

Creating a performance measurement system for the purchasing department of Geurtsen

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Management Summary

In this thesis, we address the urgent need for a performance measurement system for the purchasing department of Geurtsen, an industrial SME located in Deventer. The limited functionality of the company's ERP system and an inadequate understanding of what performance indicators to track have hindered the company's knowledge of its purchasing department's performance. As the company continues to experience growth, this knowledge gap is increasingly apparent and needs immediate attention. To remedy this, a Performance Measurement System (PMS) is created, which follows the dimensions of effective performance measurement systems.

The Design Science Research Method (DSRM), which integrates mergers and acquisitions, decision support systems, and benchmarking theory, is used to attain this goal. This methodology was chosen since visualising the PMS is an IT artefact. This IT artefact can then be demonstrated and evaluated according to the DSRM. Unfortunately, the data warehouse from the purchasing department was not ready as its dataset was not transformed into usable data. Thus, an IT artefact was made using dummy data to gain better insights into how the final artefact should look.

To determine what performance indicators the company needs to track, we first investigated the theory behind PMS, specifically PMS for a Small to Medium-sized Enterprise (SME). SMEs face unique challenges in adopting a PMS, such as limited resources, lack of expertise, and resistance to change. After identifying these specific challenges, a model was created that incorporates as many dimensions of effective PMS as possible. Although some fell out of the scope of this thesis, how these dimensions can be created for Geurtsen was discussed to create an effective PMS as possible.

After this, the PMS's performance indicators were identified using performance indicators found in the literature and during focus group discussions. The stakeholders then validated these performance indicators to ensure only relevant performance indicators were included in the PMS. These performance indicators are then judged by their balance of competitive priorities.

PMS are often visualised to be able to get more out of them. A dashboard is a good fit for the company as the visual medium for the PMS. Design guidelines are found in the literature to help understand how the dashboard should be designed. These guidelines are then used to create mock-ups for the dashboard in the first cycle of the DSRM. These mock-ups gave insights into what could be improved in the next iteration of the cycle by the stakeholders. Since the data was not ready, dummy data was used to create mock-ups in powerBI, the software that the company will use to create the dashboard when the data is ready. These mock-ups gave further insight and guidelines into how the final product must be designed.

Glossary of Abbreviations

DRSM – Design Research Science Methodology

ERP – Enterprise Resource Planning

KPI – Key Performance Indicator

PMS – Performance Measurement System

SME - Small to Medium-sized Enterprise

Chapter 1 Introduction

This section introduces the reader to the nature of the company's problem. It contains an introduction to the company and the motivation for this research. The company's problem will be identified and explored, followed by an outline of the methodology used to address and solve the issue.

1.1 Company Description

Geurtsen is an industrial company specialising in building custom-made manufacturing machinery from scratch. This sets them apart from other manufacturing companies that produce products with a steady output. As a small to medium-sized enterprise (SME) employing around 200 people, Geurtsen is currently going through a growth phase, and as a result, modernising various processes has become necessary. The company is also looking to expand into new markets and innovate its products by selling machines that various manufacturers can use. Additionally, Geurtsen offers various services to its clients, including advisory services, maintenance, and services tailored to specific machines.

1.2 Research Motivation

Due to the company's growth, management wants to improve their managerial processes, especially in their purchasing department. Geurtsen uses an Enterprise Resource Planning (ERP) system like most companies. This system is used in their daily operations for various tasks. The ERP system then stores data about its operations in its database. However, the data within the database remains largely unused. The company has recently connected the ERP system database to an external database and used this database to create dashboards. Geurtsen found that using these dashboards has improved their managerial processes as their managers have a better understanding of the company's state. Following this, they desire to improve their dashboards and create them for the departments that do not have one yet. The purchasing department's management has reported a pressing need for better insight into their data, and the company wants to give their dashboard priority.

1.3 Problem Cluster

Geurtsen has indicated a need for a dashboard for their purchasing department, but their problems need to be identified. From those problems, a potential core problem needs to be identified, and a solution can be drawn up. A problem cluster will be created to map the problems and their connections since, according to Heerkens *et al.* (2017), a problem cluster maps all problems along with their connections. It brings order to the problem context and identifies the core problem.

To get a better overview of the problem and create a problem cluster, discussions were conducted with all of the purchasing department employees, and they were asked how they perceived the problem. By incorporating the different responses, a problem cluster was created, which can be seen in Figure 1.

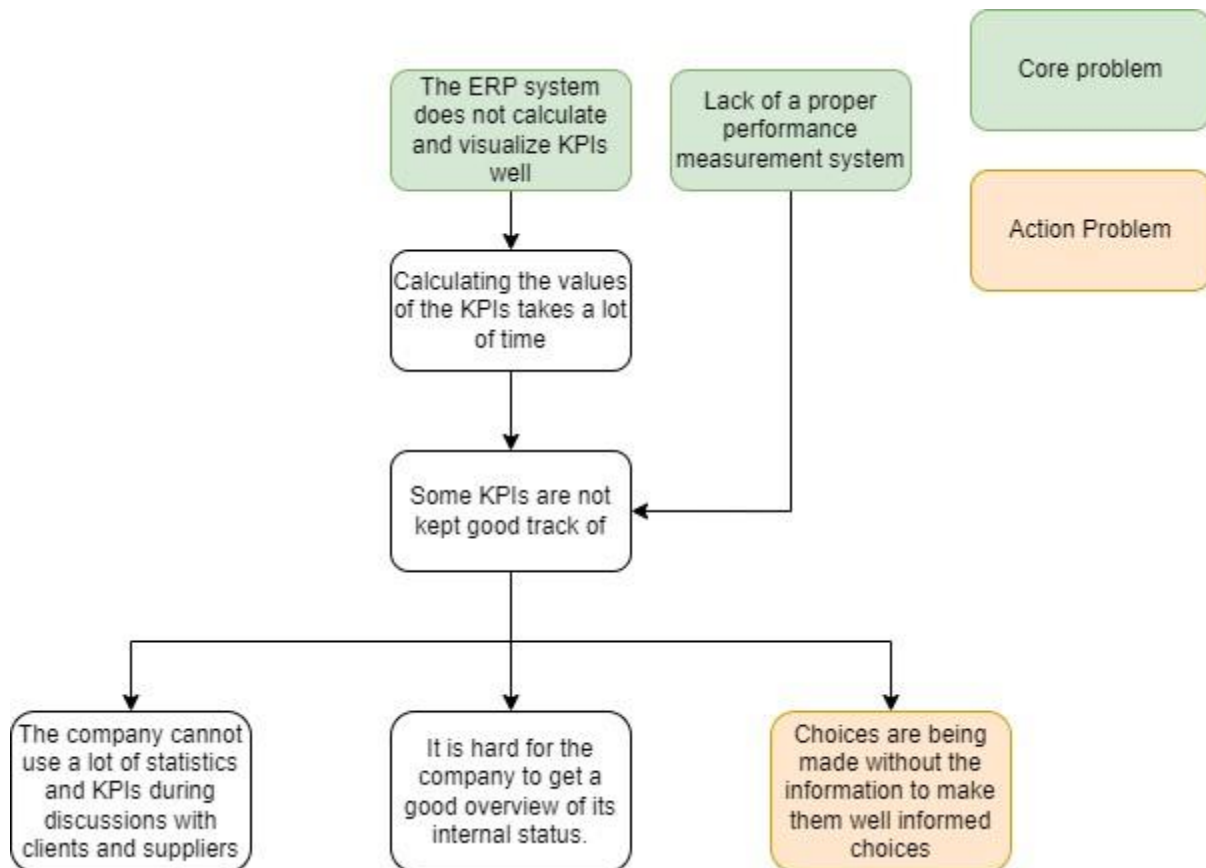


Figure 1: Problem cluster

The core problems identified are the limited functionality of their Enterprise Resource Planning (ERP) system and the lack of a proper Performance Measurement System (PMS) to guide performance reviews. The company makes use of an ERP system to do its operational activities. This ERP system stores the data of their operations. Within the ERP system, there is some functionality to process the data into Key Performance Indicators (KPI) the company wants to keep track of, but the functionality is limited. This limited functionality of the ERP system to process relevant data is the company's core problem.

Since the functionality within the ERP system is limited, when the company wants to calculate the value of a metric, it has to be done manually. This can take much time for the purchasing department's employees, especially if they have to calculate many metrics. Even worse, these metrics quickly become outdated since, after a time period, they no longer reflect the department's current performance. Because of this, calculating and keeping track of KPIs is just something they do not do enough because the time investment is often not worth it according to the company.

The company is not entirely sure what performance indicators it needs to track. According to Ismail (2017), a company's survival in the private sector depends on its ability to evaluate its current performance and identify strategies to improve the quality of planning and control decisions. Getting a good idea of what performance indicators Geurtsen needs to track is vital.

These problems result in the non-monitoring of many essential performance indicators. The company does not have a good grip on performance indicators such as supplier reliability or the number of orders placed at each supplier, creating three problems for the company. The first and most significant

of these problems is a loss of potential revenue. The company makes choices without a good overview of all relevant information. Since the company is not keeping track of performance indicators that help them make informed decisions, they often make decisions based on a "gut feeling." Even though this has proven sufficient for the company until now, it will not be in the future. Since the company is going through a period of relatively strong growth, the number of choices that need to be made is only increasing, and the "gut feeling" approach to decision-making is proving less reliable as the company gets bigger since there is a greater quantity of decisions to be made, and their scale larger. This has the consequence that the company is losing out on money that could have been made if informed choices were made. The second problem is their ability to communicate the company's state to relevant stakeholders. Since they do not track all relevant performance indicators that indicate the company's state, it is hard to indicate that state to their stakeholders. An example of this is their yearly report. The company would like to be able to include data on their yearly report that they currently cannot justify putting in the yearly report as it takes too long to calculate. This makes it harder for stakeholders to formulate a correct strategic approach for the company. The third problem is that they often do not use (visual) data during supplier meetings. As stated earlier, the purchasing department employees do not have the time to create data visualisations, as calculating the performance indicators needed for that takes too long to acquire. When talking with suppliers, they do not use this data to leverage a better position with this supplier. They, for example, cannot easily show a supplier that their reliability has decreased over the last months and correct this behaviour with a meeting with that supplier.

To solve the two core problems, the following question needs to be answered:

"How can the purchasing department of Geurtsen get a better overview of their performance indicators and what needs to be measured?."

Freeman (2010) defined stakeholders as those who can or are influenced by the company to achieve its objectives. The problem stakeholders exist at two different organisational levels. The employees of Geurtsen's purchasing department and the strategic decision-makers within the company have more managerial positions. As seen later in this thesis, there is often a divide between what both groups desire in the solution. There are currently only two employees in the purchasing department. This makes any quantitative research impossible to do, as there is not enough data. This means that any insight into the stakeholders' preferences will take a qualitative approach in the form of (focus) group discussions.

1.4 Action Problem

According to (Heerkens *et al.*, 2017)

"An action problem is a discrepancy between the norm and reality as perceived by the problem owner".

Solving the action problem requires bridging the gap between the norm and the reality of the situation. The norm is that Geurtsen and its employees have a good grip on the performance of their purchasing department and suppliers. They need to be able to find this information without spending time calculating various performance indicators and relying on a gut feeling. However, reality differs from the established norm. It is very time-consuming to gauge the purchasing department's and the company's suppliers' performance accurately. Suppose someone would like to find out about this information. In that case, they have to spend much time calculating numbers or trying to make conclusions with partial information, lowering the accuracy of the judgements that are made. They might also not be able to get a complete overview of the state of the purchasing department without

the guidance of an effective PMS. This research aims to reduce or eliminate the discrepancy between the norm and the reality. The action problem that Geurtsen has can be identified as the following:

“The purchasing department is making choices without reliable information.”

1.5 Research Methodology

The research problem falls under the research paradigm known as Design Science Research Methodology (DSRM), as an IT artefact will be introduced later in the research. To solve the research problem, the research design proposed by (Peppers *et al.*, 2007) will be used. The methodology of (Peppers *et al.*, 2007) is a commonly accepted framework for carrying out research based on various design science principles. It builds upon prior literature about design science information systems and reference disciplines and provides researchers with a mental model or template for a structure for research outputs (Peppers *et al.*, 2007).

The process divides design science research into activities that can be iterated over. The thought behind the process is that an IT artefact can never be perfect. Thus, these activities can be iterated over to improve the artefact continually. In this case, the IT artefact will be the dashboard. Figure 2 visualises the research methodology, in which one can see how the process has the possibility for iterations. Although the activities are meant to go through in sequential order, researchers are not expected to always proceed in sequential order from Activity 1 through Activity 6. They may start at almost any step and move outward (Peppers *et al.*, 2007). The sequential ordering can be seen in Figure 2. This methodology can be iterated multiple times when necessary. This does not mean the researcher has to begin at the start of activity 1; however, a more appropriate activity can be chosen. For example, the researcher might decide that the next iteration can start at the third activity to reconstruct certain parts of the IT artefact.

Several knowledge questions were created to answer the research question found in section 1.3. These questions are all part of one of the phases of the DSRM: the third phase. The exception is the last question, which seeks to evaluate designs made. This knowledge question is part of the fifth phase of the DSRM. To determine which performance indicators Geurtsen needs to track, it is important to understand the nature of PMS better, as just keeping track of some performance indicators the company finds interesting without any structure can create problems. This creates the following knowledge question:

“How should the underlying PMS of the dashboard be designed?”

The next step is the selection of the performance indicators for the PMS. Many of the company's KPIs can be found during stakeholder interviews since their desire for a dashboard comes from a need to track specific KPIs. By interviewing the stakeholders, an overview of the performance indicators can be made, but there will be performance indicators the company is unaware of. These performance indicators will be found by conducting a literature review on potential KPIs for the company. This gives the following knowledge question:

“Which performance indicators are important for Geurtsen's purchasing department?”

After finding the performance indicators, the focus is on the PMS visualisation's design, which will be a dashboard, as investigated in section 2.4. It is impractical to just put all the performance indicators on the dashboard and consider it finished. Design choices must be chosen. Finding out how it should be designed will involve first doing a literature review about how dashboards should be created. After the literature review, the wishes of the stakeholders will be very important. Geurtsen wants its dashboard to look and function in a certain way. To get a better insight into their wishes, mock-ups of

the dashboard will be created in two different design cycles. This step gives the following knowledge questions:

“How should the dashboard be designed for Geurtsen's purchasing department?”

