering), ensuring product standardisation, supporting commercial issues (total cost calculations, make or buy, cost-oriented design, applying cost-saving tools).[131]

As briefly mentioned above, there are different levels of supplier involvement/integration, which depend on technological centrality and product complexity. The level of supplier integration occurs on a scale of supplier involvement from no supplier involvement, to white box, to grey box, to black box, with black box being the most supplier involvement.[132]

At the no-involvement level, the supplier is seen as an external workbench where the supplier makes to print. The white box is characterised as informal supplier integration, where the supplier is used for consulting activities, mainly for core operations. In the white box, decisions are made by the buying company. The grey box is characterised by formal supplier integration, where the supplier is involved in joint development activities for complex products, which includes joint decision-making regarding performance and design specifications. Finally, the black box is the most extreme type of supplier integration, involving the maximum amount of integration and information sharing between the client and the supplier, as well as nearly the entire responsibility for the acquired item. The supplier drives the new product design in the black box, and the buyer just gives parameters.[133]

[131] See Schiele and Spadoto (2022), p. 15.
[132] See Petersen, Handfield, and Ragatz (2005), p. 378.
[133] See Petersen et al. (2005), p. 378-379.

Depending on the component risk involved and the degree of supplier's autonomy in NPD, white, black or grey box integration is advised.[134] Five configurations of supplier involvement in collaborative NPD projects are determined which can be seen in figure 3.

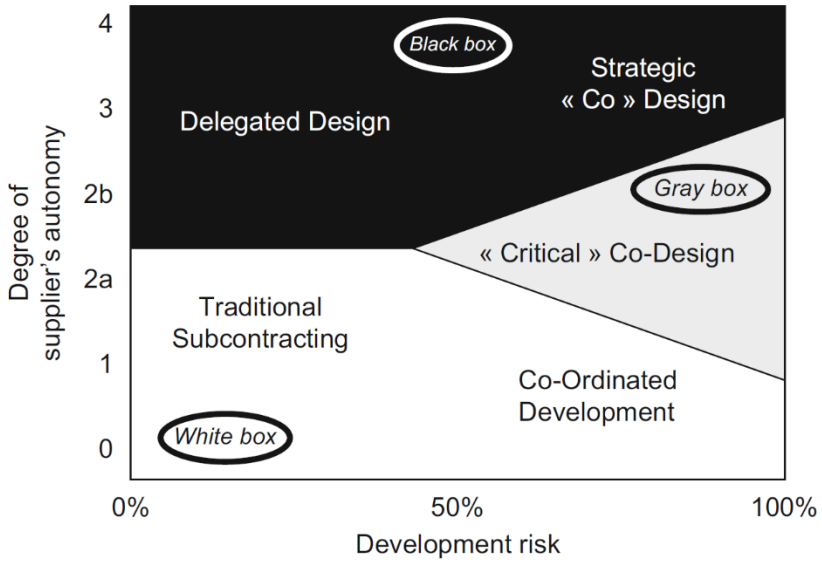

Figure 3. Determination of supplier level integration of Le Dain et al. (2010)

This is about standard products, taking into account the supplier's manufacturing and assembly capabilities. The development risk associated with coordinated development is considerable, while supplier autonomy is low. This connection is used for small components whose design is kept internal but whose technical specifications change as the project progresses. These can be seen as white box integrations.[135]

The grey box is defined by a high level of product development risk and a moderate level of supplier autonomy. Joint development activities between buyer and supplier are necessary because neither has the specifications/ability to completely integrate this into the company.[136] Delegated design and strategic co-design can be seen as black-box integration. In both circumstances, the supplier is solely responsible for the commissioned item's design and development. However, the high level of risk in strategic co-design necessitates frequent communication with the supplier to understand client needs and their evolution as the project progresses.[137]

[134] See Le Dain, Calvi, and Cheriti (2010), p. 79.
[135] See Harbi, Calvi, and Dain (2002), p. 6; as well as Le Dain et al. (2010), p. 80.
[136] See Harbi et al. (2002), p. 7.
[137] See Harbi et al. (2002), p. 6-7; as well as Le Dain et al. (2010), p. 80.

Overall, the execution of innovation projects is about the management of the co-development process and supplier integration. There are several levels of supplier involvement/integration, which are determined by the technological importance of the product and the complexity of the product, and these levels require different actions and activities.

2.2.6. Developing innovation KPIs is a systematic process and is supplier based

Controlling is useful to ensure that the supplier's track record is maintained, which enables purchasing to choose which supplier continues to get orders or which supplier is phased-out. This can be done through supplier feedback moments, in which evaluation results are communicated. Feedback moments rely on cooperation between buyer and supplier and are possible through information exchange, recommendations and requests.[138] According to Schiele and Spadoto (2022), the responsibility of purchasing is to collect and evaluate supplier innovation performance, gain feedback from the supplier and initiate development activities based on the feedback.[139]

As mentioned in the introduction, measuring the effects and results of processes and projects is essential to ensure that the pre-set objectives are met, especially in the field of innovation. An important strategy tool to meet these objectives is KPIs.[140] Banu (2018) found a correlation between objectives, expected results and KPIs, insisting that the development of KPIs must be a systematic process that is based on in-depth analysis, consisting of the following steps: “1) define and understand project objectives, 2) define and describe project results, 3) design and describe project activities, 4) develop and describe KPIs.”[141]

Moreover, Caniato, Luzzini, and Ronchi (2014) proposed a purchasing KPI tree in which six performance criteria that measure the overall performance of the purchasing department are defined: cost, time, quality, flexibility, innovation and sustainability. Overall purchasing performance is the result of a combination of supplier performance and internal purchasing process performance.[142]

[138] See Pihlajamaa et al. (2019), p. 9.
[139] See Schiele and Spadoto (2022), p. 16.
[140] See Banu (2018), p. 906-907.
[141] Banu (2018), p. 907.
[142] See Caniato et al. (2014), p. 620-621.

What was found is that the most frequently used indicators relate to cost, time and quality, while measures of flexibility, innovation and sustainability have been less widely used. For innovation, no internal process KPIs were found. However, four supplier innovation-related KPIs were found: 1) contribution to NPD, 2) innovativeness, 3) innovative proposals and 4) time to market. [143] In other words, the purchasing department is still primarily judged on cost savings and not so much on the other performance indicators.

In general, the literature offers evaluation measures for (innovation) projects, but there is little literature on purchasing and supplier innovation controlling.[144] Therefore, Schiele and Spadoto (2022) installed a focus group workshop with the community of practice to collect KPIs that are relevant to innovation purchasing, and therefore measure innovation purchasing success.

As a result, four innovation purchasing KPI dimensions are grouped: 1) the suppliers, including the number of patents that were generated, the number of ideas that were implemented, the amount of savings, the number of new product projects promoted and risk. 2) The project, including the degree of implementation and project realisation tracking. 3) The individual buyer, including the percentage of projects meeting the recommendations of the process, for example, concept competitions and lever workshops, financial impact, like additional turnover or extra savings, percentage of projects with early involvement of purchasing and quantity of proof of concepts realised. Last 4) the buying firm (the purchasing department), including savings from innovations, the percentage of ideas generated with suppliers out of the firm’s ideas and the quantity and quality of the proposed ideas, which can be measured on timing, impact and periphery.[145]

At last, Mu, Peng, and MacLachlan (2009) identified that risk management plays an important role in an NPD project. As mentioned before, NPD is a cross-functional and interrelated process, this also applies to risk management. The management of technological, organisational and marketing risks are complementary and mutually reinforcing contributions to NPD's success. Unrecognised, unmanaged or unmitigated risks are among the major causes of project failure. Companies need to understand the risks

[143] See Caniato et al. (2014), p. 624.
[144] See Patrucco, Frattini, and Di Benedetto (2021), p. 207.
[145] See Schiele and Spadoto (2022), p. 16-17.

inherent in certain projects so that project and risk management activities can be properly selected, planned, implemented and controlled.[146]

Overall, purchasing's role is to gather and analyse supplier innovation performance, solicit feedback from suppliers, and conduct development initiatives based on the feedback. KPIs are a crucial strategy tool to do this. These KPIs must be developed systematically, based on in-depth investigation and can be grouped in four dimensions.

2.2.7. In a dedicated purchasing structure, purchasing is the only interface with the suppliers which enhances innovation

The purchasing department is increasingly affecting the innovation potential of companies, as companies rely more and more on their suppliers to support this. Consequently, the purchasing department can be a determining factor in a company's ability to innovate, therefore, the structure of the purchasing department is vital in promoting and managing innovation.[147]

A study by Luzzini and Ronchi (2011) found three different configurations of structures of the purchasing department for innovation. These configurations are dedicated, integrator and coordinator. This can be found in Figure 4.[148]

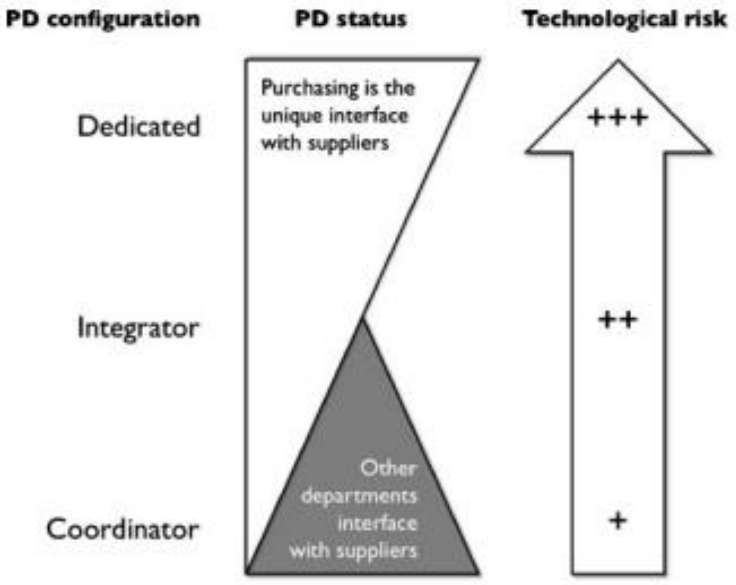

Figure 4: Configuration of the purchasing department for innovation by Luzzini and Ronchi (2011)

[146] See Mu et al. (2009), p. 177-178.
[147] See Luzzini and Ronchi (2011), p. 14.
[148] See Luzzini and Ronchi (2011), p. 20.

The ‘coordinator’ configuration focuses on organisational efficiency without losing control of innovation priorities. Although it is an important part of business strategy (especially in times when expenses must be cut), R&D and production are recognized as the company's principal source of innovation potential.[149]

The ‘integrator’ configuration is a mixture between dedicated and coordinator. Purchasers are not merely commercial purchasers (as the coordinator is), nor are they supply management professionals who are entirely dedicated to the purchasing department. The purchasing status is still relevant. Other departments recognize the buyers' dual role: on the one hand, they must assure appropriate short-term expenses and long-term cost reductions; on the other hand, they must manage the connection with suppliers through integrating with other departments. By doing so, purchasing hands over some of its expertise and responsibility to other departments. Innovation has no priority over cost reduction.[150]

In a ‘dedicated’ purchasing structure, key roles to support and enable any activity involving suppliers are: purchasing engineering, performance evaluation, purchasing quality, buyers, and reverse marketing.[151] Purchasing officers are in charge of activities that include suppliers, whereas other departments are in charge of internal activities that do not require the involvement of suppliers. Hence, purchasing is the only interface with the suppliers. The purchasing department oversees the overall purchasing and supply function and cooperation with suppliers, while coordination with other departments remains weak. A dedicated purchasing function ensures that supplier performance is monitored in terms of quality and innovation rather than just costs. The purchasing department is seen as one of the most strategic departments in the company. Direct reporting lines to the CPO, combined with coordination with corresponding centralized units, monitor coherence with overall business strategy.[152] In other words, a dedicated purchasing structure enhances innovation. Furthermore, purchasing as the only interface in innovation has a positive effect on cooperation with suppliers, and contributes to successful collaborative processes for the development of new products (NPD).[153] To achieve this, four influencing factors on

[149] See Luzzini and Ronchi (2011), p. 23.
[150] See Luzzini and Ronchi (2011), p. 22
[151] See Luzzini and Ronchi (2011), p. 20.
[152] See Luzzini and Ronchi (2011), p. 21.
[153] See Patrucco et al. (2017), p. 1270.

purchasing early involvement were found: top-management support, structural differentiation, process organisation, and collaborative corporate culture.[154]

Overall, purchasing engineering, performance evaluation, purchasing quality, buyers, and reverse marketing are crucial responsibilities in a 'dedicated' purchasing configuration to support and enable any operation involving suppliers. To manifest this, the purchasing director should be part of the firm's executive board.