The creation of the dashboard is outside the scope of this thesis. The company is still creating its data warehouse, and the purchasing department's data is not ready to be connected to the dashboard. Yet, we can create mock-ups based on the knowledge gained from the previous knowledge question. These mock-ups can simulate how the real dashboard can look and feel. From this insight, we can gain insight into how the stakeholders experience the IT artefact. To evaluate these mock-ups, the following knowledge question is created:

“How do the design mockups of the dashboard for Geurtsen's purchasing department align with stakeholder requirements and design guidelines found in literature, and what improvements can be found through the feedback cycles?”

By answering these knowledge questions, we can solve the core problems that the purchasing is facing.

1.6 Thesis Structure

This thesis comprises five chapters. Chapter 1 addresses problem identification and the problem-solving approach. Chapter 2 focuses on creating an effective PMS for Geurtsen. In Chapter 3, various performance indicators included in the PMS are explored, and different performance measures are proposed, validated, and explained. Chapter 4 delves into the design of a dashboard, including various design guidelines for creating mock-ups to determine the user-friendly design. These mock-ups are then evaluated in Chapter 5 through two different evaluation cycles, after which the research question is answered.

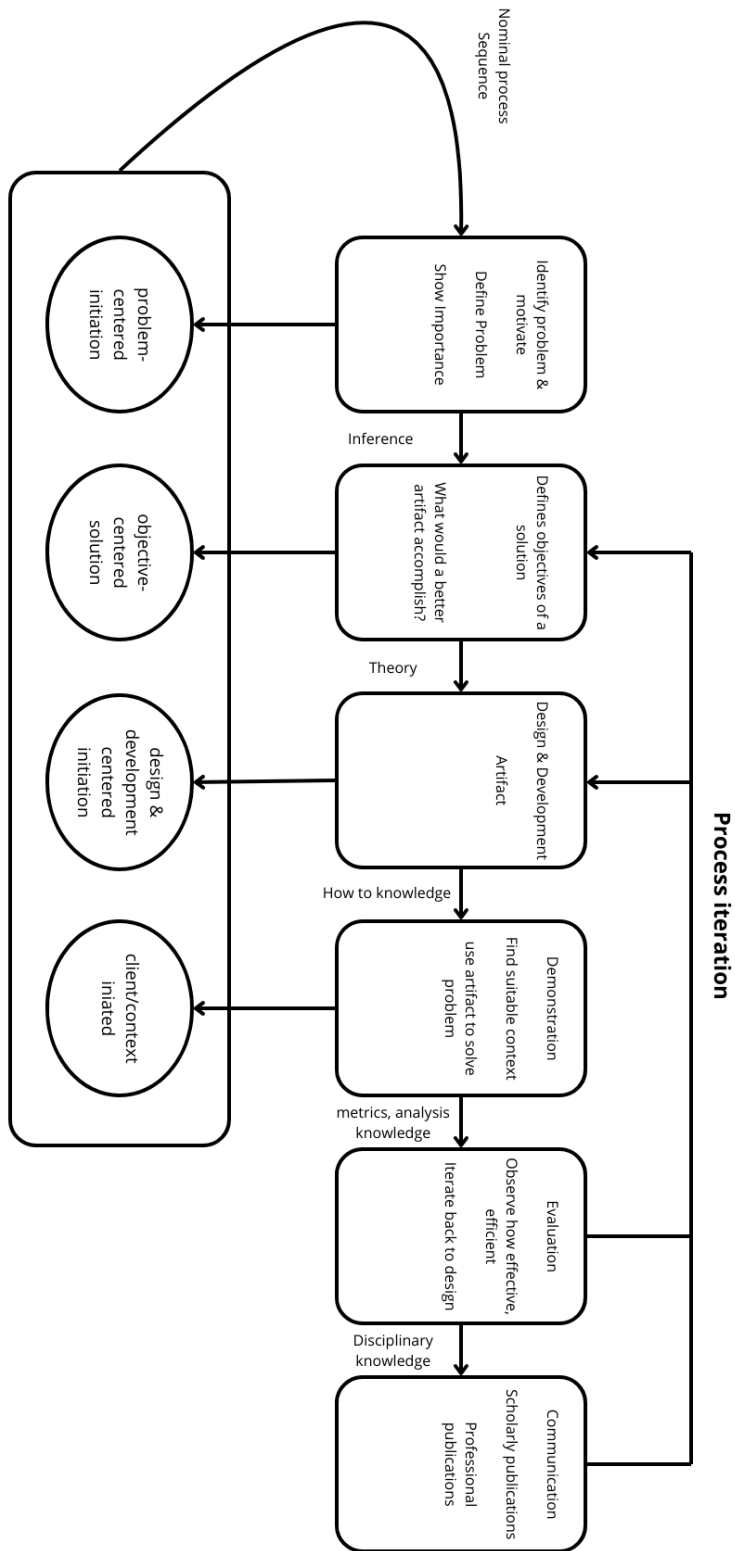


Figure 2: Design science activities (Peppers et al., 2007)

Chapter 2 Performance Measurement Systems

In this section, we will determine how to create the performance measurement system for Geurtsen. First, we will define a PMS and how it behaves in SMEs specifically. After this, the dimensions of effective PMS models are laid out and, if possible, applied to Geurtsen.

2.1 Performance Measurement Systems

2.1.1 Defining PMS

Since the company does not entirely know what performance indicators to monitor, a proper Performance Measurement System (PMS) is needed. The field of PMS literature has had a hard time defining a PMS. Franco-Santos *et al.* (2007), who provide an overview of the relevant definitions of PMS, counted 17 different definitions of PMS.

The definition used in this thesis is the one from Heinicke (2018), which defines a PMS as “a set of metrics that quantify information about the efficiency and effectiveness of actions to provide an overview of the organisational performance.” This definition from Heinicke (2018) is used as it is broad enough to cover PMS that serve different kinds of functions and allows one to draw from more literature on PMS (Heinicke, 2018).

2.1.2 Evolution of PMS

In the 1980s, traditional performance models, which were focused on financial models, received criticism as it was highlighted that the cause-effect relationships could explain the performance of the firm's operation and production function (Marchand *et al.*, 2008). Following this development, multidimensional and balanced models were created to support the development of the management of big companies (Sinclair & Zairi, 2000). Nowadays, the traditional methods of measuring a company's performance with financial performance measures have all but disappeared from larger organisations (Ismail, 2017).

2.2 Performance Measurement Systems within SMEs

Performance measurement in small and medium-sized enterprises (SMEs) presents several challenges. SMEs often struggle with dedicating time to activities that are not related to their operations, and the involvement of higher levels of management in performance measurement projects is frequently limited, making the PMS's implementation hard (Garengo *et al.*, 2005).

When SMEs create a PMS, they often do not use a predefined model like the one proposed by Kaplan and Norton (1996). This informal approach can lead to poor alignment of performance measures with the company's strategy (Garengo *et al.*, 2005). Additionally, SMEs' performance measures may focus on past activities rather than future-oriented insights, limiting their ability to support the company's forecasting (Garengo *et al.*, 2005). In addition, SMEs may not fully comprehend or appropriately implement performance measurement models when using a predefined model. They often selectively implement parts of the model without considering the proper implementation or understanding of the entire model's dimensions (Garengo *et al.*, 2005). Even when SMEs effectively implement a model, it may not align with their specific needs. For example, the Balanced Scorecard proposed by Kaplan & Norton (2016) may not always suit SMEs (Hvolby & Thorstenson, 2000; McAdam, 2000). Furthermore, SMEs tend to focus on operational and financial competitive priorities, neglecting other areas such as innovation and research and development (Garengo *et al.*, 2005). SMEs often do not create balanced models (Garengo *et al.*, 2005).

The limited number of human resources in SMEs often hinders the proper implementation of performance measurement systems, as managerial personnel may lack the necessary time and

resources for implementation (Garengo et al., 2005). SMEs often are short-term decision-makers. This can make the implementation of PMS hard because they do not have explicit strategies (Marchini, 1995). SMEs may also not fully recognise the advantages of performance measurement systems and may perceive them as obstacles to their flexibility and adaptability, which are usually an SMEs main strengths (Garengo et al., 2005)

2.3 PMS Models and Their Dimensions

2.3.1 Dimensions of a PMS Model

There exist many different effective models for PMS. These PMS are meant to be applied to a company as a whole, but much can be learned from these PMS to create a PMS for the purchasing department of Geurtsen. Garengo et al. (2005) found various dimensions characterising effective PMS models from these eight models. They are listed below.

- 1 Strategy Alignment
- 2 Strategy development
- 3 Focus on stakeholders
- 4 Balance
- 5 Dynamic adaptability
- 6 Process orientation
- 7 Depth and breadth
- 8 Causal relationships
- 9 Clarity and simplicity

To ensure that our PMS is as effective as possible, the PMS has to have as many effective PMS model dimensions identified in these PMS models as possible. Below, the dimensions are explained and applied to the PMS created for Geurtsen.

2.3.2 Strategy Alignment

A PMS must be designed and implemented in correspondence with the company's strategy to link it to the objectives of functions and its people and operational aspects (Garengo *et al.*, 2005). The lack of alignment between performance measurement and a company's strategy is one of the main obstacles to achieving the desired results of a PMS for a company (Garengo *et al.*, 2005). This is supported by other studies like Ismail (2017), who concluded that a company's strategy might also be necessary when investigating its choice of performance measures. Many PMS models investigated by Garengo (2005), such as the Balanced Scorecard (Kaplan & Norton, 1996), indicate that the PMS's strategic alignment to the company's business strategy is vital. One factor that makes it harder for an SME to create an effective PMS model is its lack of a formalised business strategy. Creating a PMS often forces the company to think about its strategy and formalise it. (Garengo *et al.*, 2005). According to Gonzalez-Benito (2007), measuring purchasing alignment to company strategy is of capital importance to assess the value of the purchasing department. Measuring this grouping of performance indicators according to competitive priorities is one of the most common ways to define business strategy (Caniatio *et al.*, 2014). To ensure that the PMS created for Geurtsen will be strategically aligned, the performance indicators will be grouped according to their competitive priorities in section 3.3.

2.3.3 Strategy Development

Another dimension of effective PMS is strategy development. A company's strategy can need to change after being exposed to changes in its internal or external environment. A PMS needs to support the company's ability to read its current situation and aid it in changing its strategy by quantifying the

effectiveness of its activities (Garengo *et al.*, 2005). It is crucial to design a PMS with the development of the system and the business strategy in mind (Bitici,1997). This could also be especially important for an SME like Geurtsen as an SME's business strategy, as stated in 2.2, is often not yet formalised. The aid of a PMS with a strong dimension in strategy development could help an SME define and evolve its strategy. As stated earlier, SMEs also exist in a more insecure environment, making their strategy development even more important. To ensure that the purchasing department's PMS has a strategy development dimension, the department needs to have objectives for its performance indicators. This will ensure that the company keeps evolving its strategy in reaction to how it has reached its objectives.

2.3.4 Focus on Stakeholders

The dimension of the focus on stakeholders has become more prevalent over the years (Garengo *et al.*, 2005). Some of the newer PMS models that Garengo *et al.* (2005) investigate focus on stakeholder needs rather than business strategy as the starting point in PMS design. An example is The Performance Prism (Neely *et al.*, 2002), which puts this dimension on a pedestal.

The focus of the stakeholder dimension of the PMS is created by involving the stakeholders in the design of the PMS. The stakeholders of Geurtsen and their desires are involved in as much of its design as possible. An example is the performance indicator validation and the design cycles with the stakeholders.

2.3.5 Balance

As stated in 2.1.2, one of the main criticisms of the PMS of the early 80s was that they were too focused on financial performance indicators. As a result, the newer PMS models became more "balanced". Garengo *et al.* (2005) define balanced models as "models that adopt different perspectives of analysis and manage them in a coordinated way." The dimension of balance is especially important for SMEs as they usually only integrate performance indicators from their operations and their finances and commonly only measure the performance of a single competitive priority (Hvolby & Thorstenson, 2000). Although these specific perspectives are important for SMEs, they need to increase and align their decision-making processes to the objectives that the company sets, which a balanced PMS could assist (Tenhunen *et al.*, 2001). The balancing of the PMS relies on whether its performance indicators are weighed accordingly (Caniato *et al.*, 2014). Section 3.3 assesses how balanced the performance indicators validated by Geurtsen are.

2.3.6 Dynamic adaptability

According to Garengo *et al.* (2005), "a PMS should include systems for reviewing measures and objectives that make it possible to adapt the PMS quickly to changes and assess a company's strategy to support continuous improvement." The author defines a dynamic system as a PMS with the following traits.

- *an internal and external monitoring system*
This will be done by ensuring that the PMS contains internal and external performance indicators, which will be contained in section 3.3.
- *a review system and internal deployment system*
The measures and objectives should decide internal objectives and priorities. The performance indicators should be revised using these new internal objectives and priorities (Garengo *et al.*, 2005). To do this, Geurtsen must have an internal PMS review system to review its targets and objectives systematically.

2.3.7 Process Orientation

According to Garengo *et al.* (2005), process management is becoming more prevalent in organisations. Process management is an approach based on a company's organisation as interconnected processes (Benner & Tushman, 2003). The performance of the company's business processes needs to be monitored as it directly influences stakeholder satisfaction (Garengo *et al.*, 2005).

For the PMS of the purchasing department, this dimension is not as important as others. The idea of process management is rooted in the perspective of the whole company, but only a PMS is currently being created for the company's purchasing department. However, the dimension of Process orientation becomes more important when creating a PMS for the whole company. Thus, when the company adopts a PMS for its company as a whole, this needs to be kept in mind.

2.3.8 Depth and Breadth

According to Garengo *et al.* (2005), the depth of a PMS is the level of detail to which performance indicators are applied, while the breadth is the scope of activities included in the PMS. Only one company department is examined for the purchasing department's PMS, meaning an in-depth PMS is being created. However, much of the literature supports a broader PMS; thus, the purchasing department's activities must be included to ensure that the PMS is also broad. This dimension is rooted in the idea that a PMS is created for the company, where it is easier to distinguish between an in-depth or a broad PMS. Thus, applying this dimension well to just the purchasing department is challenging.

2.3.9 Causal relationships

Another dimension Garengo *et al.* (2005) found was the causal relationships between results and what caused those results. According to Bitici *et al.* (2000) and Neely *et al.* (2000), a PMS needs to measure the results and the determinants of those results. Understanding the causal relationships allows periodic feedback on the performance measures within the PMS, the results of those performance measures, and incremental changes (Garengo *et al.*, 2005).