2.2.8. The innovation purchaser must possess imagination, sellership, and governance skills

The innovation purchaser must be able to attract innovations from suppliers and should support the co-development of innovations. Hence, skills and knowledge are an important part of the process of supporting and improving innovation.[155]

Certain skills and competencies have always been important in any business. Stek and Schiele (2021) state that: "(…) for purchasing and supply management (PSM), the initial focus has been on professional knowledge and skills, such as computer skills, cost reduction and financial skills, quality management, analytical skills, and strategic sourcing. Later, personal skills and traits gained more attention, such as decision-making, communication, influencing and persuasion, teamwork, creativity, and conflict resolution."[156] This change comes with the change in the role of the purchasing department. Traditionally, buyers had to deliver the right product, at the right time, with sufficient quality at the lowest price. In recent decades, however, purchasing has evolved into a more strategic policy, with additional objectives that purchasers must fulfil.[157] Especially in innovation sourcing, where competitive advantage is achieved by looking beyond risks and cost.[158]

Stek and Schiele (2021) conducted a study that identified fifteen purchasing skills supporting seven PSM objectives. The study distinguishes between necessary skills, which are essential, and sufficient skills, of which the more the merrier. What was found is that a minimum level of soft skills is needed to excel in professional skills. Also, different purchasing objectives require different skills.[159] "Innovation sourcing and implementation"

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[154] See Schiele et al. (2020), p. 24.
[155] See Grigorescu, Maer-Matei, Mocanu, and Zamfir (2019), p. 9.
[156] Stek and Schiele (2021), p. 3.
[157] See Stek and Schiele (2021), p. 5.
[158] See Legenvre and Gualandris (2018), p .98.
[159] See Stek and Schiele (2021), p. 2 and 8.

is one of these objectives that is pertinent to this study. Three necessary skills and three sufficient skills were discovered for this objective, one of which is both, as well as one skill that has a negative adequate effect on innovation sourcing and implementation, implying that this skill has the opposite effect.[160] Based on this research, a profile for an innovation purchasing manager can be made.

The first necessary skill is “sellership”, which is the ability to sell ideas and promote new concepts. Acquisition strength and canvassing ability, as well as a drive to sell and create trust with clients, are the most vital components. The second necessary skill is “governance”, which is the knowledge of project management, process management and the management of the firm. The most important factors are project management skills, and the realisation of the added value purchasing has to the company. The one necessary and sufficient skill is “imagination”. This skill is about being creative and imaginative in professional life, as well as being professionally curious, and having the motivation to learn continuously. [161]

The first sufficient skill is “supplier relationship management”, meaning the better the ability to strategically manage suppliers, the more likely innovation successes are achieved. The most important factors are cooperation with suppliers to improve their processes and product capabilities and supply risk management. The second sufficient skill is “innovation sourcing”, meaning that more training in innovation sourcing leads to better results. The most important aspects are the abilities to bundle the entire demands of the organisation and to analyse the supply market.[162]

The skill that had a negative sign was “cost focus”, indicating that solely focusing on cost reduction decreases the results in “innovation sourcing & implementing” objectives.[163]

Porter and Kramer (2007) mention that innovation can benefit both society through sustainability and a company’s competitiveness at the same time.[164] Grigorescu et al. (2019) found skills that enhance sustainable-oriented innovations. According to them, technical skills are the most important, however organisational and leadership skills are also found to be useful in enhancing sustainable-oriented innovations. Most important,

[160] See Stek and Schiele (2021), p. 10.
[161] See Stek and Schiele (2021), p. 17.
[162] See Stek and Schiele (2021), p. 17.
[163] See Stek and Schiele (2021), p. 8.
[164] See Porter and Kramer (2007), p. 88.

creativity, resourcefulness and experimentation are considered to be very important, as these are the soft skills that facilitate and support the development of, for example, technical skills.[165] In other words, these soft skills are the necessary skills for carrying out professional skills.

Overall, the change in the strategic importance of the purchasing department has led to a change in the required skills of employees. For innovation sourcing, three necessary skills and three sufficient skills were discovered. The necessary skills are sellership, governance and imagination. The sufficient skills are supplier relationship management, innovation sourcing and imagination. An organisation should base its hiring decisions on a competence model built on the aforementioned competencies.

2.3 Maturity models serve as an evaluation tool to support the classification of organisational processes and attributes

2.3.1 The basic design principles of maturity models

Internal collaboration between the purchasing department and internal customers is critical for an organisation's purchasing function, and purchasing management is critical for supplier relationship management. The purchasing function, in particular, must be organised in accordance with the supplier market, which can result in a variety of outcomes reflected in the different purchasing orientations of the purchasing development process.[166] This process, in which the purchasing function of an organisation develops from a reactive, passive and supporting function to an assertive and strategic function, describes the maturity of the purchasing organisation.[167]

Based on the assumption of predictable patterns, maturity models guide and help in a step-by-step manner how organisational capabilities should evolve along a path to reach the desired level. The model serves as an evaluation tool, where each maturity level contains the characteristics of previously defined categories and their required attributes.[168] In other words, maturity models are described at levels that equal the organisational capabilities. The assumption is that with higher maturity, comes better firm performance.[169]

[165] See Grigorescu et al. (2019), p. 9.
[166] See Dubois and Wynstra (2005), p. 8-9.
[167] See Schiele (2007), p. 276.
[168] See Pöppelbuß and Röglinger (2011), p. 2.
[169] See Schiele (2007), p. 274.

According to Mettler and Rohner (2009), typical classes are an organisation, people, or processes.[170] Kohlegger, Maier, and Thalmann (2009) however, found that maturity models should be defined in three other categories: 1) The maturing of persons, 2) the maturing of objects, and 3) the maturing of social systems.[171]

Pöppelbuß and Röglinger (2011) state that maturity models can be divided into three types: descriptive, prescriptive and comparative. For all types, the characterisation of each stage must take place in a logical sequence. In other words, the features of each level are improved in a logical order. First, the maturity model serves a descriptive purpose when it serves as a diagnostic tool to assess the current situation while exploring current capabilities. Second, a maturity model serves a prescriptive purpose when it shows how the desired state can be assessed, providing guidelines for improvement. Third, the maturity model is used for comparative purposes to enable internal or external benchmarking. Therefore, sufficient data on similar organisations or processes must be collected.[172]

Whereas Pöppelbuß and Röglinger (2011) see these three types of maturity models as distinct, Carolis, Macchi, Negri, and Terzi (2017) claim that these types are evolutionary phases of a model's lifecycle. In reality, a model's first phase is descriptive, allowing for a better knowledge of the current domain condition. A model can then evolve into a prescriptive model, as substantial and repeatable improvements can only be accomplished with a thorough understanding of the current situation. Finally, to collect sufficient data for a credible comparison, a model must be applied to a large number of organisations.[173]

Every maturity model must contain a certain set of basic information including the purpose of use, target group and the class of entities under investigation must be documented. In addition, maturity models require a definition of central constructs related to their maturation level. In other words, it must be apparent what maturity entails concerning the entity class under examination. All of this has to conform to the qualities of "understandability" and "language adequacy", to communicate the information in a target group-oriented manner.[174] A maturity model with a descriptive aim must also include assessment criteria for each level of maturity, as well as precise, short, and unambiguous

[170] See Mettler and Rohner (2009), p. 1.
[171] See Kohlegger et al. (2009), p. 4.
[172] See Pöppelbuß and Röglinger (2011), p. 3-4.
[173] See Carolis et al. (2017), p. 14.
[174] See Pöppelbuß and Röglinger (2011), p. 6-7

descriptions to distinguish between levels. Improvement measures for each maturity level must be included in models with a prescriptive purpose of use.[175]

Carolis et al. (2017) identified five common activities to build a maturity model. First, the identification of problems and participants, as well as the planning and scoping of objectives, are the primary tasks in the inception phase. Second, the model's design approach and architecture are developed during the elaboration phase. Third, during the construction phase, a tool to assess the object's maturity is created, as well as processes for its implementation and management. Next, the deployment phase, maturity model, and evaluation instrument are all validated at this point. If the model is approved, it moves into the maintenance phase, where changes are monitored and the model is updated as needed.[176]

2.3.2. No NPD purchasing maturity model is available in the literature

The development of a new maturity model has to be justified by reviewing existing models that can provide the same purpose.[177] Therefore, a literature review was conducted in January 2022 using Scopus. Scopus was chosen to collect the most relevant and recent academic maturity model proposals related to NPD on purchasing. This search included the terms: maturity model, capability model, purchasing, procurement, innovation and new product development. This resulted in 34 articles. However, based on the abstract of the articles, only six articles were found to be relevant to this research. The articles can be found in table 1.

Number	Author(s)	Year	Title
1	Van Hoek et al.	2020	Where we are heading and the research that can help us get there – Executive perspectives on the anniversary of the Journal of Purchasing and Supply Management
2	Søgaard et al.	2019	Facing disruptive technologies: aligning purchasing maturity to contingencies

[175] See Pöppelbuß and Röglinger (2011), p. 7.
[176] See Carolis et al. (2017), p. 15.
[177] See Becker, Knackstedt, and Pöppelbuß (2009), p. 218.

3	Liu et al.	2018	Evaluating supplier management maturity in prefabricated construction project-survey analysis in China
4	Tontini et al.	2016	Maturity model of procurement and supply management in small and medium-size enterprises: A benchmarking of hospitals and metal-mechanic companies
5	Úbeda et al.	2015	Purchasing models and organizational performance: A study of key strategic tools
6	Mettler	2011	Transformation of the hospital supply chain: How to measure the maturity of supplier relationship management systems in hospitals?

Table 1: Overview of relevant articles

The current literature provides no maturity model that focuses on NPD in the context of purchasing. Hence, a new maturity model, that supports the evaluation of NPD in purchasing is justified.

2.3.3. Comparison of purchasing maturity models justifies the maturity model of Schiele (2007) as guideline for this research

For the development of the new NPD maturity model in purchasing, the model of Schiele (2007) is taken as a guideline. The maturity model that is proposed by Schiele (2007) is one of three empirically tested academic maturity models in purchasing, along with the models of Cousins, Lawson, and Squire (2006) and Paulraj, Chen, and Flynn (2006). As a result, unlike previous conceptual models, the authors provide empirical support for what the maturity model assesses and what higher maturity signifies.[178] However, there is another difference between these three models. The main differences between the purchasing maturity models found in the literature concern which theory is used to delineate dimensions. A distinction can be made between maturity profiles that are deductively generated and those that are assessed by observation.[179] So, although the works of Paulraj et al. (2006) and Cousins et al. (2006) are empirically tested, such a derivation based on surveys rather than theory has its limitations regarding comprehensiveness. The

[178] See Van Pouckea and Matthyssensa (2012), p. 7.
[179] See Schiele (2007), p. 275.

model of Schiele (2007) follows a deductive structure criterion, but it has also been validated by a post-test on performance after its formulation. So, the model is empirically tested, and the model results in a matrix. On one axis are the dimensions that are analysed/measured at the level of maturity, on the other axis are the phases from low to high maturity.[180]

Schiele (2007) uses five dimensions to cover one axis of the purchasing maturity model: "1) purchasing planning, 2) the structural organisation of the purchasing function, 3) process organisation and purchasing's embeddedness in the firm, 4) established human resource systems and leadership models in purchasing and 5) purchasing controlling structures." [181] This is based on the classical management functions of planning, organisation, leadership and controlling of Daft (2007), among others.[182] Each of the five dimensions is assessed by sub-dimensions and can be seen in figure 5.

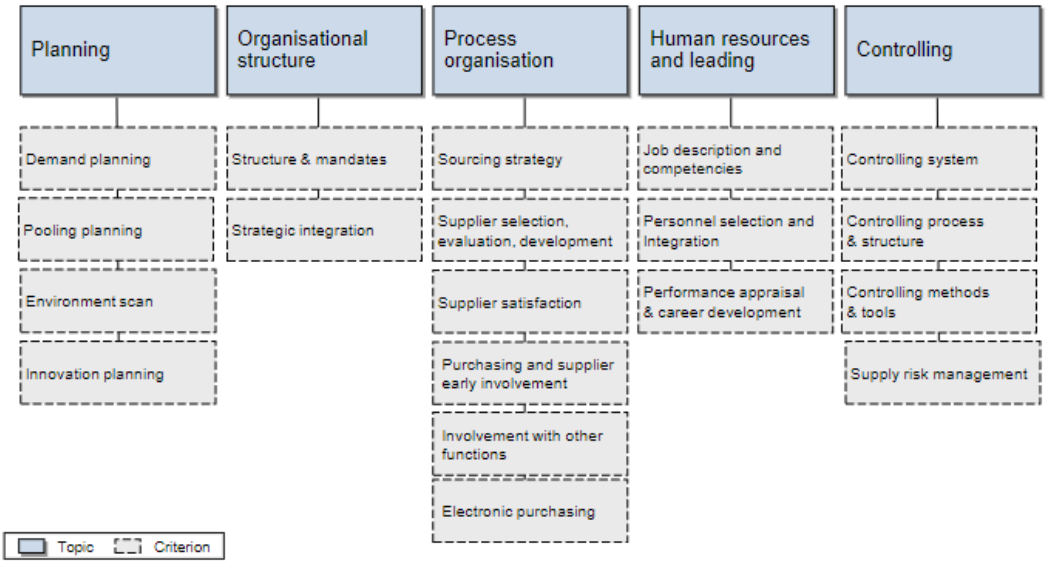

Figure 5: Dimension and items of the maturity model of Schiele (2007)

On the other axis, several stages of maturity are attached to each dimension which completes the maturity model. The maturity stages are derived either from theory or from the analysis of survey data, like the examples of Cousins et al. (2006), containing four maturity clusters/stages and Paulraj et al. (2006), containing three maturity clusters. The

[180] See Schiele (2007), p. 276.
[181] Schiele (2007), p. 276.
[182] See Schiele (2007), p. 276.

model of Schiele (2007) contains four stages of maturity.[183] According to Torn (2017), four maturity levels provide two advantages and are preferable to cover the most relevant stages. “First, the boundaries of stages are more clearly defined compared to models with three stages, because the stage in the middle is split into two distinctive groups. Second, the three central stages of models using five stages tend to become ambiguously since the differences between the stages are too small.”[184]

The maturity levels of Schiele (2007) are divided into four stages: “Stage 1: a particular best-practice activity/tool/method is known within the organisation. Stage 2: a position or person is assigned to perform the task. Stage 3: the process for completing the task is defined and documented as well as applied. Stage 4: cross-functional integration in the company is assured while basic requirements are met.”[185] This means that to reach stage four maturity, it is vital to be sufficiently structured to perform well, rather than performing individually.

[183] See Schiele (2007), p. 278.
[184] Torn (2017), p. 65.
[185] Schiele (2007), p. 278.

3. Methodology provides insight into the approach of the Design Science Research and how data has been collected

3.1. Design framework to develop a maturity model

This chapter provides the research approach for this study. The Design Science Research (DSR) framework of Peffers et al. (2007) was used to structure the research process, because of its explorative nature and practical problem-solving approach. This framework is based on the DSR guidelines of Hevner, March, Park, and Ram (2004), which can be found in Appendix I. Design Research is characterised by an iterative development and validation process for the development of new artefacts that complement prescriptive knowledge. DSR supports an early phase of research into different sections, which helps in the development of an artefact. Moreover, it applies the practical application in organisational environments of this developed artefact [186] Hevner et al. (2004) state that artefacts are broadly defined as models, methods and constructs.[187] Therefore, the development of a maturity model is subject to the application area of the DSR guidelines of Hevner et al. (2004).[188] Noteworthy is that more recently, Stange, Schiele, and Henseler (2022) published publication guidelines for design science in purchasing research. This study is still based on the DSR framework of Peffers et al. (2007), however, future relevant purchasing design science research is advised to be based on the proposed guidelines by Stange et al. (2022).

The nominal sequence, which begins with the first action in the DSR framework of Peffers et al. (2007), is based on a problem-centred approach. This means that problem identification and motivation are the first steps in developing the NPD sourcing maturity model. Accordingly, this approach is mostly applicable if the problem resulted from previous research based on another paper.[189] In this research, the approach to building a maturity model that assesses the NPD purchasing department resulted from a lack of a suitable model and is based on the maturity model proposed by Schiele (2007). The maturity model of Schiele (2007) is the only model in purchasing that has empirical validation and is proposed as a matrix.[190] Hence, the model proposed in this research will be an expansion of the model of Schiele (2007).

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[186] See Peffers et al. (2007), p. 72.
[187] See Hevner et al. (2004), p. 77.
[188] See Jansz and Back (2011), p. 3.
[189] See Peffers et al. (2007), p. 56.
[190] See chapter 2.3.3.

The problem identification and objective have been elaborated in the introduction. As the introduction specifies the research problem and the research objective practical relevance and justification for the development of a new maturity model are provided. The design & development phase refers to the second and fourth chapters of the thesis. The second chapter includes the literature reviews on which the model is designed, and Chapter 4 includes the development of the model. The demonstration and evaluation of the maturity model have been conducted to review the applicability of the model. This is done by applying the model to Company X and reviewing it. As the research contains several stages and data sources, it is beneficial to visualise every stage and the used research method. Hence, figure 6 contains a visualisation of the research framework.

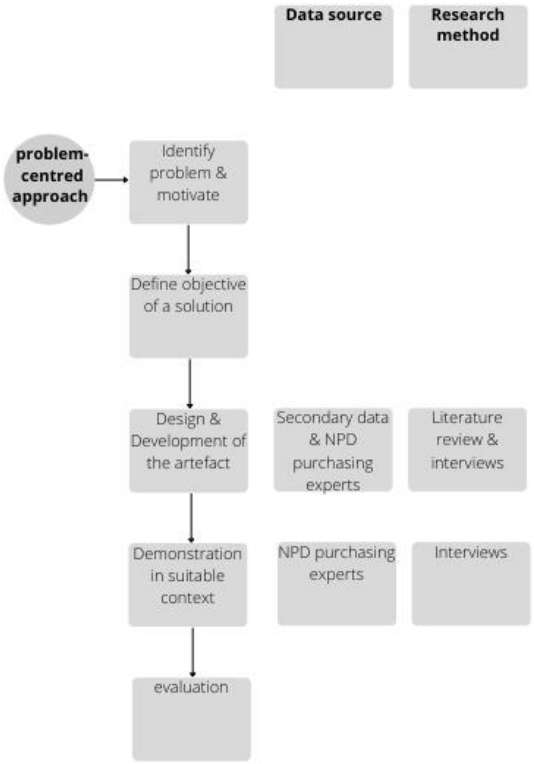

Figure 6: Design Science Research Approach to develop an artefact based on Peffers et al. (2007).

3.2. Data collection for the development of the maturity model consists of Literature and Interviews

3.2.1. The literature review provides the knowledge for the development of the model

To develop an artefact, different data collection methods are used. The following section elaborates on how the secondary data was used for the development of the maturity model.

This process was completed by adding semi-structured interviews with purchasing professionals of Company X.

At the outset, an extensive literature review was carried out to gain in-depth insights into the topics and to produce a draft version of the model on which to build further. This literature review involves the topics of innovation, NPD, ESI, early purchasing integration, demand planning, category strategy, supplier identification, contracting, executing, organisational structure and the skills of employees. Moreover, a structured literature search was conducted on Scopus to justify the need to develop the new maturity model, and a literature study was conducted to compare previously developed purchasing-related maturity models. To ensure relevant and academic literature regarding the subject, the primary search engines used were Scopus and Google Scholar.

The results confirmed the need for an applicable NPD purchasing maturity model. Moreover, the comparative literature study on purchasing-related maturity models has led to the NPD purchasing maturity model becoming an addition to the maturity model of Schiele (2007).

3.2.2. Interviews Company X to complete the model

In addition to the literature review, semi-structured interviews have been conducted with purchasing experts as part of the iterative process.[191] The interviews are held to verify and optimise the different dimensions of the model. Hence, the selection process of the interviewees is based on their professional position in the company and additional knowledge regarding innovation purchasing. For this interview, a short guide has been made to ensure that the interview can add to the optimisation of the model.

	Interview guide
1	Is there a dimension or item that you miss in the model?
2	How would you describe the design of the model in the context of usability and completeness to assess the innovation procurement department?
3	Based on your own experience(s), where do you think most innovation procurement departments are located?
4	Any general comments?

Table 2: Interview guide for innovation purchasing experts

[191] See Peffers et al. (2007), p. 54.

Together with the interview guide, the final draft version of the new model served as another tool to conduct the interview. In addition to the interview guide questions, further questions were asked when more elaboration was needed to gain more insight into the relevant dimension. All interviews were held in place at Company X and were conducted in Dutch. Before the interview, the model was run through with the interviewees to gain some understanding of the model and its various dimensions. The interview was developed in parallel using keywords, the results of which can be found in Chapter 4.2. An overview can be found in table 3.

Number	Title	Function	Duration
1	Interviewer 1	Global director NPD sourcing	00:21:48
2	Interviewer 2	SQA manager	00:22:12
3	Interviewer 3	NPD purchasing manager	00:19:46
4	Interviewers 4&5	NPD purchaser	00:16:32

Table 3: Overview of interviewed Experts for the iterative development process

As a result, three strategic purchasers and two operative purchasers have been interviewed, yielding a total of 01:19 hours of data.

3.3. Validity and reliability assessment concerning the quality of research

For any study, it is important to acknowledge the importance of reliability and validity to reduce the risk of bad performance. Reliability in scientific research regards the consistency of the study, thus the same results should be obtained if replicated by other researchers under a similar methodology.[192] Reliability is guaranteed by conducting three one-on-one interviews, and one one-on-two interview with relevant NPD purchasing experts. The interviews were held at the company. Moreover, reliability was ensured by the fact that the interviewee had not previously heard an interview regarding the model, or had been influenced by an employee of the company. Moreover, the first interview is held together with two Purchasing and Supply Management Professors of the University of Twente. The results were discussed to ensure that the same results were observed and that future assessments are done in the right way. The other three interviews are done afterwards. The outcome will be the mean of the total answers.

[192] See Golafshani (2003), p. 597.

The validity of research determines whether the research is accurate in its analysis and if the results are truthful.[193] In this research, validity is achieved by following the strict proposed structure of Peffers et al. (2007), as it provides accurate results.[194] Moreover, the assessment of NPD purchasing departments follows a scoring model which is intended to ensure the objectivity of the scoring in the model. As can be seen in table 4, each maturity stage consists of five points. The first and lowest point in the maturity stage indicates that the performance hardly meets the requirements and the absolute basic performance is available. The fifth and highest point in the maturity stage indicates that the performance meets all the requirements of the stage and is executed at a high level.

Maturity stage	**1**	**2**	**3**	**4**
Points	1-5	6-10	11-15	16-20
% Observed	1-25%	26-50%	51-75%	76-100%

Table 4: Points and % observed per maturity stage

[193] See Golafshani (2003), p. 599.
[194] See Peffers et al. (2007), p. 50.

4. Developing the maturity model based on literature and interviews is an iterative process

4.1. The literature version of the maturity model entails all activities relevant to NPD purchasing

The maturity model consists of five dimensions with sub-dimensions. With these five dimensions, the model evaluates the current situation of the assessed company on all relevant aspects of the NPD purchasing literature. The selection of the five dimensions is based on the classical management function proposed by Daft (2007): planning, organising, leading and controlling. Schiele (2007) also based its dimensions on the classical management functions to capture the main purchasing functions. In this model, the same dimensions are used as Schiele (2007) proposed with his model, hence the following dimensions are used to assess the NPD purchasing maturity: Planning, Organisational Structure, Process Organisation, Human Resources & Leading and Controlling.[195] Moreover, different sub-dimensions and items are identified in the literature review to ensure relevance to NPD purchasing and to assess the function in the best way possible. As a result, the full model can be found in Appendix II, including an elaboration of the relevance/link with the literature review taken from Chapter 2.

The planning dimension includes five sub-dimensions: Strategic Planning, Demand Planning, Pooling Planning, Environment Scan and Innovation Planning. Planning is a management role in which objectives are established and a strategy for achieving them is devised. Managers must be aware of the current state of their organisation's environment and foresee future situations in order to plan.[196]

The Organisational Structure dimension includes two sub-dimensions: Structure and Mandates and Strategic Integration. Organising entails supplying and managing resources, such as human resources, that are critical to an organisation's success.[197]

The Process Organisation dimension includes eight sub-dimensions: Sourcing Strategy, Supplier Selection, Supplier Evaluation and Development, Supplier Satisfaction, Purchasing Early Involvement in Development Process, Early Supplier Involvement Process, Process Involvement with other functions and Electronic Sourcing. Especially in NPD purchasing, this dimension is vital. Its goal is to assess the impact of formulated

[195] See Schiele (2007), p. 277.
[196] See Lamond (2004), p. 11.
[197] See Lamond (2004), p. 12.

sourcing strategies, the relationship with suppliers and the long-term sourcing plan on the results.[198]

The Human Resources & Leading dimension includes two sub-dimensions: Job Descriptions & Competencies and Personnel Selection & Training. The dimension emphasizes the necessity of purchasing professionalism as well as the employees' skill level, especially with regards to technical capabilities considering the integration with NPD.

The last dimension is the controlling dimension and consists of three sub-dimensions: Controlling System, Controlling Process and Structure & Risk Management. The controlling dimension is about performance measurement and validating that everything has been done according to plan, instructions and principles.[199]

4.2. The interviews with purchasing experts did not expand the literature-based model

According to the design science framework of Peffers et al. (2007) and the guidelines of Hevner et al. (2004), it is recommended that the artefact is evaluated and iteratively improved before it is demonstrated.[200] Hence, four interviews with NPD purchasing experts have been conducted to expand the comprehensiveness and usability.
At first, all the dimensions, sub-dimensions and items were discussed. It can be concluded that no interviewer had any additions to the presented model. All interviewees agree that the model is very complete, and no extra dimension, sub-dimension or item was proposed in the interviews. The interviewers found that the model covers all relevant NPD purchasing processes. Moreover, the interviewers agreed that the model can be beneficial for the company in terms of creating awareness of what and where it needs to improve. In other words, the usability of the model was confirmed.

4.3. The new maturity stages are based on the degree of process description, innovation link, purchasing involvement and cross-functional implementation & continuity

To provide a comprehensive assessment of the NPD purchasing maturity, the construction of the maturity stages is vital. In section 2.3.3. it is mentioned that most relevant purchasing maturity models either have three or four stages of maturity, whereas five maturity stages are also possible. However, Torn (2017) explained that four maturity levels

[198] See Lamond (2004), p. 15.
[199] See Lamond (2004), p.19.
[200] See Peffers et al. (2007), p.54.; Hevner et al. (2004), p. 88.

provide two advantages and two disadvantages and are preferable to cover the level of maturity in the best way possible. “First, the boundaries of stages are more clearly defined compared to models with three stages, because the stage in the middle is split into two distinctive groups. Second, the three central stages of models using five stages tend to become ambiguously since the differences between the stages are too small.”[201] In addition, Schiele (2007) also constructed his model encompassing four maturity stages. Since the model developed in this thesis is an expansion of the Schiele (2007) model, the newly developed model will also contain four maturity stages. An important distinction is that the model of Schiele (2007) assesses the processes, strategic integration and management functions of the entire purchasing department of an organisation, whereas this model assesses the innovative capabilities and intentions of the purchasing processes. Hence, new stages are developed which are taken as guides for the formulation of the new maturity stages. As a result, the general outline for the four maturity stages that have been developed are:

1. Unsatisfying process description. Link with innovation only exists sporadically/occasionally. Hardly any engagement in fulfilling innovation potential.
2. Rough process description. Purchasing is aware of the innovation link, some activities are implemented, however, are mainly employee-driven. Purchasing is a source of the company’s innovation potential.
3. Process is defined, fully documented and applied. Link with innovation is strongly established within purchasing. Purchasing leader in fulfilling the innovation potential of the company.
4. Processes are cross-functionally documented and implemented. Purchasing drives continuous improvements in innovation. Innovation potential is harmonised cross-functionally. Process annually/continuously updated and improved according to relevant developments.