Identifying these causal relationships would help create a better PMS, but it falls outside the scope of this thesis. However, this does not mean that improving this dimension of the PMS could not be done later, as PMS improvement should be continuous according to the dynamic adaptability dimension of effective PMS (Section 2.3.6).

2.3.10 Clarity and Simplicity

If a PMS is to be correctly implemented, it should be clear and simple (Garengo *et al.*, 2005). However, ensuring this dimension is done well is difficult, as clarity and simplicity are subjective. A PMS should have a clear definition and fixed objectives that must be communicated effectively. Defining these goals for the indicators falls outside of the scope of this research but should be done by the company when adopting the PMS. The performance indicators contained in the PMS should also have a clear definition (Garengo *et al.*, 2005). This will be done in section 3.4

The measures included in the PMS should be selected with care (Garengo *et al.*, 2005). A common issue with PMS is that sometimes, too many performance indicators are tracked. According to Dickinson *et al.* (1998), the PMS contains enough performance measures when the needs of stakeholders are met, yet the PMS should not contain unnecessary measures. Ewig and Lundahl (1996) advise a maximum of 25 performance indicators for PMS, which can increase depending on the number of managers. Thus, the PMS for the purchasing department should, at most, contain 25 performance indicators as the purchasing department has one manager and should not contain any redundant performance indicators while still satisfying stakeholder needs. Satisfying stakeholder needs was also addressed in section 2.3.4. The PMS's information must be displayed in a predefined

way, which supports understanding the information (Garengo *et al.*, 2005); this will be done in section 2.4.

2.4 Visualising PMS

The potential of PMS is not often exploited in practice (Bourne *et al.*, 2005; Jääskeläinen & Roitto, 2016). One reason is that the measurement results are possibly not communicated properly (Jääskeläinen and Roitto, 2016). This problem can be addressed by using visualisation techniques such as dashboards (Jääskeläinen and Roitto, 2016; Ismail, 2017). Using dashboards can improve the understanding of larger data sets without complex quantitative methods (Jääskeläinen and Roitto, 2016). Dashboards can also help relieve the information overload created by the data from an ERP system (Yigitbasioglu, 2012). This understanding of its larger dataset has been indicated to be a problem for Geurtsen in section 1.3. As stated in section 1.3, the company's ERP system is currently unable to do this. This means that external software needs to be used to create the dashboard. Since the company is already working with a dashboard created in PowerBI, the logical choice is to use PowerBI for this. It is also not a choice that will cost the company any extra resources, which is often a problem for SMEs, as indicated in section 2.2.

2.5 Conclusion of the Chapter

We can now answer the following question posed in the research design.

“How should the underlying PMS of the dashboard be designed?”

The PMS should be designed according to the dimensions of effective PMS models identified by Garengo *et al.* (2005) while keeping the limitations of an SME in mind. To make the PMS strategically aligned, the performance indicators of the PMS should be aligned with the company's strategy. The PMS can support strategy development if it contains performance indicators that quantify the effectiveness of its activities. The PMS should have a focus on its stakeholders. This can be done by involving the stakeholders in creating the PMS and having a good overview of their wishes. The PMS can be made balanced by making sure that the PMS contains performance indicators that are spread over multiple competitive priorities. The PMS allows for dynamic adaptability if the PMS has measures that measure the company's internal and external state and if the PMS has a review system. Since the PMS is only for the purchasing department, we have a PMS that is large in depth. It should include all of the activities of the purchasing department. The causal relationship and process orientation dimensions fell out of the scope of this thesis, but in the future, these dimensions could be improved upon.

Chapter 3 (Key) Performance Indicators

At the core of a PMS lie its performance indicators; they are the foundation on which the PMS is built. The right performance indicators need to be measured to build an effective PMS. In this section, a study will be conducted on performance indicators relevant to Geurtsen.

3.1 Performance Indicators in the Literature

Although the company will have insights into what performance indicators are important for the company, there is extensive literature we can draw from to supplement the ones from the company. Baneliené (2021) explores various KPIs for industrial Small and Medium Enterprises (SMEs), how KPIs should be modelled in SMEs, and many important KPIs for SMEs found in other literature. The article also concludes that the KPIs for a company's procurement department should focus on measuring and monitoring the stock level as a continuous flow, which would secure smoothness in all company operations. Baneliené (2021) finds the stock level performance indicators to be quite important for the purchasing department of a company. However, it also places importance on performance indicators such as the quality of delivered goods and the lead time. Habibi (2019) investigates the importance of various KPIs for a construction company. Although not all KPIs apply to Geurtsen, as some are directly linked to construction, several of the KPIs it discusses could be relevant for the company. Habibi (2019) focuses more on time competitive priority, and the measures it proposes are mostly linked to this competitive priority. A performance indicator it brings forward is the slowness of decision-making, which measures the slowness in the internal decision-making process of the purchasing department. Van Den Brink (2021) is investigates possible important KPIs for a company's procurement department. The studied company resembles Geurtsen in many ways, as they are both industrial project-based companies. Van Den Brink (2021) brings forward performance indicators such as the number of suppliers the purchasing department is purchasing products from and the number of orders it has placed. Caniato *et al.* (2014) is an article that researches purchasing performance management systems. The study researches what performance measures companies from different industries make use of. The performance indicators it finds are quite numerous and coincide with many of the other articles showing that companies in various sectors use these performance indicators. Table 2 summarises the performance indicators found from these sources.

	Baneliené (2021)	Habibi <i>et al.</i> (2019)	Nabelsi (2011)	Van Den Brink(2021)	Caniato <i>et al.</i> (2014)
Quality of delivered goods	X	X	X	X	X
Order lead time	X		X	X	X
Delivery lead time	X	X		X	X
On-time delivery of goods	X			X	X
Supplier satisfaction	X				X
Stock level	X	X			X
Material problems	X				
Slowness in decision-making		X			X
Budget vs actual and saving			X		X
Number of suppliers			X		X
Number of orders			X		
Total cashflow time				X	
Order costs				X	
Cost per operation hour				X	
Total throughput time				X	X
Quality of delivery documentation				X	
Internal order processing					X
Truck Saturation					X

Table 2: Performance indicators found in the literature

3.2 Performance Indicator Validation

Each company's environment and strategy are unique. So, although these performance indicators could be useful for Geurtsen, it ultimately comes down to what they know will be useful for them to follow the performance indicators found during the literature review. Thus, the performance indicators found during the literature review were discussed during stakeholder meetings. The stakeholders were then also asked which performance indicators they had to add to the list of actually relevant performance indicators.

A performance indicator brought up during these discussions was stock level, as it is usually one of the most important performance indicators for the purchasing department, according to the literature like Baneliené (2021). Nevertheless, the stakeholders deemed it unwanted. This can be attributed to the company's nature; since it is not a regular industrial company, it does not have continuous production. Instead, the company makes custom projects for its clients. This means they create a custom design when they order a machine. These custom orders often need customised parts, meaning that the stock level is generally not very interesting when determining the department's performance.

There seems to be a divide between what the stakeholders regard as important KPIs. For the stakeholders on the operational level, the performance indicators on which they are delivered are all about suppliers. In contrast, the strategic level is more interested in the department's performance. This is expected as the different organisational levels have different goals and tasks.

Performance Indicators and Key Performance Indicators

The stakeholders think that the following performance indicators are their KPIs

- Quality of delivered goods
- On-time delivery of goods
- Order costs
- Number of (key) suppliers
- Budget vs spending

The operational side of the stakeholders has also indicated that it is vital that they also know the suppliers that are performing the best and worst regarding these performance indicators (except budget vs spend). This means that they technically indicated eight more KPIs, but for clarity, these are not listed but will be brought back later when discussing the dashboard design in section 5.2.1.

Performance indicators that were found interesting but not key are listed below.

- Number of suppliers
- Number of orders
- First time match rate
- Purchase order lines per order
- Material problems

Since we do not exceed the limit of performance indicators set in section 2.3.10, we do not have to make choices about which performance indicators to discard for our PMS.

3.3 Assessing the Alignment to Strategy

When designing a PMS, it is important to establish performance indicators that align with the company's strategy (Caniato *et al.*, 2014). According to Caniato *et al.* (2014), corporate strategy is a set of prevailing competitive priorities. They define these competitive priorities as the following: cost,

quality, time, flexibility, innovation, and sustainability. The competitive priority of sustainability encompasses both environmental sustainability and social sustainability. It is also the most recent addition to the competitive priorities as it became part of the company's agenda (Caniato *et al.*, 2014).

By tracking an adequate number of performance indicators of the competitive priorities that align with the company's strategy, we can ensure that the PMS has an adequate strategy development dimension. To do this, the competitive priorities of Geurtsen's purchasing department have to be found as to which competitive priority the validated performance indicators are linked.

By discussing this with the stakeholders, we found the competitive priorities of the purchasing department. The most important one is the quality priority. Since the company is project-based, as mentioned earlier, the company orders parts specific to a project. This means that when the quality of supplied parts is not up to their standards, it can cause significant setbacks in their planning as parts have to be reordered, causing significant disruption in the project and even causing a temporary shutdown. This means that it is vital for the purchasing department to know about their performance indicator linked to quality.

Another important competitive priority for the purchasing department is cost. In general, one of the department's main goals has always been to reduce costs as low as possible without sacrificing elsewhere (Caniato *et al.*, 2014). This is no different in Geurtsen, as reducing costs takes up much of the department's time during daily operations. The purchasing department needs to know its performance indicators linked to costs to determine its financial situation.

The last important competitive priority mentioned is time. Since the company is project-based, it often means it can only start working when the custom parts arrive. When this is delayed, it causes waves throughout the whole project and causes the company to fall behind on its projects. Thus, the purchasing department must have a good grip on its performance indicators linked to time.

These three prevailing competitive priorities are not surprising. As discussed earlier in the thesis, companies have recognised that competitive priorities other than cost are important within their PMS, which was not the case before the 1980s. Geurtsen also displays the characteristics of an SME identified in section 2.2, where an SME often neglects the competitive priorities of flexibility, sustainability, and innovation. Thus, to ensure the PMS is strategically aligned and improves the strategic development dimension, it has to include an adequate number of performance indicators linked to these competitive priorities.

According to Caniato *et al.* (2014), purchasing results depend on the internal process and the buyer-supplier relationship. This means that a PMS should have both an internal and external focus. To ensure that the PMS has this balance of internal and external focus, the PMS has to have performance indicators related to both the internal and external. This is also in line with the dynamic adaptability dimension found by Garengo *et al.* (2005). According to Garengo *et al.* (2005), a dynamic PMS has measures for both the external and internal. Caniato *et al.* (2014) have made a framework that allows the categorisations of performance indicators to ensure a balance of internal and external focussed performance indicators. These category levels are purchasing performance, internal processes, and suppliers.

The purchasing performance level is for performance indicators that describe both the purchasing department and its suppliers' actions. The internal processes level is constructed of performance indicators that say something about the purchasing department's processes itself. The supplier's level relates to performance indicators only influenced by the company's suppliers.

Thus, to ensure the PMS is strategically aligned to improve the strategic development dimension, it has to include an adequate number of performance indicators linked to these competitive priorities. It should include performance indicators at different levels to ensure that the PMS is balanced. To find out if the performance indicators validated by Geurtsen are balanced on both the competitive priorities and the different levels, each of the performance indicators was categorised. These categorised performance indicators can be found in Table 3.

Competitive priority	Cost	Quality	Time	Flexibility	Sustainability	Innovation
<i>Purchasing Performance</i>	Budget vs spending	Number of (key) suppliers Number of orders				
<i>Internal Processes</i>				Purchase order-lines per order		
<i>Suppliers</i>	Order costs	Quality of Delivered goods Material problems First-time match rate	Supplier delivery efficiency Order lead time			

Table 3: Performance indicators categorised

From the categorisation of the performance indicators, we can conclude that the company has validated a good number of performance indicators in the prevailing competitive priorities of its purchasing department. There are also many indicators at both the purchasing performance and supplier levels.

However, long-term use of this PMS state might lead to two problems. The company does not seem very interested in performance indicators at the internal processes level. This is not abnormal as the company, especially its purchasing department, is not very large. This means it is unimportant for the company to get a better insight into its internal processes. However, as the company and its purchasing department grow, it becomes increasingly problematic not to have more performance indicators at the internal processes level. This is because as the purchasing department grows, it becomes harder and harder to get a good idea of its internal processes' performance without tracking related performance indicators. The second problem that might arise in the future is the neglect of the sustainability and innovation performance indicators. As the company continues to grow, these competitive priorities can not be ignored, as innovation is essential for the long-term health of a company, and sustainability becomes a way for the company to get a competitive advantage.

For now, however, forcing the company to track performance indicators in categories it is uninterested in will only make the adoption of the PMS more difficult. Since the PMS should be continuously improved throughout the years, performance indicators linked to these categories can be added when the company feels more comfortable with them. The PMS should be aligned well enough to have good balance and strategy development dimensions.

3.4 KPI Elaboration

In this section, we will analyse the performance indicators validated by Geurtsen, focusing on the specific indicators that require formula-based calculation. We will provide corresponding formulas for each, aiming to gain a comprehensive understanding of these indicators and their calculation methods.

Number of rejected items

The number of rejected items is the number of received items rejected by Geurtsen's quality control. When this number is high, it means that the company is receiving a high volume of low-quality items. Suppliers could ship shipments with large amounts of sub-par items when this happens, and action should be taken.

Quality of delivered goods

The quality of delivered goods is the number of rejected or “low-quality items” compared to the total number of items received. It is calculated using the following formula:

$$\text{Quality of delivered goods} = \frac{\text{number of rejected items}}{\text{number of items received}} \times 100\%$$

, where the number of rejected items is the total number of items rejected during a specific timeframe, and the number of items received is the total number of items rejected during that same timeframe.

On-time delivery of goods

On-time delivery is the percentage of deliveries that arrive on time. When this is too low, it often means that a supplier is not very liable and often has delayed shipments. This can cause delays in Geurtsen's internal processes, meaning it is vital for Geurtsen to make sure that their suppliers do not have regular delays. It is calculated using the following formula:

$$\text{On time delivery of goods} = \frac{\text{number of on time orders}}{\text{number of orders received}} \times 100\%$$

, where the number of on-time orders is the total number of orders delivered on time within a specific timeframe and where the number of orders received is the total of orders received during that same timeframe.