As seen in section 4.1.2. – 4.1.6., the model contains five dimensions, twenty sub-dimensions and sixty items. Besides, the model contains four maturity stages, which bear a value between 1-20 and a percentage between 1-100%, which is visualised in table 5. Hence, the total value of the model is therefore between 60-1200 points, where 60 points are the absolute lowest number of points and 1200 is the highest number of points.

[201] Torn (2017), p. 65.

Maturity stage	**1**	**2**	**3**	**4**
Points	1-5	6-10	11-15	16-20
% Observed	1-25%	26-50%	51-75%	76-100%

Table 5: Points and % observed per maturity stage

5. Demonstration of the model in an organisation obtaining insights in Company X

5.1. The planning dimension lacks activities/tools that support proactive market research of new technologies and innovations

The planning dimension contains the strategic planning, the demand planning, the pooling planning, environment scan and innovation planning. The results of the strategic planning did not vary much and indicate that there is room for improvement. At the strategic level, it is clear that the strategy has changed towards dual sourcing and local sourcing, however, no clear strategic planning has been established for NPD purchasing. The demand planning is relatively sophisticated. All interviewees agreed that Company X is a financially driven firm, hence demand planning is largely based on budget planning which is documented. Moreover, there is a close collaboration between purchasing, sales and product line management, which can be seen as the marketing of engineering. In this cooperation, sales bring orders from customers to product line management, where they translate the customer's requests into possibilities within Company X. This means that Company X is mostly dependent on customer requests, these requests follow a process from sales to engineering to purchasing, where NPD purchasing is responsible for finding capable suppliers.

The pooling planning for Company X is found to be difficult. Although Company X is part of a larger group of companies, all these companies are different and therefore use different materials and products. Hence, pooling within the group is unsophisticated.

The environment scan scores very low on the maturity model. No process has been established for NPD purchasing to research the market for new developments/innovations. Innovation signals mainly come from engineering; NPD purchasing is not involved in this. NPD purchasing is responsible for enquiries from the customer, purchasers are not expected to research new technologies. If they do, it is on their initiative. As can be expected, no push tools are documented. NPD purchasers sometimes attend innovation trade fairs to gather insights into new technologies and innovations. Noteworthy is that Company X has been approached for a tool to connect innovative buyers with new suppliers, however, there is no response to this as it is not expected from top management. Furthermore, Company X sometimes collaborates directly with second-tier suppliers. This is sporadically done to order raw materials, however, there are no initiatives to set up contracts or projects with these suppliers.

The innovation planning also scores low on maturity. The identification of new technologies is sporadically done on the NPD purchaser's initiative. It is not part of the

NPD buyers' responsibilities and therefore no documented process has been established. Some employees, for example, sign up for webinars and go to trade fairs. New technologies are identified mainly through enquiries from customers. However, it should be noted that new technologies are not avoided if the customer asks for them. NPD purchasing is always open to this. As a result of the lack of technology identification, it can be noted that there are no initiatives in organising pull tools/activities for the identification, such as supplier workshops or supplier days, where a supplier can pitch their innovations. Moreover, Company X has no intent on collaborations with start-ups. In the automotive branch, there is a high emphasise on certifications like ISO 9000 and ISO 16494; these certifications are not present in start-ups, which means that collaborations are not even considered. At last, NPD-buyers are insufficiently involved in compiling the technology roadmap. The roadmap is known and available in purchasing, but it is led and made by engineering. Purchasing used to be more involved in this, but due to understaffing, it is less so. Roadmaps of important suppliers are not known.

Overall the planning dimension scores low in stage two, as can be seen in table 6. A common theme is that planning is not done proactively but as a result of the enquiries of customers. This means that setting up contracts with suppliers is difficult as you plan reactively. Another common theme is the lack of documented processes. Furthermore, no clear strategy is formulated for NPD purchasing, hence there is no view of where decisions are based, besides cost reductions. However, it can be said that the communication between functions in the company is relatively mature, as the cooperation between sales, (marketing) engineering and purchasing is reasonably good. The biggest improvement can be achieved by conducting proactive market research to identify innovations / new technologies and plan activities to realise them.

Function	**Score (1-20)**
Planning	**5.5**
Strategic planning	4
Demand planning	10.5
Pooling planning	5
Environment scan	5
Innovation planning	2.8

Table 6: Final score of the dimension: Planning

5.1.2. Support from top management is low, so the strategic integration of the procurement department is unsophisticated

The organisation structure dimension contains two sub-dimensions; structure & mandates and strategic integration. The results of structure and mandates score relatively high. At Company X there is an advanced sourcing structure in place which includes an NPD purchasing department which includes five employees. Responsibilities are defined, although in practice there is still ambiguity at times. In Company X, global category managers validate and release suppliers together with the supplier quality assurance (SQA) manager. This means that products/materials are allowed to be ordered from these suppliers. The majority of all products are ordered by purchasing. Small-scale purchasing for prototypes, for example, can be ordered by engineering, but almost always goes through the authorised suppliers. If products/materials are not available, new suppliers are sought to approve so that these products/materials can still be ordered. Hence, few regulations are in place, simply because they are not necessary as this is well defined in advance. One thing that is missing in the structure is a cross-functional innovation board/committee, which is in like manner with the planning, where it showed that innovations are mostly driven by the enquiries of customers.

The strategic integration of the purchasing department of Company X is low. The purchasing manager of Company X reports to the senior vice president of the group, who is in turn subordinate to the chief operations officer (COO). Hence, purchasing is not considered (one of) the most strategic functions. This is a problem as this is one of the main drivers for innovation in purchasing. Furthermore, almost everything is bought, which leads to a limited depth of production. Purchasing is however involved in major make-or-buy decisions.

Overall the organisational structure dimension scores average in stage two, as can be seen in table 7. There is a well-defined structure for NPD purchasing with clear responsibilities. The first main point of improvement is the lack of an innovation committee in which a cross-functional team evaluates innovations and technologies. The other area for improvement is the strategic integration of purchasing into top management, which is an important driver for including NPD in purchasing, as can be seen in the literature review.

Function	Score (1-20)
Organisational Structure	**8**

Structure and mandates	9.8
Strategic integration	6.3

Table 7: Final score of the dimension: Organisational structure

5.1.3. Cross-functional teams are included early on in the development processes, however, lack a documented systematic process

The process organisation dimension is the most extensive and contains eight sub-dimensions; sourcing strategy, supplier selection, supplier evaluation and development, supplier satisfaction, purchasing early involvement in the development process, early supplier involvement process, process involvement with other functions and electronic sourcing.

The sourcing strategy is characterised by its aim for dual sourcing and localisation, as already mentioned in the planning part. Moreover, there is no timeline or process involved and most of all, innovation is not part of the strategy. Furthermore, no tactics are in place to operationalise the sourcing strategy. These tactics can be innovation levers mentioned by Hesping and Schiele (2016). However, category managers and the SQA manager release suppliers based on a global process audit (VDA 6.3), which implies that purchasing is the process owner to match suppliers with the strategy.

Supplier selection is therefore based on a process which is (partially) cross-functional. The main problem is that suppliers are not based on their innovative potential, but mainly on the cost price. In other words, there is no insight into which supplier is more capable to collaborate in innovation. However, there is a preferred supplier list available that is based on a vendor rating, filled in on subjective experiences of the purchaser. Thus, no process is developed. Negotiation is done based on the experience of the purchaser; thus, no systematic negotiation preparation is involved. There are predefined targets set to achieve, price is the main target. Contracting is based on generic rules of the ERP system. The contracts mainly include logistic and price agreements, but also minimal and maximal production volume, payment agreements and general delivery conditions. No difference in contracts for innovation purposes, such as co-development processes.

Supplier evaluation and development are done through hard criteria in the ERP system. No annual questionnaire was sent out to suppliers. Agreed contracts are assessed and communicated to customers every month. After three months of no improvement, SQA is called in to see how things can be improved. Usually done on the initiative and with insights of the buyer, no fixed process is established. Supplier development is done

reactively when there are problems with suppliers, not looking at innovations. SQA is responsible for supplier development. This happens systematically, but no clear process is available. Supplier phase-out plans exist and are a documented cross-functional process in which engineering, purchasing, logistics and SQA is involved. The process is linked to an end-of-production process available in the system.

Supplier satisfaction scores very low in the maturity model. Company X suffers from staff shortages as a result of which supplier satisfaction is (almost) not performed. Company X employees know that they are difficult to work with, this is due to their feelings and the fact that several suppliers have terminated their cooperation. Activities to make Company X more attractive for innovation are therefore not established.

Purchasing is early involved in the development processes. The main objective is to deliver monthly cost estimations throughout the process. The purchaser is included in the new product development process from the beginning and helps with brainstorming to determine what materials are most appropriate for each case. Alongside purchasing, also engineering, logistics and sales are included in these brainstorms. There is no total cost calculation, but when the costs far exceed the budget, cost calculations and commercial support tools are used to check and manage this. Engineering determines which materials are needed and used; however, purchasing does have a say in this. Sometimes standard catalogue items are available, but this is frequently changed. Also, engineering is often aware of what materials are available and what is feasible. For this reason, engineering often determines what will be included in the drawing, in close cooperation with purchasing.

Suppliers are involved early in the development process. There is no fixed procedure for this, but each project is examined individually to determine how this is implemented. This is especially the case with suppliers with high technological capabilities and with projects where the product is very complex. The integration with these suppliers is different than with regular suppliers, for example, these suppliers are visited and hosted more frequently to manage the relationship. However, this is not done via a systematic approach, but in consultation with the supplier. Hence, no supplier integration activities/tools are in place to manage the process, like supplier participation coordination or an R&D function support.

The process involvement with other functions sub-dimension scores relatively high and is therefore in stage three. As mentioned above SQA is part of the purchasing department and plays an important role in releasing and approving suppliers to do business with.

Moreover, logistics are also part of the cross-functional project teams. Logistic systems

engineers are responsible for packaging, transport and other parameters. There are also expediters on the production floor whose main task is to ensure that ordered products arrive for production to continue (firefighting). In case of escalation, category buyers are informed. The process is known for purchasing, however, is not documented.
At last, there is no electronic sourcing tool in place in which innovations can be proposed and managed.
Overall, the process organisation dimension scores below average in stage two. A common theme is that Company X lacks documented processes that support the activities across the whole dimension. Supplier satisfaction is the sub-dimension that scores the lowest and therefore needs to be improved on. Process involvement with other functions and purchasing early involvement is quite sophisticated, which implies that the project teams are cross-functionally integrated at an early stage in the new development process.

Function	Score (1-20)
Process organisation	**6.7**
Sourcing strategy	7.8
Supplier selection	6.3
Supplier evaluation and development	7.3
Supplier satisfaction	3.4
Purchasing early involvement in development processes	9.3
Early supplier involvement process	6.6
Process involvement with other functions	12.3
Electronic sourcing	1

Table 8: Final score of the dimension: Process organisation

5.1.4. The purchasing department has its own NPD purchasers with different targets and job profiles

This dimension consists of two sub-dimensions; job descriptions & competencies and personnel selection & training.
Job descriptions and competencies are well developed for the NDP purchasing department.

The NPD purchasing team consists of four people all with their job descriptions. Innovative competencies do not carry a higher priority than others, but they are (somewhat) included in the process, which is also a result of staff shortage. No standardisation of innovation purchaser role. Technical competencies are a must, although this applies not only to NPD buyers but also to category buyers.
Personnel selection is based on 25 different competencies/skills elements described within the function, although no level is attached to these skills. Innovation is part of the skillset, although not more important than others. NPD buyers must set and motivate their targets every year, which are discussed every six months. These targets are usually based on cost savings per project and partly come from the goals of the company. NPD buyers have different targets than regular buyers, although these are not based on NPD-related KPIs. In addition, there are opportunities for self-development within the company. Every year, a budget is made available for this. Noticeable is that the training courses are not offered based on performance but on the initiative of the employees themselves. This is then discussed with the manager to see whether the training chosen is a good fit for the employee. However, the skills training sessions are not focused on innovation.
Overall, the human resource and leadership dimension scores perfectly in stage two. The purchasing department has its own NPD purchasers, which have different targets and job profiles than regular buyers. However, targets and training of skills are predominantly cost reduction related and are not driven by innovation.

Function	Score (1-20)
Human resources and leading	**10**
Job descriptions and competencies	11.5
Personnel selection and training	8.6

Table 9: Final score of the dimension: Human resources and leading

5.1.5. The procurement department lacks innovation-related KPIs

The controlling dimension consists of three sub-dimensions; controlling systems, controlling processes & structure and risk management.
The sub-dimension of controlling systems is characterised by a lack of clear objectives

resulting from a business innovation strategy. As mentioned earlier in the process organisation dimension, there is no clear innovation strategy showing that Company X has a clear vision. As mentioned before, targets mainly result from cost reduction. The most important task of NPD buyers is therefore to keep the cost development of the bill of material as low as possible. Innovation-oriented KPIs have not been set and are not known within the company. The controlling processes and structure within the purchasing department are somewhat existent. This means that no planning and control tasks have been formulated. Within the NPD purchasing department, the manager is responsible for this and fulfils this role. However, there are project dashboards available where monthly checks are done regarding costs and the delivery of documents, such as feasibility reports. Depending on the criteria in the project dashboards, suppliers gain a different status; a red colour if agreements are not kept and improvements have to be made. A green colour when all agreements have been kept and no improvements are necessary. However, this is not a systematic approach. Innovation planning and control tasks of purchasing are not defined and thus not documented. Moreover, there is no system or process for checking the integration of a supplier, which was to be expected, as the chapter on process organisation had already concluded that no specific tool/process is available for this. Also, there are no innovation targets/KPIs involved in the sourcing cockpit of category buyers.