Order lead time

The order lead time is the amount of time it takes for the order to be accepted and acted upon by a supplier after the procurement department has placed it. The longer the order lead time, the longer it takes for Geurtsen to receive the ordered items. When this is too long, it can cause delays in Geurtsen's internal processes.

Budget vs spending

The budget vs. spend performance indicator is the difference between the budget allocated to a particular project and the actual spending of the purchasing department for that project. This is important for the company, as going over the allotted budget could create financial losses. The indicator can help the department know how much they can spend and when they have to sacrifice the quality or speed of their supplier for lower prices. When the department regularly goes over the allotted budget, it could mean that the budget is too small or that the performance of the department financially needs changes.

Number of suppliers

The number of suppliers is the number of different suppliers Geurtsen has used within a specific timeframe. The company needs to know when to diversify or reduce the number of suppliers it deals with. Having too few suppliers gives the suppliers bargaining power, as they can realise their strong position, leading to higher prices. Too many suppliers can indicate a lack of focus, as building supplier relations is integral to the purchasing department.

Number of orders

The number of orders tracks how many orders the purchasing department has made within a certain timeframe. When this becomes too high, it could indicate a high workload or an inefficient ordering period. When the company orders products, it incurs various costs. When the company makes many small orders, these costs can rapidly stack up and rival the products' costs.

Order costs

The company wants to track the three costs incurred when placing an order: small order costs, packaging costs, and delivery costs. One of the purchasing department's largest responsibilities is managing costs, and these ordering costs are where they can save money. Thus, the purchasing department needs to know how much it is paying. It is calculated using the following formula:

$$\text{Total order costs} = \sum_1^i \sum_1^j \text{Order cost}$$

, where i is the total amount of suppliers, where j is the total amount of orders of that supplier, and where order cost is the ordering cost of that order j.

First-time match rate

When the purchasing department purchases something, they interchange documents with the company they buy from to ensure everything has been paid for and received. If there is a deviation between these documents, it has to be resolved by the purchasing department. The purchasing department can spend much time resolving these issues, which costs them valuable time (Procurify, 2023). The purchasing department needs to know which suppliers often have these issues and are costing their time to be able to correct their behaviour. The first-time match rate reflects the rate at which these issues occur. It is calculated using the following formula:

$$\text{First time match rate} = \frac{\text{number of matching invoices}}{\text{total number of all processed invoices}}$$

Purchase order lines per order

The purchase order lines per order track how many lines the average order within a specific timeframe contains. A line specifies the product and quantity ordered in a purchase order. When this number is small, the purchasing department makes many small-sized orders. This means that they are paying for many ordering costs. These can be prevented by combining orders together to make more efficient orders. It is calculated using the following formula:

$$\text{Purchase order lines per order} = \frac{\text{total number of purchase order lines}}{\text{number of orders}}$$

3.5 Conclusion of the Chapter

With the insight found in this chapter, we can answer the following knowledge question:

“Which performance indicators are important for Geurtsen's purchasing department?”

The following performance indicators are KPIs for the company:

- Quality of delivered goods
- On-time delivery of goods
- Order costs
- Number of (key) suppliers
- Budget vs spending

The following performance indicators are important but not necessarily KPIs for the company at the moment:

- Number of orders
- First time match rate
- Material problems
- Purchase order lines per order

These performance indicators should form the foundation of the PMS for Geurtsen. After having used these KPIs in its PMS, the company might find some of these KPIs not to be relevant or might find other KPIs that should go into the PMS. The KPIs in the PMS are always subject to change, which was discussed in section 2.3.6.

Chapter 4 Designing the Dashboard

In this section, the dashboard's design is explored. Various design philosophies and principles are explored, and choices are made. From these principles and philosophies, mockups are created and evaluated in the next chapter.

4.1 Aligning with Existing Workflows

To start the dashboard's design, the future dashboard's actual use was investigated. As stated in section 1.3, there are two different kinds of stakeholders in the problem. These two groups, the strategic and operational levels, have indicated that they will use the dashboard for different purposes. To ensure that the focus on the stakeholder dimension of an effective PMS is upheld, these uses are detailed below to allow the design to accommodate these uses.

4.1.1 Strategic usage

The strategic level of the company has indicated that they would use the dashboard for the following tasks.

- **Year-review**
Once a year, the group controller has a review with important stakeholders and employees of the company. In this yearly review, he goes over various indicators and tries to gauge the health and growth of the company. He wants to be able to use the dashboard to aid him in gauging and showing the health of the company so that he can improve the quality of the yearly review meeting. To aid this, the dashboard must graphically show important metrics. Graphs can be used to give a visual representation of the development of these metrics to the participants of these yearly review meetings. It is also important that the dashboard shows the development of the metric over the year. Just showing the current state of the metric does not suffice, as it is important that the company's performance throughout the year can be seen.
- **Monthly reports**
Once a month, the group controller makes a monthly report for various company managers. The company's performance during the last month is reported and reflected on in this report. The group controllers need the dashboard to aid them in creating a better monthly report. Like the year review, this report calls for the dashboard to show relevant metrics visually. It is also important that the dashboard shows the relevant metrics for the month and compares them to other months.
- **Check-up**
The group controller needs the dashboard to take a quick look at the current performance of the purchasing department. This makes his check-up meetings with the purchasing department employees better informed, making them more productive. To do this, many relevant metrics should be used to show the performance of the purchasing department. A visual showing if performance measures look better or worse than last month would help gauge the purchasing department's current state. Being able to choose which timeframe this metric is gauged could also give a deeper understanding of the current purchasing state. For example, a button compares the metric to last week's or month's state.
- **Gauge the state of the company**
Geurtsen is a company that goes through heavy fluctuations in the workload of its employees based on the deadlines of their projects. The group controller would like to gauge the pressure the company is under from the dashboard. This means that a measure that can gauge this measure should be able to communicate this to the user somehow. For example, when a

measure indicates that the pressure the company faces is mounting, the number could become a different colour. Another option would be to have a pressure gauge that roughly shows the pressure that the company is under. However, this might be hard to show using the performance measures of just the purchasing department, but it could be scaled down to only the purchasing department.

4.1.2 Operational usage

The company's operational level has indicated that they would use the dashboard for the following tasks:

- **Evaluating suppliers**
One of the main responsibilities of the purchasing department is to evaluate the company's suppliers. The department needs to know if its suppliers are underperforming so that it can take action. To facilitate this, the dashboard should be able to list several different measures for a single company. This means being able to drill down into performance measures to isolate companies. Another way this could be done is to have a measure that indicates which suppliers are doing the worst in certain performance measures to determine the worst offenders quickly.
- **Finding optimisation**
The company works with many different suppliers, which means that it is common for the company to receive small shipments that cost it a large amount of money. The dashboard should be able to facilitate the optimisation of these shipments by making the purchasing department aware of possible adjustments to the small shipments. This could be done by, for example, combining shipments into bigger ones. The dashboard could facilitate this by, for example, showing the quantity of items within a shipment/ weight of a shipment.
- **Gaining insight into the current state of the department**
The purchasing department wants to quickly get an insight into how the department and its suppliers are performing. The dashboard needs to be able to give this insight.

The company's envisioned dashboard aligns with Caniato *et al.* (2014) on both the strategic and operational levels. The article states that many firms in their sample stated that the motivator for developing the PMS was better controlling and monitoring overall spending and internal communication. The companies, from their cases, reported that the insight into their spending is to foster continuous improvement and gain more informed decision-making. Other cases reported that they started developing a PMS to improve the level of service the purchasing department provided for the company. Some of their cases also extended this to outside the company as the PMS could support communication with suppliers, customers, and stakeholders. These reasons can be found in the various use cases the company envisions for the dashboard.

4.2 Design Guidelines

Guidelines are needed to create the dashboard, as we need to find the best practices for dashboard design.

4.2.1 High-level Design Guidelines

According to Bach *et al.* (2023), “a dashboard should not overwhelm its users, should avoid visual clutter, should avoid poor visual design, carefully choose KPIs, should align with existing workflows, not show too much data, should provide consistency, should provide interaction affordances and manage complexity, and should organise charts symmetrically, group charts by attributes, while separating these groups of charts, and order them according to time”. To design a good dashboard, a

good balance has to be found between the visual complexity of the dashboard and information utility (Yigitbasioglu & Velcu, 2012)

According to Bach et al. (2023), dashboard design is about balancing parameters in a dashboard. The parameters, abstraction, screenspace, number of pages, and interactivity should be minimised in the design process while still conveying as much information as possible. This means that a designer should try to design a dashboard that conveys as much information as possible, with as little screen space as possible, with as little abstraction as possible, on one page, with no interaction. If possible, this would be the gold standard of dashboard design as it would show all the information needed at a glance without costly interaction. This is often not possible, and tradeoffs have to be made. The tradeoffs can be seen in Figure 3.

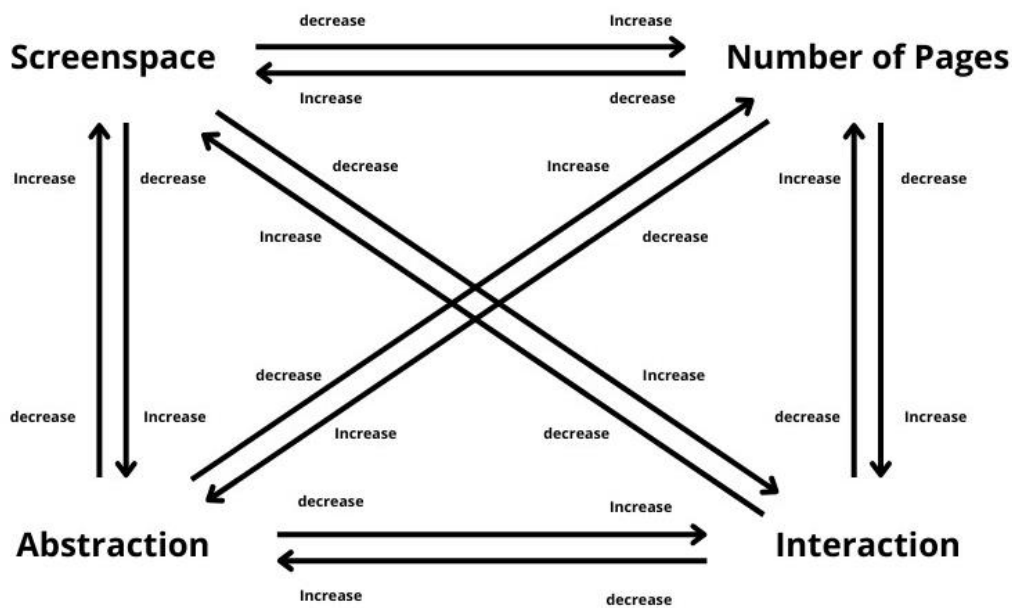


Figure 3: Design tradeoffs (Bach et al., 2023)

Adjusting one of the design parameters found by Bach et al. (2023) means it affects one or more other parameters. If, for example, we want to decrease the number of pages on the dashboard, we will have to increase the amount of screen space we use. If we want to decrease the amount of interaction on the dashboard, we must increase one of the other parameters somewhere else.

The design features on the dashboard are dependent on the purpose of the dashboard, the tasks, the knowledge, and the personality of the user of the dashboard (Yigitbasioglu & Velcu, 2012). The last point is in line with the stakeholder focus discussed in section 2.3.4. Thus, it is important that the dashboard contains a large amount of interactivity and flexibility. This offers a different visual experience for different users, accommodating users with different knowledge, purposes and personalities.

4.2.2 Low-level Design Guidelines

4.2.2.1 Layout

According to Juice (2015), there are three good ways to structure the layout of a dashboard: flow, relationships, and grouping. The flow structure tries to show how the performance indicators flow into each other using a sequence of events using charts (Juice, 2015). The relationship structure tries to

show the relationships between the performance indicators (Juice, 2015). The grouping structure puts similar performance indicators together, bringing accessibility and logic to an otherwise haphazard dashboard (Juice, 2015). Since the performance indicators do not flow well into each other, as there is no sequence of events that the performance indicators describe and do not have many relationships, it makes sense to use the grouping structure. A logical way to group the performance indicators is to use the dimensions of the performance indicator classification proposed by Caniato et al. (2014). In a dashboard used for analytics, the page should not overflow. All the data should be on the screen without the need for scrolling to improve the clarity of the dashboard (Bach, 2023).

4.2.2.2 Colour

According to Juice (2015), colour can draw the eye to what is important on a dashboard and tie together things. Colour variation should reflect value variation (Bera, 2016). The use of colour can needlessly attract the attention of viewers, causing them to search for meaning where there is none to be found (Bera, 2016). This means that colour should not be used without any purpose on the dashboard to avoid unnecessary attention attraction. If contrasting colours are unrelated to the user's task, their use distracts the end user (Bera, 2016). Colour should be on the dashboard to support Geurtsen's use cases. This means that the colour needs to support the decision-making that needs to be made based on the information the dashboard displays. The colour scheme used can evoke an emotion or feeling about the dashboard, and thought should be put into it (Juice, 2015). The colour scheme could help create a dashboard's visual identity and should converge with the company's philosophy (Martins, 2022). To align the dashboard's visual identity with the company's, we should use the company's colour scheme as the dashboard's base. We can then use contrasting colours to tell a story to the end user.

4.2.2.3 Visualisations

According to Bera (2016), bar charts are used more frequently in dashboards than any other way of visualising information. Bar charts help the end user identify trends and patterns, which helps with decision-making (Bera, 2016). Analytical dashboards, like the one for Geurtsen, use complete visualisations like bar charts, line graphs, and tables to show large data sets (Bach, 2023). Bar charts and line graphs can help identify relations (Juice, 2015), and tables can help compare two values (Martins, 2022). Alongside bar charts and line graphs, pie charts can show how the whole breaks into its constituent pieces (Juice, 2015; Sarikaya, 2018). Relative data should be used rather than absolute data in the visualisations (Garengo *et al.*, 2005).

4.3 Conclusion of the Chapter

Following the findings from the design and evaluation chapter, we can answer the following knowledge question:

“How should the dashboard be designed for Geurtsen's purchasing department?”