Risk management is centrally regulated in America. There is a supplier portal where the released suppliers are listed and orders can be reported. Furthermore, an NDA is agreed upon with each supplier to minimise the risk of knowledge leaking (from both sides). No tool has been developed for risk management in the supply chain. However, each supplier must have certifications from the first contact. In other words, the fact that every supplier must first be cleared by category managers and SQA guarantees that the supplier will be able to meet the requirements of the contract. Moreover, in co-development projects, many reports and capability analyses are made, which means that at an early stage it can be determined whether the project can proceed. Therefore, as already mentioned in Chapter 5.1.3., no special contract is made for co-development projects.

At last, Company X does not take initiative in green innovations. Sustainable development goals are not implemented in innovation projects. There is a code of conduct which must be followed, however, no link between sustainability and innovation is actively made. However, more emphasise has been placed on the ethical conduct of employees, as annual training sessions are held to ensure and improve this. By using the approved suppliers, it does mean that these suppliers have all been tested, which reduces the chance of

cooperating with an unspecified or unqualified supplier.

Overall, the controlling dimension scores below average in stage two. The top management steers for cost reduction, so the procurement department lacks innovation-related KPIs and targets. Furthermore, a systematic approach to assessing both suppliers and employees is missing. This stems from the lack of a steering function for the entire department, which in turn stems from understaffing. Risk management is ensured from the very first contact with suppliers through the necessary certifications, many analyses and the use of approved suppliers, which also minimises unethical issues with the supplier.

Function	**Score (1-20)**
Controlling	**6.5**
Controlling systems	3.9
Controlling processes and structure	6.6
Risk management	8.9

Table 10: Final score of the dimension: Controlling

6. Discussion on model evaluation, contribution and future research

6.1 The last step of the design science research approach of Peffers et al. (2007) is the evaluation of the maturity model

The evaluation phase is the last phase of the design science research framework of Peffers et al. (2007). In the evaluation phase, the developed artefact is verified based on the extent to which it supports a solution to the problem. Therefore, in this phase, the objectives of a solution are compared with the observed results and all appropriate evidence or logical proofs can be included.[202] The problem was that there was no model available that supports the assessment and evaluation of the purchasing department in terms of innovation/NPD, therefore a new artefact is developed. As part of the iterative development process, interviews were held to verify and complete the model, which is where the evaluation phase is based on. At first, interviewees were asked for the completeness, comprehensibility and usability of the model to support the assessment and evaluation of the purchasing department in terms of innovation/NPD. The participants all agreed that the maturity model is complete and therefore covers all relevant activities for the assessment. Moreover, the interviewees of the assessed company confirmed that the model is comprehensible and useable to overcome the problem that was stated in the introduction. Thus, the evaluation phase is based on the development and demonstration phase utilizing semi-structured interviews with the purchasing experts of the company. Overall, the model serves its purpose by enabling and supporting the assessment and evaluation of the purchasing department in terms of innovation/NPD.

6.2 Contribution to the theory by providing a new maturity model to support the assessment and evaluation of the purchasing department in terms of innovation/NPD

This paper aimed to contribute to the current literature in the field of innovation purchasing by providing a means, as an extension of the maturity model of Schiele (2007), to assess and evaluate the performance of a purchasing department in regards to innovation/NPD (projects). Current literature emphasises the growing importance of involving suppliers early on in development processes and the inclusion of purchasing in these processes but does not describe how this should be done. Recently, however, Schiele and Spadoto (2022) set the first step in presenting a design of a process model for innovation purchasing. In this research, a model is presented in which the steps of the purchasing year cycle were

[202] See Peffers et al. (2007), p. 54.

supplemented with innovation-oriented activities.[203] The identified gap pointed out that the literature lacks a model that enables the assessment and evaluation of the purchasing department in the area of innovation/NPD. In a similar fashion to the paper of Schiele and Spadoto (2022), this research aims to provide a first step in measuring the sophistication of a purchasing department regarding its performance in the area of innovation/NPD. To do so, the design science research framework of Peffers et al. (2007) was used to structure the creation of an artefact. The literature review provided key insights on innovation, early supplier involvement, early purchasing inclusion, and the above-mentioned innovation purchasing process of Schiele and Spadoto (2022), including organisational structure and skills of employees and relevant design principles for the development of the maturity model.[204] Furthermore, the maturity model has been verified based on input from purchasing experts of Company X. Next in the structure, the model was demonstrated at Company X. For this purpose, four interviews were conducted with purchasing experts of the NPD purchasing department of Company X, to assess and evaluate the department. This demonstration provided insights into the sophistication of the NPD purchasing department of Company X. Based on the iterative development process, the contribution of this research is presented by the first maturity model that supports the assessment and evaluation of a purchasing department in the area of innovation.

6.3 Limitations and future research with regards to the newly developed model

The study does not come without limitations. Starting with the development of the maturity model. The model is structured using the design science framework of Peffers et al. (2007) and is therefore based on a comprehensive literature review and feedback using interviews with NPD purchasing experts of Company X. Nonetheless, the model has been designed as an extension of the previous work of Schiele (2007), and therefore the same principles were followed regarding the number of maturity stages and the same dimensions that are used. However, aspects of inconsistency or incompatibility with the model cannot be ignored, as the newly developed model measures the sophistication of the purchasing department in a different subject/area. Furthermore, the model was developed in the application of Company X. For this reason, the feedback interviews were only conducted with employees of Company X's NPD purchasing department. The feedback interviews did not result in an extension of the model; however, it is possible that feedback interviews

[203] See Schiele and Spadoto (2022), p. 24-25.
[204] See Chapter 2.

with other experts could have resulted in an extension of the model, or other findings. Moreover, three out of the four assessments of the NPD purchasing department of Company X were carried out by a single researcher. A higher number of assessors would have increased reliability. Therefore, the assessed results must be viewed with restraint. Lastly, the model is not empirically tested. Therefore, it is not known what is measured. In other words, it is not clear what is achieved when a company scores high in the newly developed maturity model. However. It is assumed that high maturity is associated with better performance.[205]

Also, culture and top-management support are found to be vital drivers for innovation in purchasing. A lack of top-management support can prevent innovation in purchasing from being effectively utilized, as the review of Company X has demonstrated. How this might be improved may therefore present a challenge for future research.

As earlier mentioned, the newly developed model is the first model that supports the assessment and evaluation of innovation sophistication in a purchasing department. Thus, the model is likely to be only the first step in innovation purchasing maturity evaluation; therefore, the model should be considered and evaluated by a larger sample. The model presented here could serve to structure and guide research that will ultimately benefit companies by allowing them to better evaluate innovation within the procurement department.

[205] See Schiele (2007), p. 274.

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Appendix I: Design science research guidelines of Hevner et al. (2004)

Table 1. Design-Science Research Guidelines

Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Appendix II: Maturity model to support the assessment and evaluation of innovation purchasing

NPD purchasing maturity assessment compiled by _____, Firm _____, Date_____, not for distribution without prior consent. This document is incomplete without oral explanation.
Total result: _____
Source: based on Schiele (2007), Journal of Purchasing and Supply Management, Vol. 13 (4), p. 274-293

	Function	Questions for Analysis	% observed	points (1-20)		Stage 1 (0%-25%)	Stage 2 (26%-50%)	Stage 3 (51%-75%)	Stage 4 (76%-100%)
PL	Planning		0%	0,0					
PL1	Strategic planning		0%	0,0					
	NPD purchasing strategy	Does the organisation have an innovation strategy for purchasing? Does the NPD purchasing strategy links with the innovation strategy? Is purchasing involved in corporate innovation strategy formulation?	0%			An innovation purchasing strategy only exists informally. It is not directly linked to corporate strategy.	There is an innovation purchasing strategy, which reflects corporate priorities and supports corporate strategy. Purchasing priorities are clearly formulated. Corporate strategy is well known with purchasing. The innovation purchasing strategy is reviewed annually.	Procurement is fully embedded in the corporate strategy formulation, including an innovation strategy. NPD purchasing has a technology roadmap in place how to achieve strategic innovation targets, which are regularly measured, with tools such as a balanced scorecard. Purchasing has a clear vision on how to contribute to the competitive advantage of the firm and become preferred customer of strategic (innovative) suppliers.	Purchasing is strongly influencing corporate strategy. The clearly formulated, cross-functionally embedded measurable and controlled purchasing innovation strategy is continuously developed further in a systematic process and through benchmarks.
PL2	Demand Planning		0%	0,0					
	Process	To what degree is (innovation) purchasing involved in the project / technology planning? Is this a documented and revolving process?	0%			Technology or project planning is sporadically known to purchasing.	Dedicated innovation purchasing personnel are informed about technology or project planning. Innovation purchasing demand planning process is partly derived from corporate financial planning.	Purchasing is integrated into technology and project planning and utilises existing demand planning systems. Purchasing inclusion points are defined in the process documentation.	Early involvement of purchasing in technology and project planning is always ensured. Planning results are an integrative component of the innovation purchasing strategy.
	Assessment of Demand linked with marketing planning	Are the requirements and demand for innovation purchasing derived from the marketing planning? Is this process described?	0%			Assessment of demand in innovation purchasing is sporadically linked with marketing.	Innovation purchasing is sometimes in contact with marketing to assess the demand and requirements.	The assessment of demand in innovation purchasing is derived from marketing. Purchasing-marketing integration provide insights in the customer expectations. The process is documented.	The assessment of demand in innovation purchasing is derived through the cross-functional purchasing-marketing integration. The process is systematically derived and continuously updated.
	Assessment of Demand linked with R&D planning	Are the requirements and demand for innovation purchasing derived from the R&D planning? Is this process described?	0%			Assessment of demand in innovation purchasing is sporadically linked with R&D.	Innovation purchasing is sometimes in contact with R&D to assess the demand and requirements.	The assessment of demand in innovation purchasing is derived from R&D. cross-functional integration provides insights in development processes and R&D needs. The process is documented.	The assessment of demand in innovation purchasing is derived through the cross-functional integration with R&D. The process is systematically derived and continuously updated.

Schiele and Spadoto (2022) state that a particular challenge for the formulation of category strategies, regarding sourcing innovation, is to design the strategic approach in such a way that sufficient suppliers that can contribute to innovation are present and willing to commit resources to the innovation process of the purchasing enterprise.

Schiele and Spadoto (2022) found in a community of practice that innovation-oriented purchasing activities in the demand planning process are derived from either financial planning, marketing & sales or R&D planning.

The inclusion of marketing in the demand planning contributes to the consistency of NPD throughout the supply chain, from product specification to market launch (Gonzalez-Zapatero et al., 2016).

In innovation sourcing demand planning it is critical that sourcing understands the needs of Research & Development (R&D). Purchasing should look beyond present demands and consider opportunities that could give them a competitive advantage in the future (Legenvre & Gualandris, 2018).

PL3	Pooling Planning		0%	0,0					
	Planning	Are innovative suppliers analysed for multi-firm new product development pooling potential? How is purchasing integrated in the purchasing network of the group / resp. in case of a single location organisation: collaborating with other firms? Does this regularly happen to the innovative suppliers?	0%			Occasional analysis of resource pooling potential in innovation purchasing. Purchasing acts locally without exchange with other purchasing departments.	Resource pooling potential is occasionally analysed in innovation purchasing, remedially exchanges information with other purchasing departments. Pooling planning is based on commercial goals.	The analysis of resource pooling potential in innovation purchasing is a permanent process based on R&D and technological goals. Purchasing is an active part of the group-wide procurement network.	Purchasing is integrative part of the worldwide procurement network of the group. Cross-functional partners are involved. Decisions are made based on technology uncertainty and demand side complementarities, based on this, a different co-development approach is picked.
PL4	Environment Scan		0%	0,0					
	Process	To what degree is the purchasing department involved in the analysis of the innovative supply market? How is the process of the innovation supply market analysis described and documented? How are partner functions involved in drawing conclusions out of the analysis results?	0%			Process is described unsatisfying. Results out of the supply market analysis remains mostly at one department (purchasing or engineering).	Process is partially described. Few active exchanges with other process partners (e.g., engineering, marketing). Appropriate personnel allocated.	Process is documented and applied. Regular information exchange process with cross-functional partners (e.g., engineering, marketing).	Process is subject to regular reviews. Cross-functional acceptance and commitment. Exchange of market analysis results occur continuously and protected against non-authorised use.
	Push tools (You attend something organised by another)	Are push tools/instruments used to discover relevant innovative suppliers? e.g., supplier conversations, innovation days/fair, a web-based idea platform.	0%			Push tools to discover new innovative suppliers are sporadically used in purchasing.	Push tools to identify innovative suppliers are known to purchasing and partially set out. A regular list of tools is available.	Push tools to discover new innovative suppliers are frequently set up. Multiple tools are used and are formally described as a process.	The identification of new innovative suppliers via push tools is fully implemented in the purchasing department. It is a fully documented process which is cross-functionally agreed. Tools are continuously updated and benchmarked.
	N-tier suppliers	Does the NPD purchasing team engage with supplier further down the supplier network, in order to improve long-term performance?	0%			Hardly any engagement with n-tier suppliers	Appropriate personnel are occasionally in contact with n-tier suppliers	N-tier supplier engagement is a structured process. Actions and activities are documented and applied.	The n-tier supplier engagement is determined by cross-functional integration between purchasing and other departments (marketing, R&D). All departments work together to achieve improved long-term performance. Continuously updated.