The dashboard should be designed with its users in mind. It should be navigated based on the different uses of the stakeholders. It should include various ways to interact with and transform the data. The visualisations on the dashboard should be appropriate for their measures to make sure they make the dashboard as clear as possible. The dashboard should make use of colour to convey the status of the performance indicators and to help the user make conclusions, and the layout of the dashboard should follow the grouping layout to help the dashboard tell a story.

Chapter 5 Evaluation

In this section, we evaluate the mock-ups created using the design principles in Chapter 4. Based on this evaluation, we create and evaluate a second set of mock-ups, which provides more insight.

5.1 First Design Cycle

The first mock-ups were discussed in two focus group discussions, one with each stakeholder group. During these meetings, the stakeholders were asked how they felt about the mock-ups and if they had any improvements they would like to see. In this section, the findings from these meetings will be discussed.

Something became very apparent from the meeting with the stakeholders and the creation of the user stories. There was a big difference in how the operational and strategic levels interact with the dashboard. The strategic level wants a better insight into the department's performance and maybe to get a small amount of insight into their biggest suppliers. They are, however, much less interested in the performance of specific suppliers. The operational layer heavily contrasts this, as one of their main goals for this dashboard is to get a better insight into their specific suppliers. They want to be able to get an insight into their best and worst-performing suppliers and to be able to dig deeper into them. This is because much of their daily work is concerned with contracting the best possible suppliers for the company and continuously improving to reduce costs and increase their suppliers' quality.

5.1.1 Layout

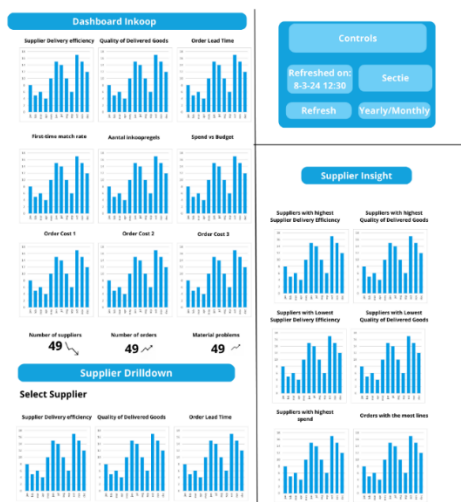


Figure 4 one page dashboard

Figure 4 revealed that mixing the performance indicators of the strategic and operational layers and their various use cases created a convoluted and unnecessarily large dashboard. Keeping this dashboard overseable will require removing various performance indicators, hampering its usefulness for all its use cases. Thus, the dashboard should be split into different pages, which is acceptable for an analytical dashboard (Bach, 2023).

The stakeholders' preferences were analysed by reviewing the dashboard overview page during the evaluation process. The dashboard's layout was also investigated, and three designs were presented. One of the designs did not categorise the performance indicators in any way but presented them in the order of importance, with the KPIs placed in easily visible spots. An example of this would be figure.

The second layout grouped the performance indicators on the competitive priorities proposed by Caniato et al. (2014). The stakeholders reacted very positively to this layout. They found that the layout made the dashboard clearer and more understandable than the ungrouped layout. This confirms the findings in the low-level design guidelines.

Designing the dashboard to have a layout where the performance indicators are grouped will aid in keeping the balance dimension of the PMS. The labels will be a visual reminder for the stakeholders of the need for balance within a PMS. Thus, when the company inevitably changes its continuous improvement effort and upholds the dynamic adaptability dimension, the labels will guide them not to upset the balance of the PMS. An example of this can be found in Figure 5, where the performance indicators are grouped according to their competitive priority.

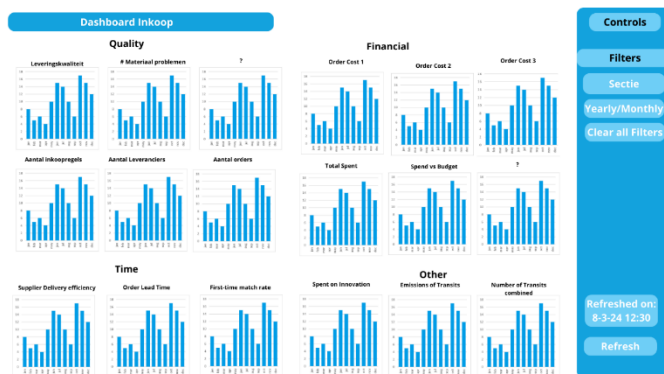


Figure 5 Dashboard with grouped structure

The last layout tested during the meeting was one where the performance indicators were grouped according to their description: purchasing performance, internal processes, and suppliers. This mockup can be found in Figure 14 in the appendix. This layout would help balance the PMS by having them think about this dimension of the performance indicators. Although this layout is probably better for the dynamic adaptability dimension of the dashboard, it was rejected during the meeting in favour of the second layout.

5.1.2 Colour

The way colour should be used in the dashboard was also a focal point during the meetings as it mostly comes down to what the end-user will prefer. Since the stakeholders indicated earlier that they would like some colour in the dashboard to help interpret it, they also indicated that the dashboard should balance colour and readability. To make it easier for the dashboard to be integrated into the company's workflow and to make it feel familiar, the base colour used for the dashboard and the graphs is the shade of blue in the company's logo.

The mockups experimented with four different possible uses of colour. These mock-ups can be found in Figures 6, 21, 22, 23, and 24. The strategic group indicated that the emotive and contrasting single-value way of using colour was preferred over the other variations. This was because it highlighted important data points within the graph while keeping it readable. The choice of the strategic stakeholder is logical, as one of the main uses of the dashboard is the creation of reports. Readers of these reports will then be quickly able to look at the most important data points on the graph while still not being overwhelmed by contrasting colours. The operational layer indicated they would like more control over the colours.

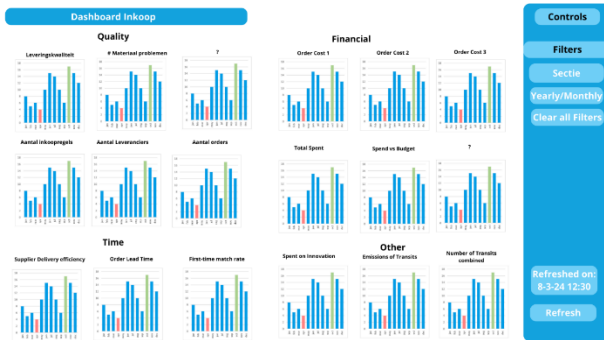


Figure 6 Dashboard with contrasting colours

5.1.3 Visual representations

The first few mock-ups shown to the stakeholders included only bar charts. The stakeholders quickly noted how these felt very chaotic to look at. Later in the discussion, more kinds of visual representation were used, such as line charts, pie charts and tables. The feedback to these was very positive as the stakeholders found the dashboard much easier to look at, especially when the mock-ups had a mix of different visual representations and added more colour. In Figure 7, you can see a mock-up using visualisations different from bar charts. Figure 8 shows a mock-up that has a lot of different visualisations.



Figure 7 Dashboard using both line and bar charts

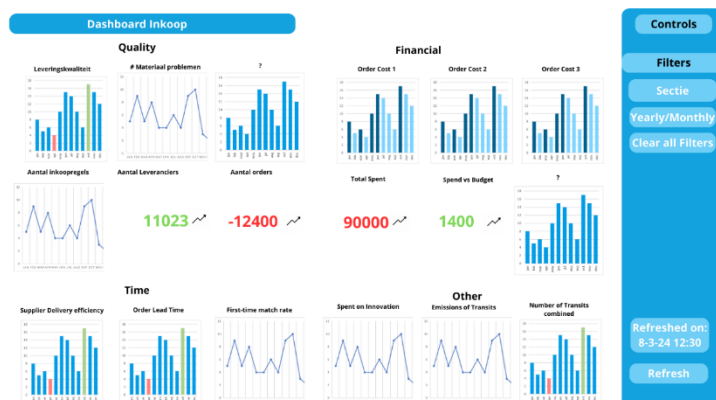


Figure 8 Dashboard with contrasting colours and different visualisations

During the discussion came the topic of the number of performance indicators on the dashboard. The mock-ups included most of the performance indicators that Geurtsen verified they were interested in checking. During the discussion, the number of performance indicators was said to be good. They were not too much. This is not that unexpected, as the dashboard has three different pages with different KPIs. Suppose these were all going to be on one page. In that case, there might have been too many performance indicators on the dashboard, which would then have warranted the need to select which performance indicators go on the dashboard. However, the stakeholders reacted positively to the use of multiple pages for the dashboard, meaning that it is unnecessary to select which performance indicators should go on the dashboard.

5.1.4 Conclusion of the first design cycle

There is a heavy emphasis on the variation in visual representation as the stakeholders indicated a greater clarity of the dashboard using around three or four different visual representations. Thus, more attention will be given to this aspect of the dashboard mock-ups in the next iteration. Colour can be used somewhat, especially when multiple visual representations are introduced, but should be subtle. The performance indicators will be grouped according to their competitive priorities for the layout.

5.2 Second Design Cycle

Geurtsen already has a few dashboards in use. These dashboards were made using PowerBI software, and the purchasing department dashboard will also be made using this software. Thus, to get closer to what the end result will look like, the mock-ups of the second design cycle were made in powerBI. The second mock-ups were discussed in one focus group discussion with both groups of stakeholders. In this section, the findings from this meeting will be discussed.

5.2.1 Layout

Following the results of the first design cycle, the performance indicators were again grouped based on their competitive priorities, which the stakeholders reacted to positively. During the first design cycle, the stakeholders asked for the possibility of filtering the data using several parameters, such as data and suppliers. This is easily possible in powerBI using its slicers. In powerBI, it is possible to switch the graph axis. A wish that the stakeholders had was to switch the graph to a quarterly and monthly view from a yearly one. However, this makes the graphs take up much space in powerBI. The mock-ups from the first design cycle were not perceived as overwhelming in their amount of performance indicators. However, when that mock-up was translated into powerBI, the number of performance indicators became a problem.

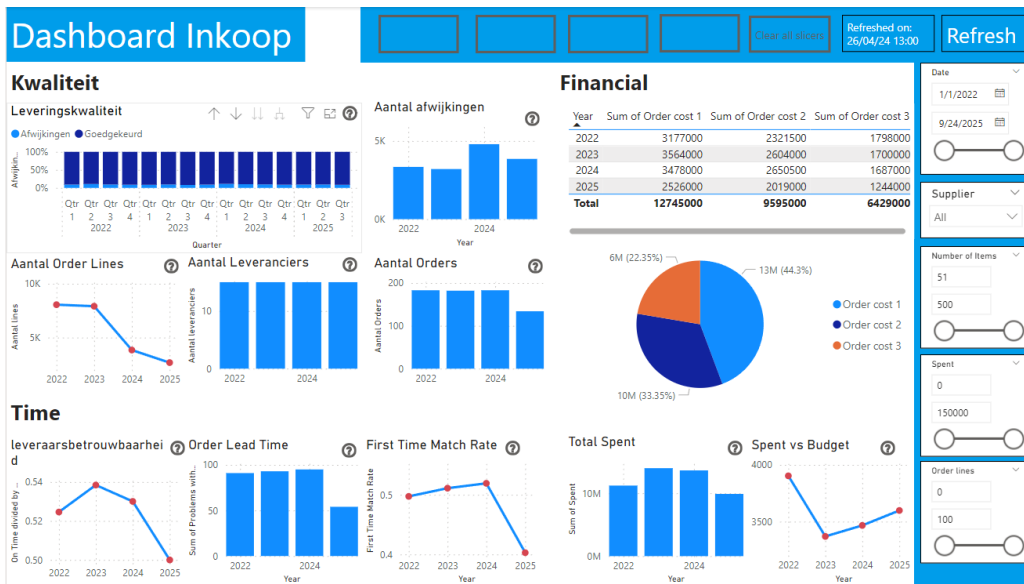


Figure 9: dashboard mock-up

This meant that the dashboard should be split into several pages. After a discussion, the following pages were thought to be good to have: a page for the KPIs found in section 3.2, a page going deeper into the quality performance indicators, a page going deeper into the time/financial performance indicators, a page that is used during supplier meetings, and lastly a page showing supplier outliers. Juice (2015) supports the idea of having one single page for KPIs. They write, “Keep critical information on the front page and suppress ancillary information” (Juice, 2015). Figure 10 displays how a page for the department's quality performance indicators could look. Mock-ups for the other pages can be found in Appendix B.

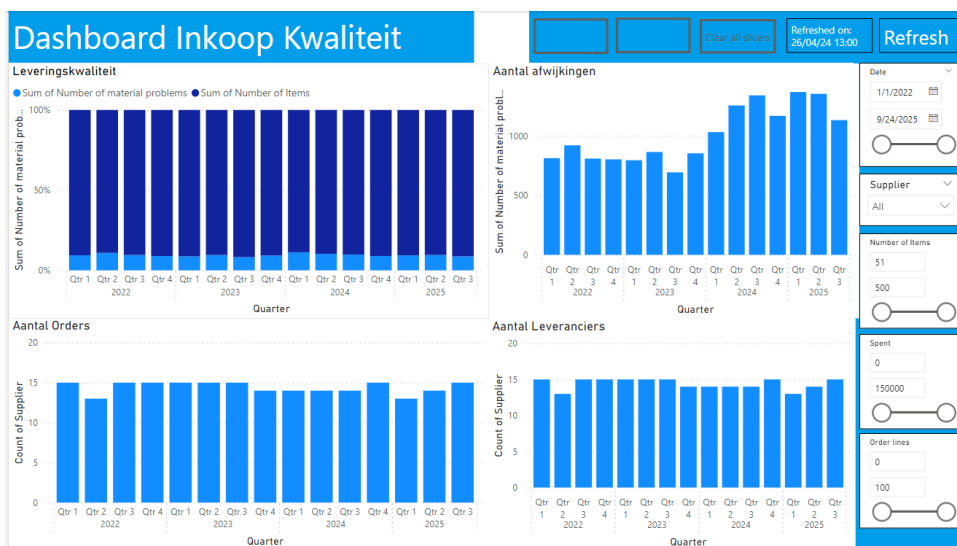


Figure 10: Page showing quality performance indicators

5.2.2 Colour

powerBI is quite limited in its ability to change the colour of bars automatically. This means that the outlier approach of the first mock-ups is impossible in powerBI. Instead, colour was used relatively conservatively, only to draw the eye to data points and to show the difference in data. The stakeholders found the colours to be easier to look at.