Part of the Hesping and Schiele (2006) classical cost-oriented instruments. Highly/More applicable in category buying, also beneficial for innovation purposes.

Legenvre and Gualandris (2018) found activities in which purchasing was involved in exploring new supply opportunities.

One of the three main activities to design the strategic approach that sufficient suppliers that can contribute to innovation; the monitoring of supplier markets for innovation and the identification of company needs. This can be done through pull and push instruments, like scouting activities, supplier days, workshops and an online web interface where innovative ideas can be pitched (Schiele & Spadoto, 2022).

Legenvre and Gualandris (2018) found activities in which purchasing was involved in exploring new supply opportunities; purchasing teams engage with suppliers further down the supplier network, to improve long-term performance.

PL5	Innovation Planning		0%	0,0						
	Technology Identification	How do you keep track of technology trends? Is there a formal process of technology monitoring? Are tools used to discover new innovation and technology trends?	0%			Purchasing reactively follows procedures of process partners (e.g., Engineering, Sales, marketing)	Purchasing presents remedially information about technology trends to their process partners. Technology monitoring is part of purchaser's responsibilities, but applied in a sporadic or passive form.	Purchasing acts pro-actively following established processes. The process is documented.	Purchasing supports systematically product or technology development. Information about technology trends used by cross-functional partners. A set of tools for innovation generation is available (value engineering, functional specifications, innovation	According to Schiele (2010), technological trends can be discovered by, for example, using technology roadmaps.
	Supplier innovation process	To which degree is purchasing involved in the innovation management process? How would you describe the innovation management process in purchasing?	0%			Technology innovations comes from R&D. Process is planned. Process not known to purchasing.	Rough process of innovation management in purchasing is available. Sporadic application.	Detailed purchasing-supplier innovation process available, based on the corporate innovation process. Clear early purchasing inclusion points are implemented and applied.	Detailed purchasing-supplier innovation process available, based on the corporate innovation process. Clear early purchasing inclusion points and early supplier inclusion process is implemented and applied. Continuously updated and benchmarked.	Legenvre and Gualandris (2018) state that purchasing needs to support supplier integration. The goal is to acquire a structured innovation ecosystem in which purchasing enhances connectivity with and between internal and external partners.
	Pull tools (You organise something where others come to)	Are pull tools/instruments used to discover relevant innovative suppliers? e.g., supplier workshops, concept competition, supplier days	0%			Pull tools to discover new innovative suppliers are sporadically used in purchasing.	Pull tools to identify innovative suppliers are known to purchasing and partially set out.	Pull tools to discover new innovative suppliers are frequently set up. Multiple tools are used and are formally described as a process.	The identification of new innovative suppliers via pull tools is fully implemented in the purchasing department. It is a fully documented process which is cross-functionally agreed. Tools are continuously updated and benchmarked.	One of the three main activities to design the strategic approach that sufficient suppliers that can contribute to innovation; the monitoring of supplier markets for innovation and the identification of company needs. This can be done through pull and push instruments, like scouting activities, supplier days, workshops and an online web interface where innovative ideas can be pitched (Schiele & Spadoto, 2022).
	Start-up innovation process	To which degree is there a special innovation process for start-ups / new venture suppliers?	0%			No start-up innovation process set up.	Start-up innovation process is partially known and integrated in purchasing.	A dedicated start-up innovation process has been established, including special start-up innovation contracting.	A dedicated process for start-up identification, contracting and project embedding is established, controlled and continually improved.	Start-ups must be evaluated and aligned in the field of technological fit, strategic fit, resource & capabilities fit, and market fit (Kurpjuweit et al., 2021).
	Start-ups	How do you keep track and embed innovations generated by start-ups? Are tools used to discover new venture suppliers / start-ups?	0%			Startups are treated as normal suppliers, sporadically work with young companies.	Projects for identification of start-up ideas are organised. Start-up pitches occur.	The firm has established a regular process of start-up identification. Dedicated start-up innovation identification tools has been established.	There is a regular and global process to ensure identification of promising start-ups solutions. The firm is known in the scene for being open to collaboration. Cross-functional tools are annually reviewed and continuously updated.	Legenvre and Gualandris (2018) found that the most advanced purchasing teams work with start-ups.
	Technology Roadmaps	Do purchasers know the technology roadmap of your company and your suppliers? Is there a methodology of correlating your technology roadmaps with those of your suppliers?	0%			Own product and technology roadmaps exist and are partially known to purchasing.	Own product and technology roadmaps are known, those of strategic suppliers are partially known. Responsibilities for roadmap analysis defined.	Process of matching own product and technology roadmaps with the roadmaps of significant suppliers.	Implementation of harmonised product and technology roadmaps with selected suppliers, cross-functionally agreed. Suppliers regularly present their technology roadmaps. Purchasing part of the core team in roadmap development.	According to Schiele (2010), technology roadmaps play an important role in successful cross-functional integration between departments, as collective and cross-functional technology roadmaps usually reflect market expectations and technological trends.

OS	**Organisational Structure**		**0%**	**0,0**					
OS1	**Structure and Mandates**		**0%**	**0,0**					
	Organisational Structure	Is an innovation/NPD purchasing organisation established? Are responsibilities defined?	0%			Innovation purchasing organisation is insufficiently established. Purchasing is not the primary source of the company's innovation potential.	Innovation purchasing organisation is formally in place. Persons are dedicated to innovation purchasing. Purchasing is a source of the company's innovation potential.	Advanced sourcing organisation is established. Innovation purchasing policy is described, communicated and documented.	Advanced sourcing organisation is continuously further developed based on business strategy, benchmarks, interviews or process reviews. The advanced sourcing department oversees the overall innovation purchasing and supply function and cooperation with suppliers, ensuring that supplier performance is monitored in terms of quality and innovation.
	Mandate	Is NPD purchasing responsible for all activities involving suppliers? Do you have regulations for sanctions in case of non-compliance (maverick buying)?	0%			Innovation potential is not managed by purchasing.	Early purchasing integration sometimes initiates programs and measures for mandating innovation procurement fields. Penetration > 50%.	Purchasing early inclusion leads to complete innovation purchasing volume defined mandatorily and communicated. Penetration > 80%.	Regulations for sanctions in case of non-compliance are introduced. Early purchasing inclusion is fully embedded in innovation potential management. Penetration
	Cross-functional integration	Are interfaces towards partner functions defined? Are they cross-functionally agreed and responsibilities defined? Is (someone from) purchasing part of cross-functional innovation committee?	0%			Purchasing is sporadically involved in innovation committee.	Innovation committee interfaces are cross-functionally agreed for isolated function. Respective tasks and responsibilities at the partner functions are known. At least one purchaser involved (participates) in innovation committee (meetings).	Tasks and responsibilities are coordinated with all interfaces according to company wide defined processes, and are described in a guideline. Purchaser(s) run innovation management committee.	Purchasing drives continuous improvements in innovation. Cross-functional innovation committee is ran by purchasers to achieve cross-functional innovation targets.
OS2	**Strategic Integration**		**0%**	**0,0**					
	Board participation	Does the purchasing director take part in board meetings?	0%			Purchasing director participates occasionally in the board meetings.	Purchasing director is permanent member of the board committee.	Purchasing director is permanent member of the executive committee of the business unit.	Purchasing director is part of the firm's executive board.
	Make-or-Buy Decisions (in-outscoring decisions)	Is purchasing involved in all make-or-buy decisions? Does purchasing take part at core competency definition and strategic decisions?	0%			Purchasing is informed about procurement related aspects in make-or-buy projects. Core competencies of the business units are defined, but without purchasing involvement.	Procurement is involved in major make-or-buy decisions. Core competencies of the business unit are detailed documented and published.	Purchasing is involved in all make-or-buy decision and influences the definition of core competencies, as part of strategy definition.	Purchasing is the leading part of the make-or-buy decisions. Purchasing tasks are documented and cross-functionally accepted. Potentials for optimisation of the depth of own value added are indicated along the product life-cycle.

Luzzini and Ronchi (2011) found three different configurations of structures of the procurement department for innovation: dedicated, integrator and coordinator.

Purchasing is the only interface with the suppliers in a 'dedicated' purchasing structure (Luzzini & Ronchi, 2011).

NPD is a higly cross-functional process in which cross-functional teams must effectively manage a continuous stream of successful new products in order to stay competitive. Hence, cross-functional teams/inegration is highly important. (Nijssen et al., 2002).

NPD projects cannot begin without purchasing knowledge in an innovation-oriented culture where purchasing managers are members of the board (Schiele, 2010).
Companies collaborate with external partners, as well as outsource tasks and commodities. In other words, partnerships are established with suppliers to benefit from their technical expertise in design and manufacturing. Hence, involving suppliers early and closely in the NPD process is vital to remain competitive (Schiele, 2010).

PO	Process organisation		0%	0,0					
PO1	Sourcing Strategy		0%	0,0					
	Sourcing Strategy	Are commodity strategies formulated and is innovation included in these strategies? How is innovation included in the commodity strategies? Is it documented and known to your partner functions?	0%			Definition of a sourcing strategies is in progress. No inclusion of innovation	Systematic sourcing strategy is documented and applied for all major material and technological groups. The strategies defines amount suppliers, supply chain model, locational concept, pooling model, creation of competitive advantage. Innovation partly involved in	Sourcing strategy includes innovation and is derived out of corporate strategy, cross-functionally agreed , documented and applied.	Sourcing strategy is defined, including innovation strategy and has a project-based implementation plan, regularly updated, adjusted to corporate strategy and tied into target agreements. Key issues of the competitors' sourcing strategies are known and documented.
	Sourcing innovation tactics (lever analysis)	Are tactics applied to operationalise the innovation commodity strategies? Are there certain sets of activities used to operationalise the strategy?	0%			Tactics to operationalise sourcing strategies are sporadically used.	Tactics to operationalise sourcing strategies are in place. Appropriate personnel responsible for execution.	Annual tactics in place linking the sourcing strategy to sets of activities in order to achieve targets. Lever analysis applied, known only to the purchasing department.	Cross functional tactics applied. Sourcing strategy is operationalised through multiple cross-functional innovation levers. Annually updated and benchmarked based on evaluation
	Responsibility	Who is responsible for the selection of innovative suppliers?	0%			Purchasing is not involved in innovation supplier selection. --> There is no innovation supplier selection	Purchasing is partly involved in innovation supplier selection and supports supplier decisions.	Purchasing is process owner for the innovation supplier selection process.	Cross-functional decision-making committee (e.g., Sourcing Committee) is in charge of the innovation supplier selection
PO2	Supplier Selection		0%	0,0					
	Process documentation	Is the sourcing process documented?	0%			Approach for sourcing has not been defined or has been defined internally in purchasing	Compliance with the documented and cross-functionally accepted sourcing process.	The organisation is fully aligned to support the sourcing process, which is continuously and systematically improved.	The aligned and continually updated sourcing process systematically integrates external business knowledge.
	Process supplier selection	To what extent is the innovation supplier selection carried out? Is it systematically and according to requirements profile and selection criteria? Is the selection process well defined, logical and documented? Are supplier innovation assessment tools included?	0%			Innovation supplier selection process is not or only partially described.	Innovation selection process is defined. Innovation supplier selection occurs systematically based on requirement profiles and selection criteria.	Selection process is completely applied. Supplier decisions are traceable documented (e.g., quotation comparison sheet). Innovation suppliers are identified through innovation assessment tools.	Innovation supplier selection is based on complete application of insights and decisions throughout the company (e.g., pooling organisation, supplier evaluation results, etc.). Selection process is continuously adjusted to latest requirements of NPD (purchasing). Cross-functional innovation supplier assessment tools are implemented and
	Preferred suppliers list	Is supplier portfolio management available? Do you know the innovation potential of all the suppliers? Are suppliers classified in a portfolio, to consider innovation activities with certain suppliers? Are certain suppliers awarded with a preferred customer status?	0%			Supplier portfolio management is sporadically applied in purchasing.	The biggest suppliers are classified mostly based on price. Innovation availability and capabilities of suppliers sporadically known.	Innovation is a key consideration in supplier portfolio management. Suppliers are classified based on willingness to co-operate and innovation abilities. Portfolio management is a documented process.	Supplier portfolio management is cross-functionally set up to identify innovative suppliers and to support supplier selection decisions and take a strategic view on the (innovation) sourcing portfolio. Best suppliers are awarded with a preferred customer status. Continuously updated

A strategy is defined for each sourcing category, which reflects the objectives of the corporate budget planning and defines the reflection of this strategy in the category (Schiele, 2019).

Lever analysis by Hesping and Schiele (2016).

According to Servajean-Hilst and Calvi (2018), supplier selection takes place through a series of exchanges between R&D and the potential supplier.

Covered by Chapters 2.2.1. - 2.2.8. Highlights the most important parts of the whole process.

When identifying NPD partners, Emden, Calantone, and Droge (2006) found three phases purchasing managers go through: technological alignment, strategic alignment and relational alignment.

If a buyer is a preferred customer, the supplier will allocate resources more efficiently, therefore, it is more likely that the supplier will deploy its best staff for co-development or offer innovations that the buyer's competitors don't have (Hüttinger, Schiele & Veldman 2012).

	Negotiation	If preparing a negotiation, do you follow a uniform and systematic approach? Are decision criteria, tactics and targets agreed cross-functionally? Are the negotiations on innovation prepared differently?	0%			Less systematic negotiation preparation.	Systematically preparation approach. Negotiation targets are explicitly defined and documented electronically. Customer requirements are considered in the negotiation strategy. Sporadically differences with innovative suppliers.	Cost structures of suppliers are analysed. Procurement relevant consequences from possible negotiation results are analysed and evaluated. Negotiation targets are methodically deducted and explicitly defined. Process is described, also for innovative suppliers.	Future influencing factors on cost structure of suppliers are considered (cost reduction potentials, market prices, funding, etc.). Innovation negotiation separately prepared. In the case of awarding high-volume contracts, structured negotiation strategies are applied. Decision-making criteria are accepted cross-functionally.	Contract negotiations ensure the long-term commitment and motivation of internal and external actors by setting out their respective expectations, rights and obligations (Servajean-Hilst & Calvi, 2018).
	Contracting	Does purchasing have a role in the design of the contract with suppliers which are involved in the innovation processes? Are innovation contracts with suppliers different from 'regular' supplier contracts?	0%			There are no difference, innovation purchasing uses supplier's contracts.	Innovation contracts sporadically applied in co-development processes.	Special contracts for innovation, short / fat contract, aligned with pooling, fully under control of purchasing.	Cross-functional innovation contracts are set up based on multiple innovation contracting elements (contract details, agility, coordination and penalties). Systematically updated through benchmarking with innovative suppliers.	A crucial role of purchasing in the innovation process is the contract design with suppliers involved in co-development processes. Purchasing's role in the innovation process is to ensure professional development contracts with suppliers, including confidentiality agreements, management of intellectual property rights and assisting suppliers in managing the administrative requests of the purchasing company (schiele & Spadoto, 2022).
PO3	**Supplier Evaluation and development**		**0%**	**0,0**						
	Process	To what extent is a systematic procedure for Supplier Evaluation in place? Are innovation KPIs for suppliers part of the qualitative evaluation system? Is it a well-documented and systematic process?	0%			There is no supplier evaluation systematics in place.	Less than 60% of the purchase volume is evaluated according to applied, qualitative supplier evaluation systematics. No innovation evaluation system in place.	60 - 80% of the purchase volume is evaluated according to a applied, cross-functional supplier evaluation systematics. Supplier innovation oriented KPIs are applied.	More than 80% of the purchase volume is evaluated according to applied, cross-functional supplier evaluation systematics, including innovation evaluation.	According to Luzzini and Ronchi (2011), one of the key roles to support and enable any activity involving suppliers is performance evaluation.
	Communication with supplier	Are evaluation results communicated to suppliers? On a regular basis?	0%			Evaluation results are sporadically communicated to suppliers (e.g., during price negotiations).	Evaluated suppliers are promptly informed about the evaluation results. Results are internally recorded (e.g., central database).	Evaluation results are regularly discussed with selected suppliers within purchasing.	Evaluation results are planned and discussed with selected suppliers under involvement of cross-functional teams.	Pihlajamaa et al. (2019) mention that suppliers should be made aware of any changes in behaviour that are desired. Moreover, frequent communication and meetings with suppliers enhances supplier stimulation, which is about the buyer company's actions that aim to enhance its suppliers' innovativeness, and/or guide its suppliers' innovation processes, and/or encourage its suppliers to share their innovations (Mikkelsen & Johnsen, 2019).
	Supplier devel	To what extent is a systematic procedure for supplier development in place? Is the process described and communicated within the company?	0%			Supplier development measures are defined individually and sporadically.	A regular and systematic supplier development process is implemented.	The supplier development process is defined. Supplier development plans are derived from the supplier evaluations and are implemented.	Development process is implemented and regularly updated. Development plans are harmonised across the organisation and derived from the supplier development strategy. Communication of all results is...	According to Schiele and Spadoto (2022), the responsibility of purchasing is to collect and evaluate supplier innovation performance, gain feedback from the supplier and initiate development activities based on the feedback.
	Phase Out	How would you describe the supplier phase out process? Who decides about phase out?	0%			Suppliers will be phased out based on subjective criteria.	Responsibilities for phase out decisions are defined.	Phase out strategy exists. Process with defined criteria is described.	Consequent application of phase out strategy, cross-functionally agreed.	Nothing found on innovation-related supplier phase-out. However, based on the literature of Schiele (2007), it can be concluded that this is vital. Also, if not even more so, for innovative suppliers.

PO4	**Supplier satisfaction**		**0%**	**0,0**					
	Assessment of supplier view	What does the organisation know about the perspective of its suppliers?	0%			Little is known on the view suppliers have on the buying firm.	Supplier feedback is sporadically collected from selected key suppliers. The results are jointly assessed by the purchasing department.	There is a systematic process of assessment of supplier satisfaction. Third party involvement ensures anonymous and unbiased supplier feedback. More than 30% of all A and B suppliers regularly provide feedback.	Results of the supplier satisfaction survey is cross-functionally discussed and used as input for organisational development. The process is repeated on an annual basis. Supplementary conversations with key suppliers provide insights in improvement opportunities. More than 70% of the A and B suppliers respond.
	Preferred supplier actions	Has the company set up measures so that the suppliers regard the customer as an innovative company?	0%			Little criteria are in place that measure innovativeness of the company. Supplier satisfaction considerations hardly taken into account.	Supplier satisfaction criteria are in place with a few suppliers. These criteria measure the innovativeness of the company. Appropriate personnel allocated.	Measures of supplier satisfaction are in place. Innovativeness measurement processes are applied and documented in order to become preferred customers.	Cross-functional measures are created to become a preferred customer. The company regularly and systematically improves its standing with the supply base. Based on the ability to meet or even to exceed the expectations of the supplier. Continuously updated each cycle.
	Improvement of standing in supply market (upstream marketing)	What does the organisation do to improve its position with the supplier? Did it achieve preferred customer status with key suppliers?	0%			There are little systematic activities to improve attractiveness with suppliers.	Some activities are undertaken to improve supplier satisfaction. e.g., supplier feedback, preferred supplier lists, supplier days.	Regular and systematic activities to improve supplier satisfaction is been conducted (e.g., supplier day, supplier club). There is a process description and responsibilities are assigned. Exclusive access is sometimes granted by suppliers.	The company regularly and systematically improves activities to achieve higher customer satisfaction. With all key suppliers preferred customer status has been achieved. Purchasing contributes to the competitive
PO5	**Purchasing Early Involvement in Developme**		**0%**	**0,0**					
	Process	To what extent is there a purchasing early involvement process within product development? Does the process follow a documented path? Are tasks and responsibilities well defined within the overall process?	0%			There is no early purchasing involvement process existing. Purchasing is not considered within the product development process.	Processes of early procurement involvement are described, responsibilities are defined on a personal level.	Processes of early procurement involvement are synchronised with the product development process. Responsibilities are clearly documented. Process targets are defined and responsible persons are measured at these targets.	Product development processes are cross-functionally agreed. The new product development processes are compared and continuously improved by benchmarks of business units/other companies.
	Cross-functional integration	How is purchasing involved in the product development process?	0%			Purchasing is sometimes invited to team meetings by the engineering team.	Purchasing is integrative part of the cross-functional engineering team during the design phase.	Purchasing is integrative part of the cross-functional engineering during the concept phase.	Purchasing is actively involved in the idea phase (e.g., concept workshops) and supports product- and program planning in respect to feasibility of product ideas.
	Commercial support tools	Are tools in place to support commercial issues with the integration of suppliers?	0%			Tools to support commercial issues are rarely in place.	Commercial tools to stimulate innovation integration are described, responsibilities are defined on a personal level.	Commercial tools to stimulate innovation integration are a fully documented process. Multiple tools are integrated. e.g., total cost calculations, design to cost and cost reduction tools.	Commercial tools to stimulate and support innovation integration are cross-functionally described and developed. Multiple tools are integrated and continuously updated.

Griffin and Page (1993) mention that one of the key measurements of NPD succes is customer satisfaction. Hence it is important to know what is takes to be a good customer. There is more recent literature available on supplier satisfaction, for example by Vos, Schiele and Hüttinger (2016). However, this study is not mentioned in this research.

Pulles, Veldman, and Schiele (2014) found that being a preferred customer appears to be the best predictor of supplier innovativeness.

No literature mentioned in the research, however, taken from the model of Schiele (2007). The same principle applies as for supplier development, but reversed.

Schiele et al. (2020) state that: "(…) it is not only beneficial but clearly advised to involve purchasers early on in NPD in order to benefit from early supplier involvement. In the absence of professional purchasers, early supplier integration in NPD can even have detrimental effects."
Companies form strategic alliances with external partners and build cross-functional teams internally to achieve this.
Purchasing/sourcing is an example of a business function that can help with NPD (Nijssen et al., 2002). Emphasis on the cross-functional teams internally.
in the case of innovation projects, execution starts at the beginning of the development project, includes the ramp-up and then connects to the "normal" execution process. Here, the particular emphasis is on the management of the co-development process and the activities performed by procurement (Schiele & Spadoto, 2022).

	Standardisation	Does purchasing pursue consequently measures to reduce complexity of products, processes and sourcing procedures?	0%			Standardisation is not consequently considered within the product/project development process.	Purchasing influences consequent reduction of unnecessary complexity of components, processes and sourcing structures.	Defined standards (e.g., modules, component catalogues), suppliers per product/service resp. technologies are applied.	Concepts of standardisation (e.g., product platforms, modules) are defined cross-functionally together with purchasing. Effective enforcement mechanisms are in place.
	Material-/ Functional Release	Has purchasing any impact on material-/functional release?	0%			Purchasing remedially determines material/functional release.	Material-/functional release occurs cross-functionally by engineering, quality and purchasing.	Purchasing is integral part of material/functional release process and driver for 2nd Source.	Purchasing monitors and improves material/functional release procedure based on jointly agreed targets together with partners.
P06	**Early Supplier Involvement Process**		**0%**	**0,0**					
	Early Supplier Involvement	To what extent are suppliers incorporated into the phases of product development?	0%			Hardly any involvement of suppliers.	Suppliers provide regular, focused and comprehensible input. Preliminary value added stages are explicitly considered.	Suppliers are systematically involved following a defined process. Development capacity of the supplier (resident engineer) is used on demand.	Suppliers are integrated on the basis of total cost of ownership criteria. Simultaneous engineering/joint project management with the supplier occurs on demand.
	Supplier Integration	Does the level of supplier integration varies depending on technological centrality and product complexity?	0%			The purchasing department is hardly aware of different levels of supplier integration.	The purchasing department is aware of different levels of supplier integration based on complexity and autonomy.	The configuration of the supplier integration is a systematic process. The process results in the appropriate supplier relationship and determines the sequence in which the supplier should be involved.	The distribution of the various suppliers across the portfolio is a cross-functional systematic process which is annually analysed and, if necessary, suppliers are repositioned.
	Innovation Integration Support Tools	Are tools integrated to support the innovation processes in a cross-functional management process?	0%			The purchasing department hardly supports the innovation integration process.	Innovation integration support activities are implemented on a personal level.	Main purchasing activities to support the co-development process are documented and applied. e.g., co-ordinating supplier participation, R&D function support.	Purchasing activities that support the project execution are cross-functional integrated. The activities are annually reviewed and continuously updated.

Utterback and Abernathy (1975) describe standardisation as part of the iterative process of innovation. More recently, Schiele and Spadoto (2022) state that ensuring product standardisation is part of the procurement activities during the implementation phase of a project.

No literature used in this research. However, is based on the model of Schiele (2007) and emphasises the role of purchasing in the innovation process. Hence, found to be relevant for innovation purposes.

Hoegl and Wagner (2005) defined ESI in NPD as "the extent to which a buyer organisation shares responsibility with a supplier organisation for the development and design of the subsystems (or components) of a new product." Fundamentally, ESI is concerned with the integration of supplier capabilities into NPD projects (Dowlatshahi, 1998).

Schiele and Spadoto (2022) state that purchasing needs to support supplier integration, which relates to formulating and implementing secure supplier involvement guidelines, creating a communication interface with the supplier and coordinating development activities at the supplier (black box involvement) or with the supplier (grey box).