A feature within powerBI is adding static lines to line graphs. An example of this can be seen in Figure 10. They could help conclude when a supplier is performing inadequately as they can indicate when a supplier goes below the company's standard. It also encourages Geurtsen to set and adjust the targets for its performance indicators, improving the PMS's strategy development dimension. The stakeholders confirmed that this was desired. However, not all performance indicators require such a line, as it does increase the visual clutter of the dashboard and can make it more overwhelming. In the end, the ones that need it will be the ones that Geurtsen wants to keep a closer eye on.

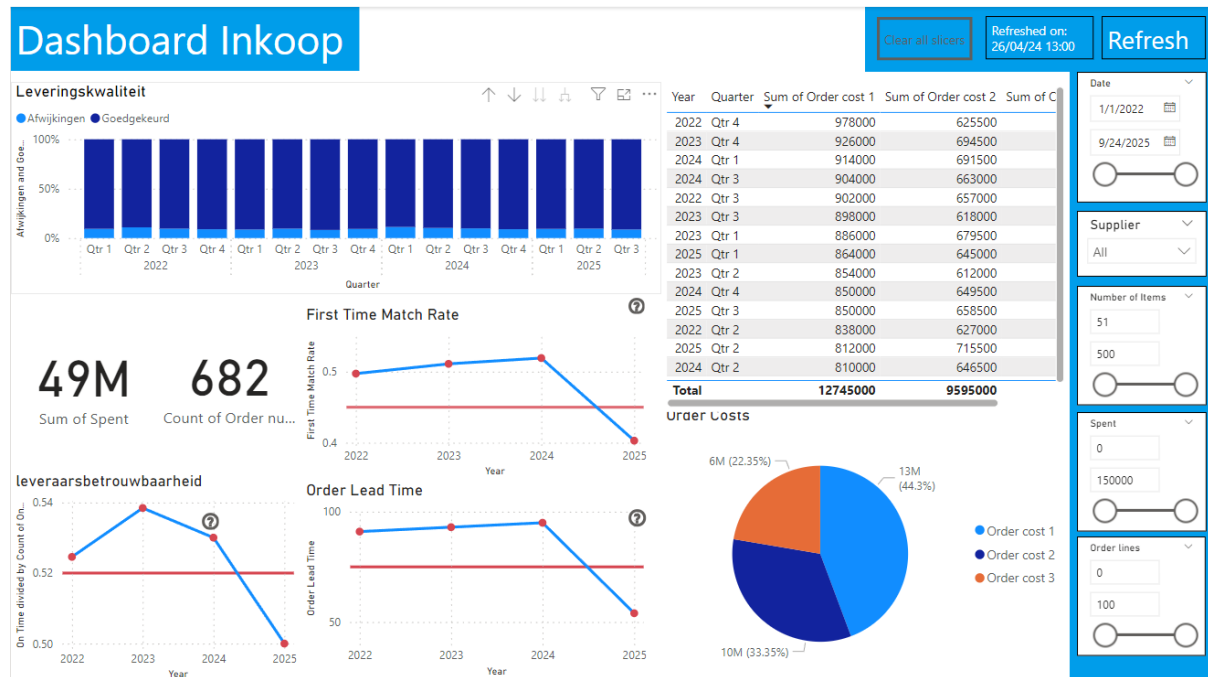


Figure 11: Dashboard with static lines

5.2.3 Visualisations

The mock-ups included various different visualisations. The stakeholders found the mock-ups with different visualisations much less overwhelming. They also found the choices for which performance indicator each of its visualisations is good, but they also noted that they think they are subject to change with use. The use of a scatterplot to find outliers was also thought to be a good future addition. The scatterplot could aid in finding which suppliers fall out of the boat in certain performance indicators, as it is very easy to see the outliers with the naked eye in a scatterplot.

5.2.4 Conclusions from the second design cycle

The main findings from the second design cycle were the following. The dashboard should have multiple pages for different purposes. Although some early designs were made, they could be more explored. Using different visualisations is good as it makes the dashboard less overwhelming for the user. The use of scatterplots could be investigated as it could help find outliers.

5.3 Conclusions from the Design Guidelines and the Mock-ups

Following the findings from the evaluation chapter, we can answer the following knowledge question:

“How do the design mockups of the dashboard for Geurtsen's purchasing department align with stakeholder requirements and design guidelines found in literature, and what improvements can be found through the feedback cycles?”

The design mock-ups align quite well with the stakeholder requirements. The mock-ups demonstrated that the layout proposed by the literature seemed natural to the end users. The idea of colour being used to help reach conclusions was also reacted to positively by the stakeholders. They also expressed the same concerns as the literature with the use of colours, as they felt it could quickly become too overwhelming. Some improvements for future design cycles would be the inclusion of more varied visualisations such as the scatterplot. The interactivity feature of drill-down should also be explored better in future design cycles as it was not explored in the design cycles.

Conclusion

Since we have answered each of the knowledge questions, we can answer the core research question:

“How can the purchasing department of Geurtsen get a better overview of their performance indicators and what should be measured.”

To better understand their performance indicators, Geurtsen needs to create an effective PMS and clear visualisation of the PMS. The PMS needs to be constructed according to the dimensions of effective PMS models. Firstly, the performance indicators included in the PMS must be strategically aligned with the company’s strategy. These measures need to quantify the effectiveness of the company’s activities. These measures must also encompass the company’s internal and external activities. It is also vital that the stakeholders of the PMS are involved in its creation process, and their unique needs must be considered while designing the PMS. The PMS needs to have a review system in place to ensure that the PMS is still adequate in reflecting the current state of the purchasing department. From the focus group discussion with the stakeholders and the literature, several performance indicators were found that could serve as a good foundation for PMS performance indicators. The stakeholders validated the following performance indicators to be interested in:

- Quality of delivered goods
- On-time delivery of goods
- Order costs
- Number of (key) suppliers
- Budget vs spending
- Number of orders
- First time match rate
- Material problems
- Purchase order lines per order

The PMS also needs visualisations that will give a better overview, which can be done by creating a dashboard. This dashboard needs to be designed with the end-users experience in mind, and their wishes need to be kept in mind while creating it. The following insights into how the dashboard must be made were found from the evaluation. The dashboard needs various ways to interact with and transform the data. The visualisations that are present on the dashboard must be varied and need to be appropriate for the performance indicator it is visualising. This is to make the dashboard as engaging and clear as possible. The colours on the dashboard need to be chosen carefully, and they need to help the user conclude the data. This can be done by using contrasting colours to point out outliers. Another option to help the user make conclusions about the data is to have visual bars that can indicate the goals for each performance measure, which will help set objectives for the performance indicators as well as help in finding problems in performance. The performance indicators on the dashboard need to be put on the dashboard in a layout that has thought behind it. For the performance indicators of the purchasing department, a grouping layout is a good idea as it helps in creating a story.

This thesis has added to the knowledge base by applying much of the theory surrounding PMS for SMEs. Dimensions of effect PMS models have been applied to create a PMS for a manufacturing company. This can be used by similar companies looking to create a PMS for their purchasing department. The thesis also provides several performance indicators similar companies and departments could use to measure their performance. The thesis also applied design guidelines to create mock-ups. The mock-up findings can help other companies create their own dashboards.

Limitations

The research done in this thesis was not without its limitations, however. For example, not all the dimensions of effective PMS were constructed. The process orientation and causal relationship dimensions were neglected due to the time available for the thesis. Thus, it could be argued that the PMS guidelines are not complete. Much of this thesis's research has nothing to do with an IT artefact, yet the research design chosen was the DSRM. Thus, although the DSRM was a good choice for the research design while creating and evaluating the dashboard, another approach could have maybe fit better while researching PMS and its performance indicators.

Since the purchasing department's data warehouse was not ready to be used to create a dashboard at this time, the actual dashboard could look quite different. The data warehouse could not have the data to calculate some measures. Although the measures validated by the company and the data they require are not very complicated, this should not be a problem to add in the future. However, this does mean the thesis has the assumption that the performance indicators proposed are calculable with the data in the data warehouse.

A significant limitation during the design process was the size of the purchasing department. Since the department consists of only two people at the moment, there were not a lot of different perspectives in the focus group discussions. Since these employees of the companies evaluated the mock-ups and their perspectives weigh heavily in the findings from the iterations, they are subjective. If these employees were to be replaced, or if others were hired into the department, these new employees could have a different perspective on how the dashboard should be designed. Another problem with the small size of the purchasing department was that getting any quantitative data was useless as there would be just not enough input. This resulted in the thesis relying on qualitative data gathered during focus group discussions.

Future Work

More research could improve the PMS and its visualisation. Firstly, Geurtsen can do more research into the two unapplied dimensions of an effective PMS model. Although the process orientation dimension needs to be researched company-wide, the causal relationship dimension could be researched for the purchasing department's PMS. Also, more research could be done to find more performance indicators that could reflect the department's performance, as currently, there is not a very large number of performance indicators included in the PMS. There is also some research surrounding what visualisations specifically fit and what performance measures are needed. In the future, each performance indicator could be visualised systematically rather than as what the stakeholders experienced as appropriate.

Recommendations to the Company

- Make a proper review system of the PMS

One of the dimensions of an effective PMS model is the dynamic adaptability dimension. To make sure that this dimension is part of the PMS model, Geurtsen needs to set up a proper review system for their PMS. The PMS must be reviewed periodically by the relevant stakeholders to judge if any changes need to be made. This needs to be a periodic activity, such as every six months or every year. In this review, the stakeholders need to determine how well the current performance indicators included in the PMS reflect the department's performance. When changes are made to the PMS, they need to be made with respect to the dimensions of effective PMS models. One of the changes that can be made in the future is to include more diverse performance indicators from different competitive priorities, as they are currently quite concentrated in three of the competitive priorities. This review system

needs to include the performance indicator contained within the PMS and the dashboard design, as the visualisation of the PMS is a large part of how the stakeholders interact with the PMS. Also, ensuring that the dashboard is integrated well into the purchasing department's workflow is necessary to ensure that the PMS offers information that is used in its operations.

- Create the dashboard

To keep the research in this thesis as accurate as possible, the dashboard should be created as soon as possible. This will allow the purchasing department to start working with the PMS and its visualisations. Although the structure of the PMS was created in this thesis, the final visualisation was not. This means that if Geurtsen wants to solve the core problems that the purchasing department is experiencing and to bring the norm and reality closer, they will have to create the visualisation of the PMS. This should be done sooner rather than later, as the longer it takes for the PMS to be used, the larger the chance becomes that the PMS structure created in this thesis will become worse at reflecting the current state of the purchasing department. The dashboard's design can follow the mock-up findings and should follow the design guidelines found in Chapter 4.

- Make a larger PMS

Although the purchasing department has the foundation for its PMS, a logical next step would be to make a PMS for the whole company. Although the company has already taken steps to make dashboards and find KPIs for the rest of its departments, these PMS need to follow the dimensions of effective PMS as was done for the PMS of the purchasing department. Doing this would make the performance measurement within the company as effective as it can be, especially as the company grows larger.

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Appendix A Other mockups used during the first design cycle

Mockups that showed different layouts

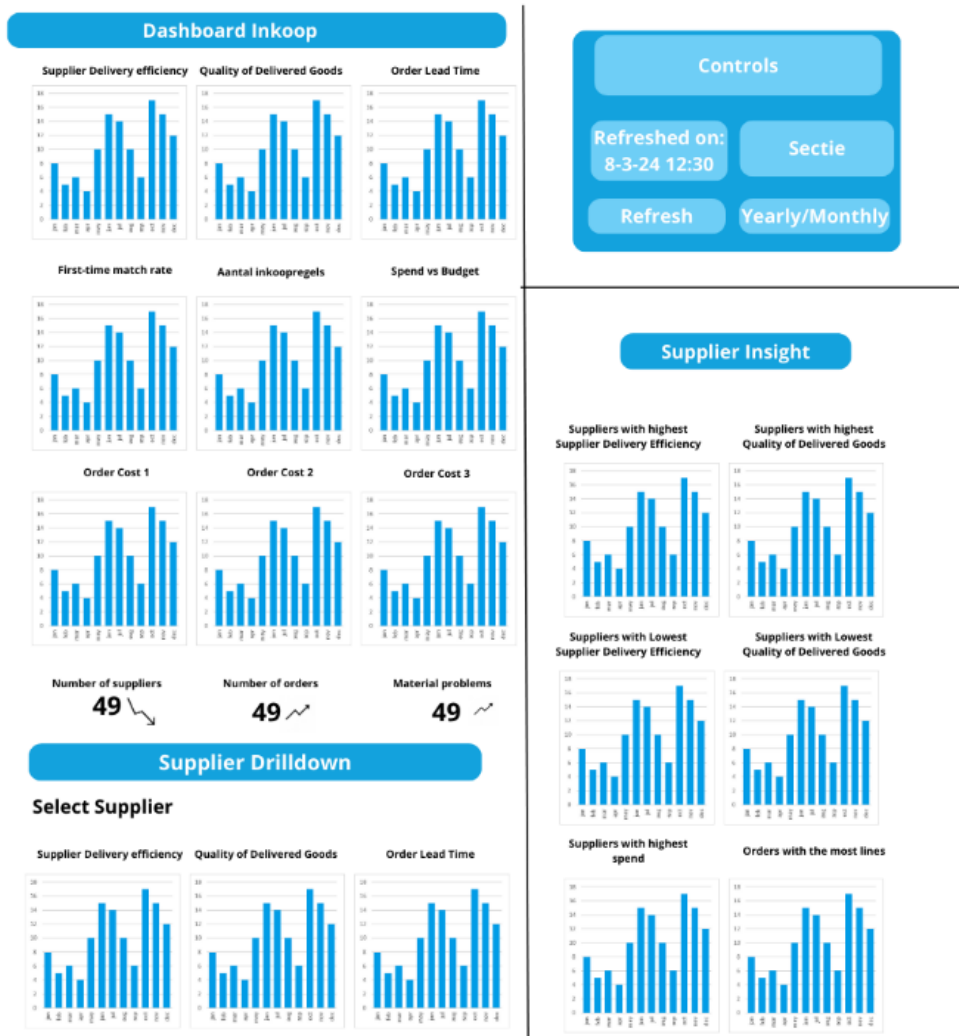


Figure 12: Full dashboard

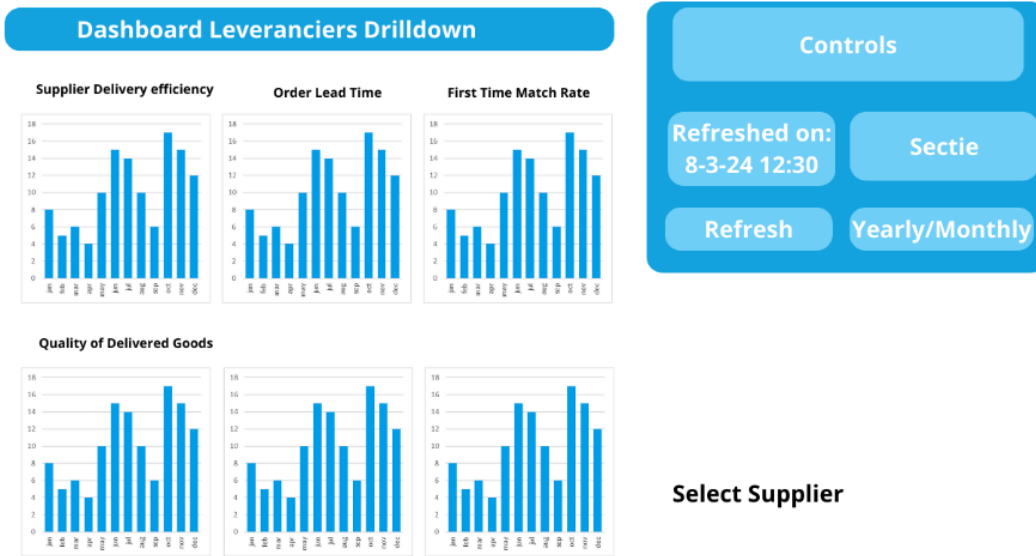


Figure 13: Supplier Drilldown

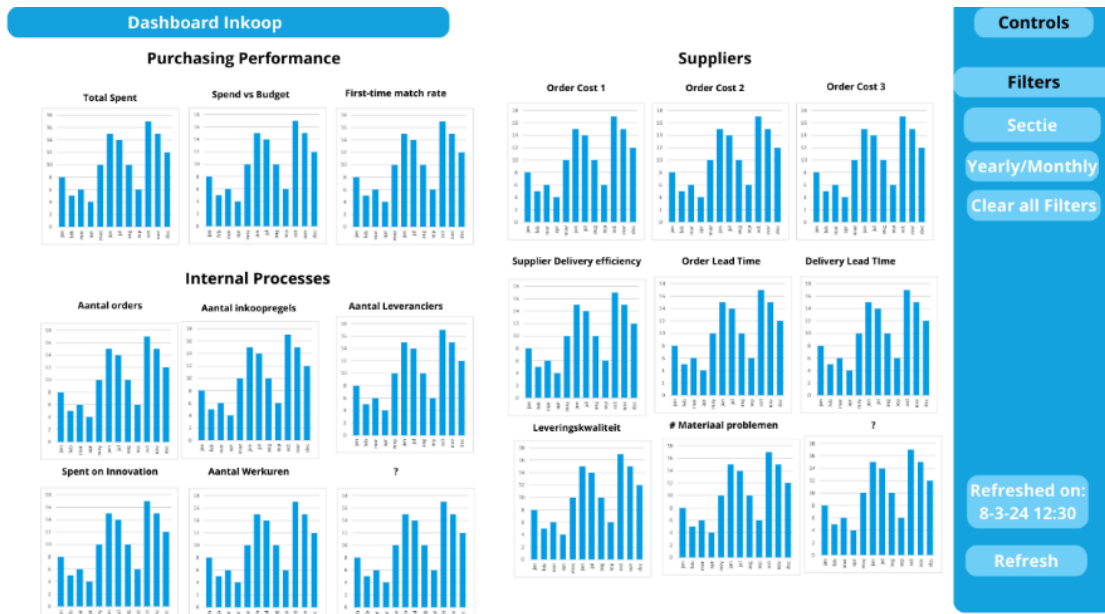


Figure 14 Grouped by Level

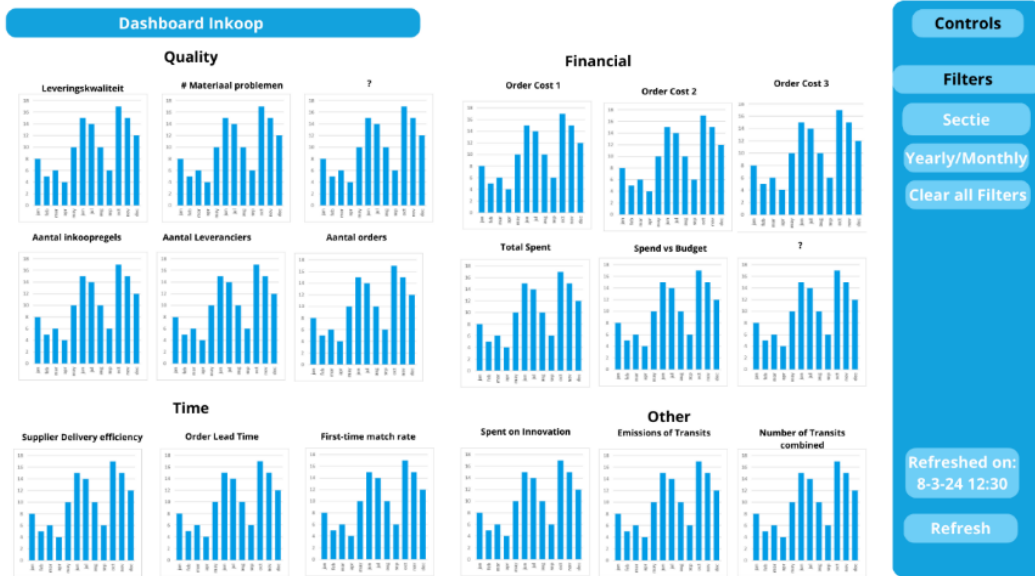


Figure 15: Grouped by competitive priority



Figure 16: Grouped by competitive priority and lines



Figure 17: Dashboard with fewer KPI

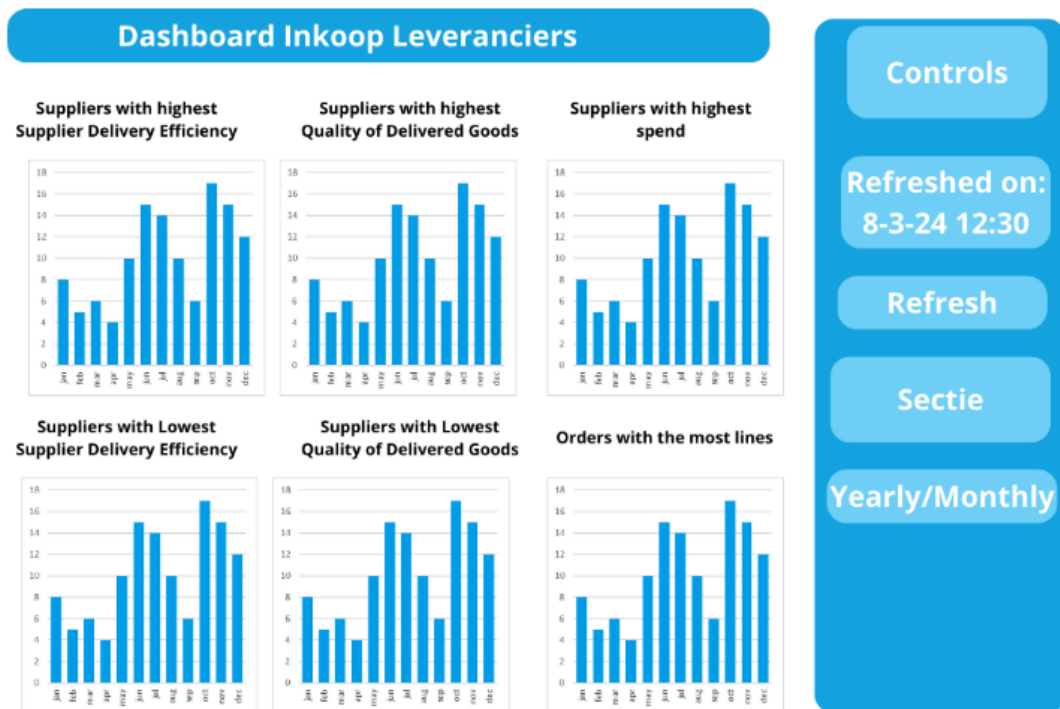


Figure 18: Dashboard with insight into outliers



Figure 19: Ungrouped KPI



Figure 20: Ungrouped with Lines

Mockups which showed different colour variations

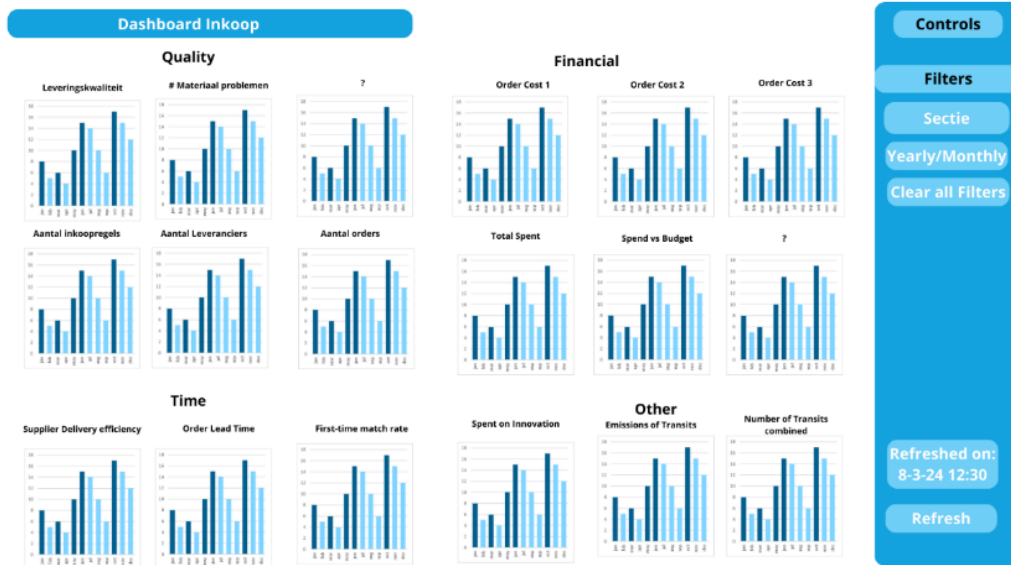


Figure 21: Dashboard with relatively subtle colours

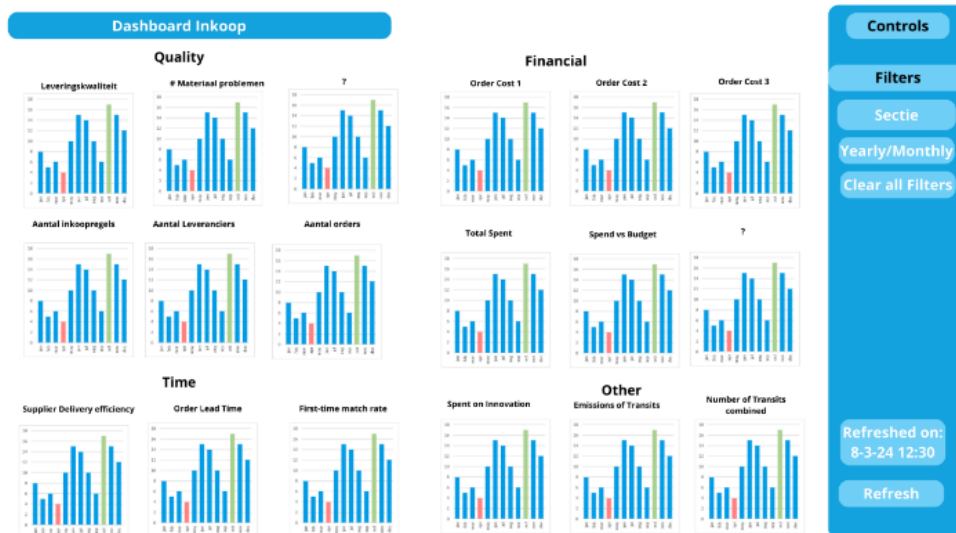


Figure 22: Dashboard with emotive colour value

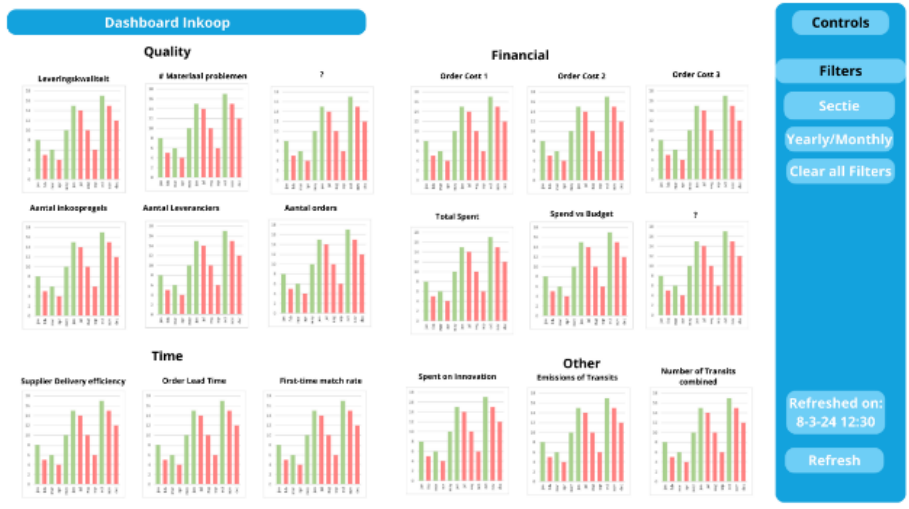


Figure 23: Dashboard with relative emotive colours



Figure 24: Dashboard with emotive values (Numbers)