Schiele and Spadoto (2022) state that one part in the execution phase is about support and business integration. This is about finding a balance between supply orientation (category management) and product orientation (engineering), ensuring product standardisation, supporting commercial issues (total cost calculations, make or buy, cost-oriented design, applying cost-saving tools

PO7	**Process Involvement With Other Functions**		**0%**	**0,0**					
	Involvement Quality	Is quality management included in the supplier selection process? Do purchasing and quality department form one face to suppliers?	0%			Integration of purchasing depends on single persons. Integration occurs incidentally, criteria for integration are not existing. Quality management is subject to quality department.	Purchasing supports the quality department in quality related issues resp. supplier issues (e.g., claim and extra expenses cases). Interfaces established.	Integration and tasks of purchasing into the quality management system. Responsibilities and tasks of purchasing are clearly described. Resources with respective quality competence are existing in	Quality engineering function is established in purchasing. Suppliers are integrated into the quality management system and carries out quality improvement programs together with the quality department.	Hard to capture in one line. However, the quality criteria is referenced multiple times in the literature review, therefore this is an important issue to check for.
	Involvement Logistics and Production / targets	How and to what extent is the procurement logistics / material handling process defined?	0%			Inbound logistics processes are unstructured and not or only partially documented. Logistics targets are known to purchasing and sometimes part of supplier negotiations.	Logistics processes are structured, documented and implemented. Tasks of operative procurement are described within the logistics processes. Escalation model (e.g., trouble shooting for missing parts) is described. Logistics targets are partially known to purchasing and	Processes are regularly reviewed and improved. Purchasing is involved with all product ramp-ups and phase-outs as well as into the change management procedure. In the regular process, logistics agreements are concluded together with logistics department at substantial suppliers.	Logistic processes describe the applied sourcing models. Purchasing drives activities along the value chain and is integrated at each phase. Logistics targets are defined jointly with logistics, continuously updated and implemented.	No literature found on this topic, taken from the model of Schiele (2007). However, as mentioned multiple times, NPD is a cross-functional concept, which makes it obvious that process involvement of production and logistics is viable.
	Involvement Operative Procurement	Are agreements of strategic purchasing known by operative procurement? Is a consisted information exchange ensured between both departments?	0%			Agreements of strategic purchasing are not known to operative procurement and vice versa.	Agreements of the strategic purchasing are known to operative procurement. Information exchange between the departments is ensured.	Strategic and operative purchasing systematically exchange important subjects about suppliers (approach, agreements, problems). Agreements with suppliers are	Strategic agreements with the supplier are fully implemented by operative procurement and are complied. Topics of operative procurement are agreed with suppliers by strategic purchasing.	No literature found on this topic, taken from the model of Schiele (2007). However, as mentioned multiple times, NPD is a cross-functional concept, which makes it obvious that process involvement of operative procurement is viable.
PO8	**Electronic sourcing**		**0%**	**0,0**						
	Tool	Does the company have a tool available to support the sharing of innovations process?	0%			No tool available.	Tool is available to certain suppliers. Specific personnel responsible for application.	Tool available for all suppliers. Innovation sharing tool follows a documented process. Human interaction still needed.	Cross-functional tool supports the autonomous innovation sharing without human intervention. Advanced Artificial Intelligence is used as a self-	An online web interface where innovative ideas can be pitched (Schiele & Spadoto, 2022).
HR	**Human Resources and Leading**		**0%**	**0,0**						
HR1	**Job Descriptions and Competencies**		**0%**	0,0						
	Roles	Are key innovation purchasing functions described? How are they described?	0%			Individual innovation purchasing functions are described in general.	Substantial innovation purchasing roles are standardised described, documented and adapted to the innovation strategy. Differentiation between strategic and operative roles, as well as direct and indirect purchasing, e.g., Innovation purchaser.	Innovation purchasing roles and skills are described in detail and agreed with cross-functional partners. Descriptions of innovation purchasing roles are standardised at all sites and linked to the company-wide competence model. Differentiated on level.	Developments/tendencies of innovation job profiles are observed and forwarded for review on group level. A differentiated role profile exists, linked to distinct competences.	Stek and Schiele (2021) found three necessary skills and three sufficient skills beneficial for innovation purchasing. Hence, innovation purchasing roles need to be defined accordingly.
	Technical Competencies	Is there technical competence available in purchasing? Are designated competences available, e.g., advanced sourcing engineer?	0%			Partial existence of technical competence.	Technical competence in innovation purchasing is mostly existing, further development is planned.	Technical competence in innovation purchasing is existing. Project management competence in purchasing is sufficiently developed for efficient collaboration with project teams.	Competencies for innovation purchasing is existing and will be continuously developed, remedial and temporary introduction of special knowledge (e.g., consultants).	Grigorescu et al. (2019) found skills that enhance sustainable-oriented innovations. According to them, technical skills are the most important.
HR2	**Personnel Selection and Training**		**0%**	**0,0**						
	Selection	On which methods / systematics is the recruiting process based on? Is recruiting executed in a systematic and structured manner? Is innovation part of employee selection?	0%			Recruiting is mainly based on experience.	Recruiting is based on generally described purchasing job profiles. Innovation skills sometimes described.	Recruiting occurs methodically, structured and is aligned to the vacant purchasing function. Innovation competencies integrated in employee selection.	Recruiting occurs on the basis of a competence model. Structured interviews on the basis of standardised interview questionnaires with systematic and cross-functional analysis of	Personnel selection based on the innovation competencies of Stek and Schiele (2021).
	Target Agreements	Are targets defined on employee-level? To what extent? Do targets contain qualitative and quantitative elements? Are innovation targets part of employee target agreements?	0%			(Innovation) Target agreements on the non-managerial level is not existing. There is only case wise feedback procedure in place.	Occasional finalisation of target agreements on the non-managerial level. Innovation target agreements include qualitative and quantitative targets.	Target agreements finalised with the complete staff. Continuous support and review. Application of the available human resource instruments and regular feedback of cross-functional partners. 360° feedback is collected. Innovation target agreements documented and integrated.	Target agreements are defined with cross-functional partners, including innovation target agreements. Annual employee dialogue of all employees with purchasing department manager, based on the target agreements and the overall human resource development plan. Cross-functional, regular feedback with process partners (e.g., workshops,	Schiele and Spadoto (2022) found four groups of innovation purchasing KPIs, one of them is about the individual buyer.
	Integration and training	Are training plans available and systematically implemented?	0%			Training plans are under development, some generic training offered by standard institutions takes place.	Training plans exist for main roles (operative / strategic) and are implemented based on individual career plans, not just generic "purchasing" training. A standardised skills mapping and development scheme is implemented, including innovation skills.	Systematic integration based on training plans with defined checkpoints. Plans are available for all functions and are derived from the departmental skills development plan.	Cross-functional training plans are enhanced by target agreements. Training supports the adaptation of the purchasing function to new roles. Skills maps are continuously adjusted through internal and external benchmarks. Plan for future roles (e.g., deriving from I4.0 technologies) exists.	No literature used for this item. Taken from the model of Schiele (2007). However, the study of Stek and Schiele (2021) found innovation enhancing competencies, which must be trained if not possessed, for example. Therefore, training is vital.

CO	Controlling		0%	0,0					
CO1	Controlling System		0%	0,0					
	Target Results Definition	Are the targets for the NPD purchasing function derived from the business plan of the group? Is purchasing involved in defining innovation targets together with executive management?	0%			Innovation targets are derived isolated out of business planning targets.	Innovation targets are derived from the business planning targets under involvement of purchasing. Targets are not cross-functionally agreed.	Innovation is comprehensively involved in the target setting of the business unit planning process. Innovation targets are partially cross-functional accepted.	Purchasing is significantly involved in the innovation target setting of the business unit. Input out of procurement markets are considered in the process. Impact of purchasing targets on innovation business results are integrated in the budget and rolling forecast.
	Measurement Figures (KPIs)	Are innovation measuring parameters defined?	0%			Only limited target follow-up based on existing performance figures possible.	Substantial innovation performance figures (e.g., individual purchaser innovation targets) are implemented.	Group-wide mandatory innovation performance figures are set up through a systematic process, based on in-depth analysis. KPIs are grouped along four dimensions: the supplier, the individual buyer, the buying firm	Key innovation performance figures for all targets along the four dimensions are continuously and cross-functionally defined.
CO2	Controlling Process and Structure		0%	0,0					
	Organisational Structure and Responsibility	Is the function of planning and steering available for innovation purposes? Are innovation planning and steering tasks of purchasing clearly defined and documented? Is this linked with controlling?	0%			Planning and controlling function for innovation purchasing controlling is not existing. Tasks and responsibilities are insufficiently described.	Planning and controlling for innovation purchasing controlling is allocated to sufficient personnel.	Planning and controlling tasks of innovation tasks in purchasing are described and implemented. Tasks and responsibilities are sufficiently described and documented.	Planning and controlling tasks of innovation in purchasing are cross functionally described and implemented with defined processes. Tasks and responsibilities are described according to requirement profiles
	Support Tools Controlling Process	Are controlling processes for supplier integration supporting tools implemented? How are deviations from plan handled?	0%			Controlling processes for supplier integration supporting tools not regularly implemented.	Controlling processes for supplier integration supporting tools are regularly implemented. Necessary correction measures initiated partially.	Measurable input for supporting tools are documented and applied in the controlling process, based on activities that support co-development in project execution. Correction measures are consequently implemented.	Business results of the identified measures are annually reviewed and documented. Process is continuously updated based on commodity strategy planning and previous controlling results.
	Category Management / Sourcing cockpit	How advanced is the category management? Is there a sourcing cockpit available and what does it show? Are innovation targets involved?	0%			Category management is only performed through manual analyses and limited ERP-system usage. There is no sourcing cockpit available. No innovation included.	There is structural use of ERP-systems and limited use of EP-software to perform category management, with also a basic sourcing cockpit with few generic KPI's available which include innovation. Data can be extracted from a data warehouse.	EP-software performs a majority of category management tasks (e.g., portfolio and eCl@ss-classification) based on limited human input, automatically generates required data and autonomously gives alerts to end-users in the sourcing cockpit based on many generic KPI's. Innovation KPI's are involved.	EP-software is used to autonomously perform category management, and continuously improves itself through the use of Big Data and Artificial Intelligence, by giving strategic suggestions in the sourcing cockpit based on many specific KPI's.

Banu (2018) insists that the development of KPIs must be a systematic process that is based on in-depth analysis, consisting of the following steps: 1) define and understand project objectives, 2) define and describe project results.

Schiele and Spadoto (2022) found four groups of innovation purchasing KPIs: the suppliers, the project, the individual buyer and the buying firm.

According to Schiele and Spadoto (2022), the responsibility of purchasing is to collect and evaluate supplier innovation performance, gain feedback from the supplier and initiate development activities based on the feedback. This item checks for a dedicated person/team for the controlling task.

In row 66 the concept of support tools is brought forward. This item checks if these tools are controlled for.

Schiele and Spadoto (2022) state that a particular challenge for the formulation of category strategies, regarding sourcing innovation, is to design the strategic approach in such a way that sufficient suppliers that can contribute to innovation are present and willing to commit resources to the innovation process of the purchasing enterprise. Controls for innovation targets in the category purchasing.

CO4	**Risk Management**		**0%**	**0,0**					
	Security of data	How are data and services in digital systems protected against misuse (e.g., unauthorised access, modification, or destruction)? How is the privacy of data guaranteed (e.g., with usage analytics or confidential information)? Is there a difference in security of data in innovation projects?	0%		The firm has little knowledge on (cyber) security in innovation projects. There is no collaboration with partners to face this challenge.	The organisation sometimes takes part in meetings with partners to discuss (cyber) security in innovation projects and how to ensure protection.	(Digital) Information in innovation projects (e.g., NDAs, patents, IP security, knowledge leakage) is protected from unauthorized access, corruption, or theft throughout its entire lifecycle. The organisation regularly takes part in meetings with partners to discuss (cyber) security and how to ensure	Data and services in digital systems are strictly protected by the firm and they provide openness on how this is done. (Cyber) Safety is regularly checked by independent organisations.
	Supply chain risk management	How are risks and disruptions in the innovation process detected, mitigated and/or prevented? How does the organisation deal with the challenges of filtering the good from the bad innovations? How does this work with project risk management?	0%		There is low attention to detecting or preventing innovative ideas, with only manual analyses by R&D personnel.	There is a limited view in detecting risks and disruptions in innovation projects. The first steps for preventing and detecting are taken, with risk reviews for key suppliers.	Through the flow of information from completing studies of technological feasibility, competitor behaviour, regulatory and market demand, it is possible to detect risks and disruptions for most innovation projects in an early phase. Contracts are built on the high amount of uncertainty inherent in innovation projects, including the possibility of abandoning a project.	Possible risks and disruptions in innovation projects are detected and mitigated and/or prevented autonomously, by having integrated real-time analytics (from internal and external sources, including Blockchains) through EP-software. Risk reports are integrated in the whole EP-software suite.
	ESG/CSR risk compliance	How is compliance to supply chain human rights due diligence legislation ensured?	0%		Starting to implement ESG compliance, no inclusion of innovation goals.	Position implemented responsible for ESG compliance. Sustainable development goals are implemented in innovation projects. Regular reporting in place. Responsibilities within purchasing are clearly described and communicated to the employees. The process is handled manually.	Specially trained ESG responsible rely on regular process, cross-functionally ensuring compliance both for environmental and social legal requirements. Only innovation projects are accepted that benefit society through sustainability (green innovations). Full transparency till tier -2 and deeper in selected chains. Accounting requirements are collaboratively controlled. A dedicated risk management	Full transparency of the entire multi-tier supply chain ensured. Mechanisms for documentation, corrective action implemented and documented. Software identifies risks in advance.
		Total	0%	0,0					

Schiele and Spadoto (2022) state that purchasing's role in the innovation process is to ensure professional development contracts with suppliers, including confidentiality agreements and management of intellectual property rights

The management of technological, organisational and marketing risks are complementary and mutually reinforcing contributions to NPD's success. Unrecognised, unmanaged or unmitigated risks are among the major causes of project failure. Companies need to understand the risks inherent in certain projects so that project and risk management activities can be properly selected, planned, implemented and controlled (Mu, Peng, & Maclachlan, 2009)

Taken from the model of Schiele (2007). ESG/CSR risk compliance is vital, moreover, Porter and Kramer (2007) mention that innovation can benefit both society through sustainability and a company's competitiveness at the same time.