Mockups that showed different chart types

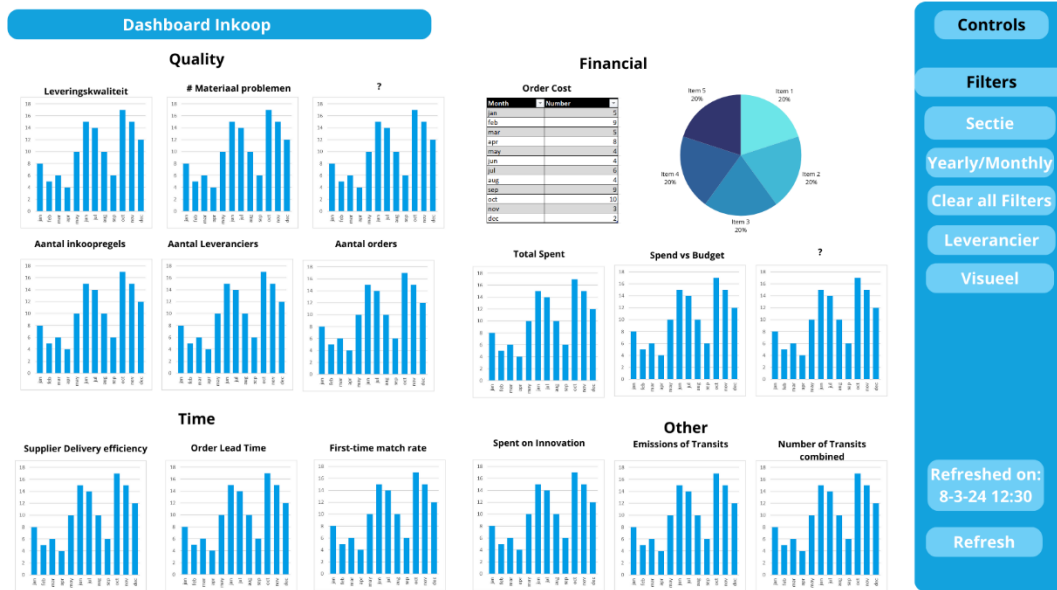


Figure 25: Dashboard with pie chart

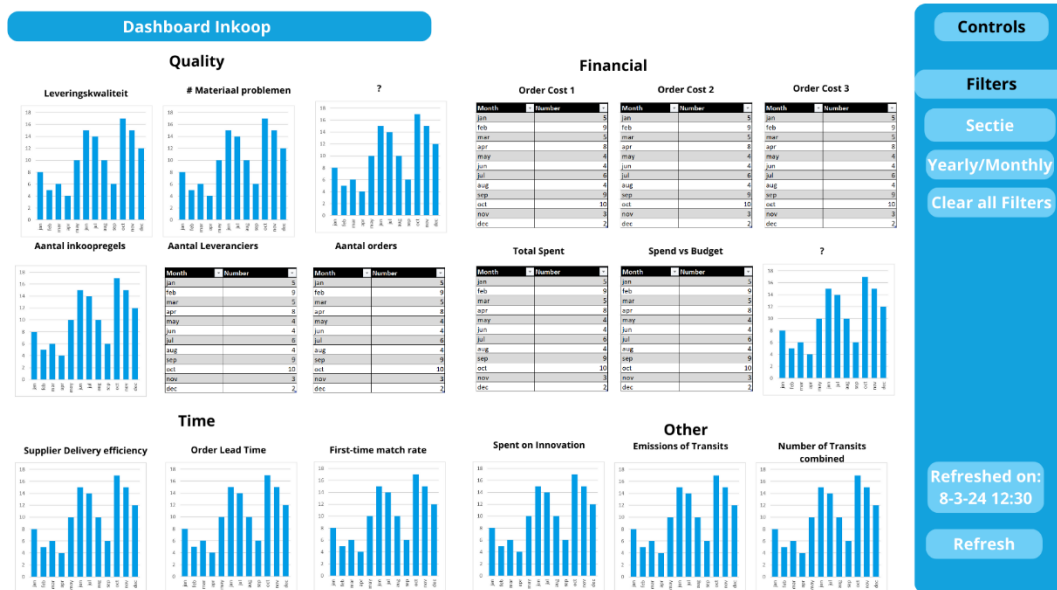


Figure 26: Dashboard with tables

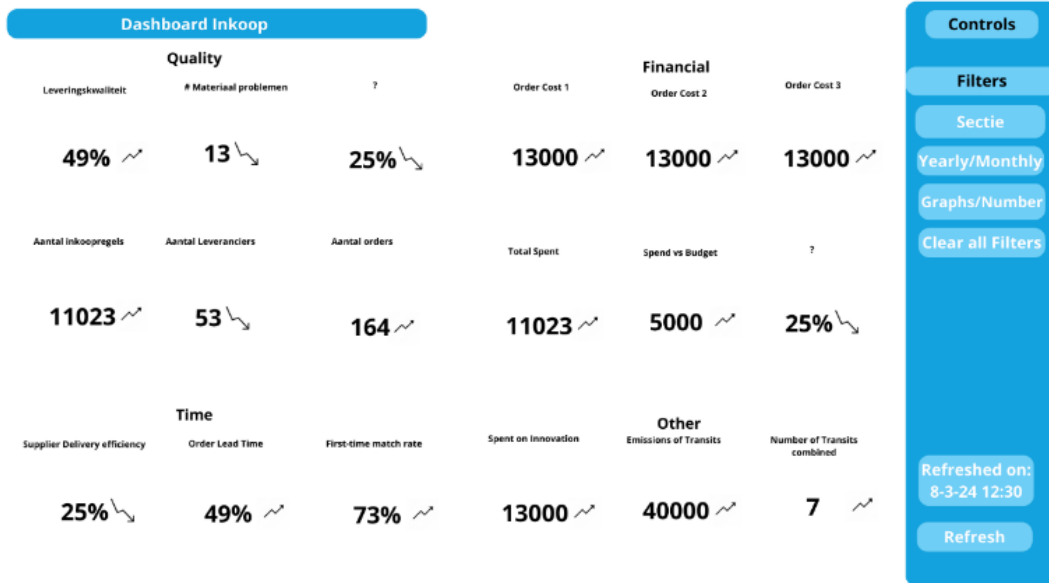


Figure 27: Dashboard with single values and icons

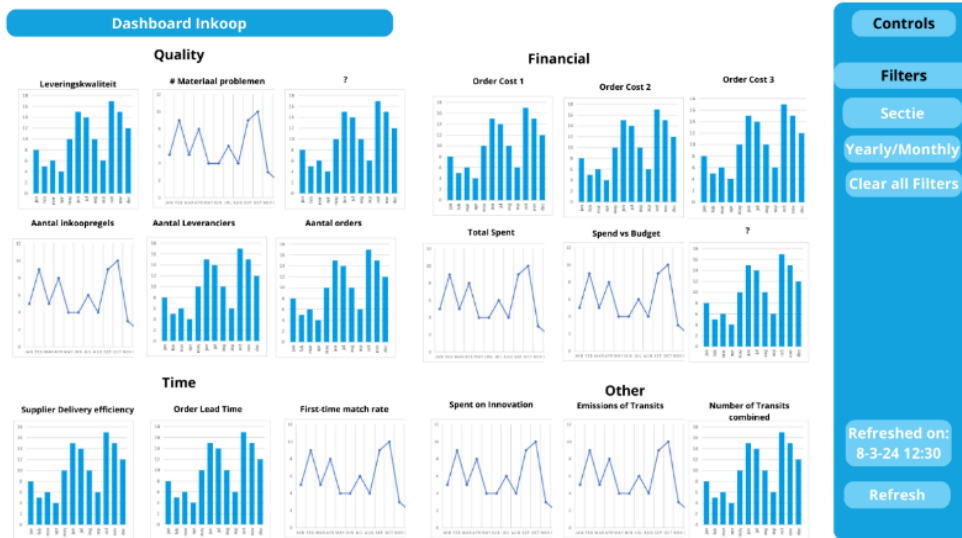


Figure 28: Dashboard with line- and bar charts

Mockups that showed many different variations

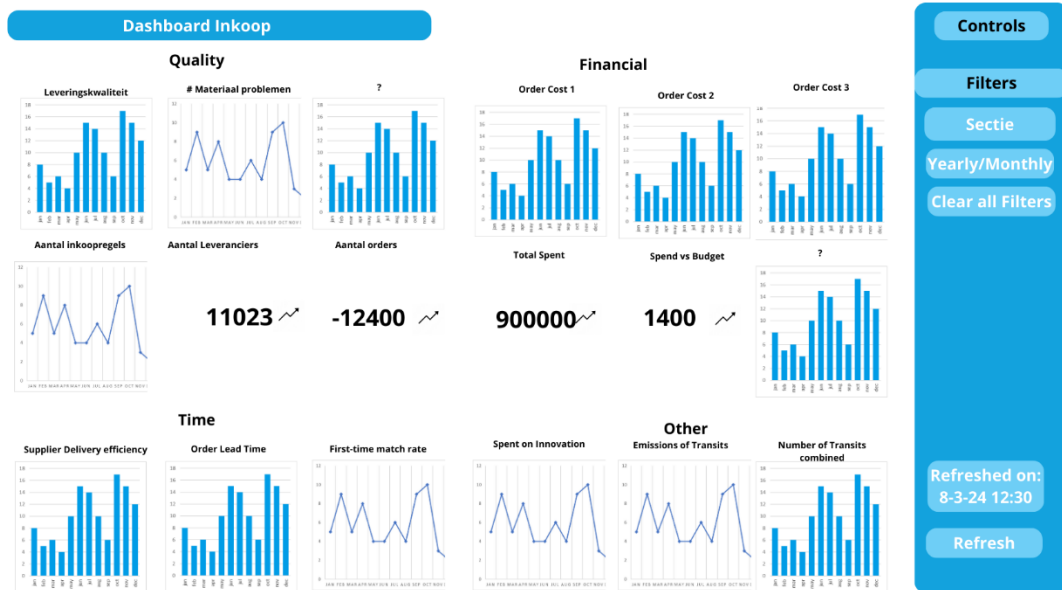


Figure 29: Dashboard with multiple visualisations

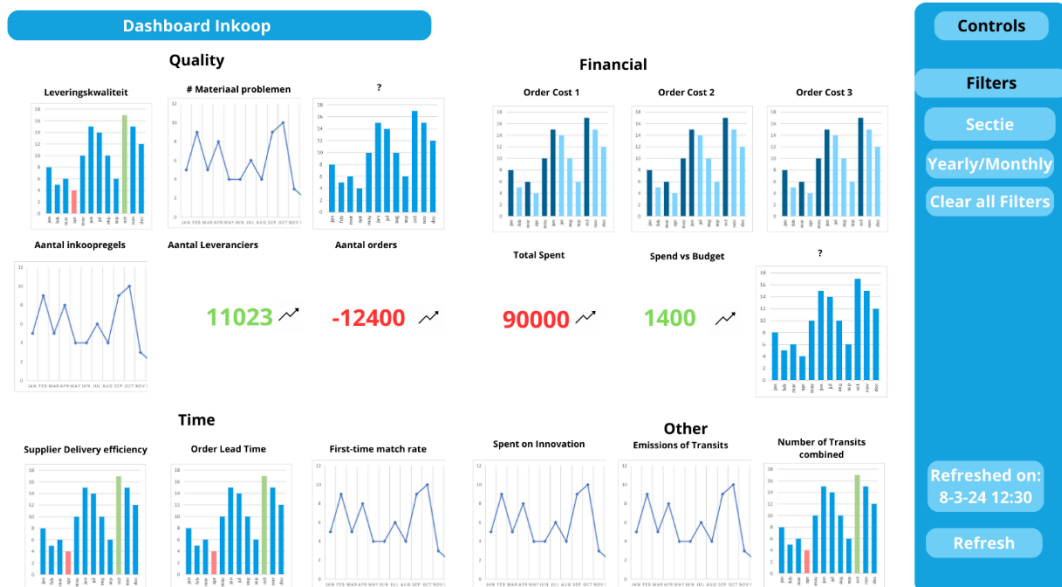


Figure 30: Dashboard with different visualisations and colours

Appendix B Other mock-ups used during the second design cycle



Figure 31: Dashboard with time/financial indicators

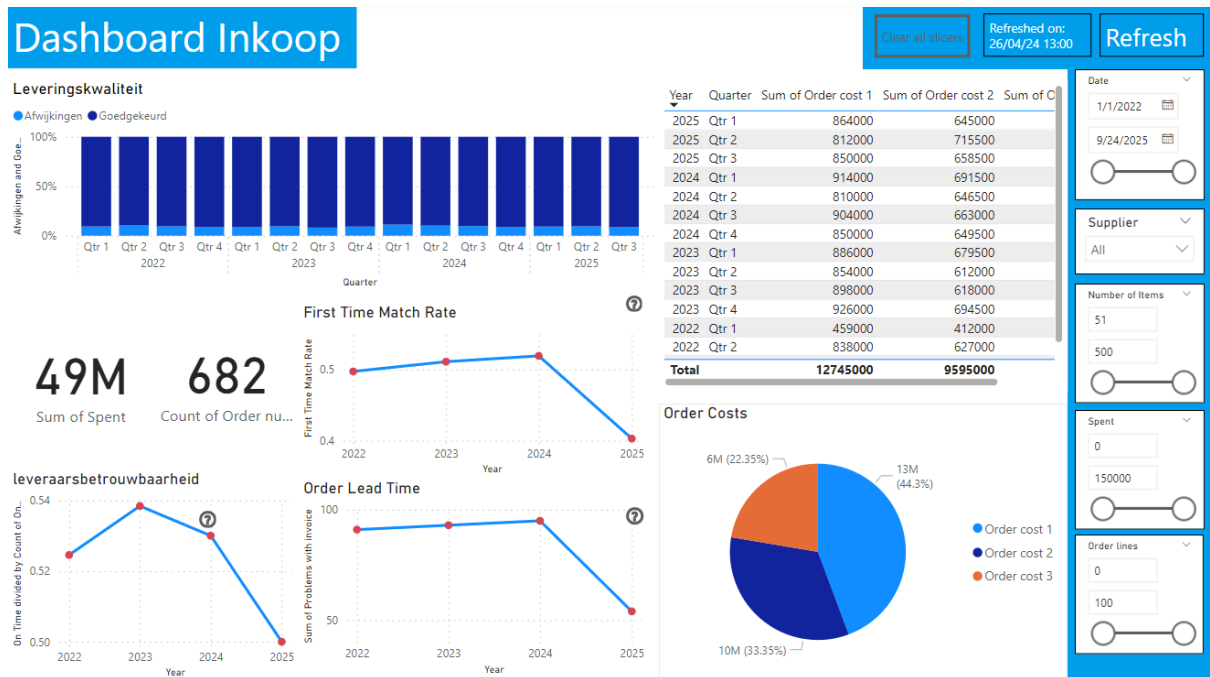


Figure 32: Dashboard supplier drill-down page

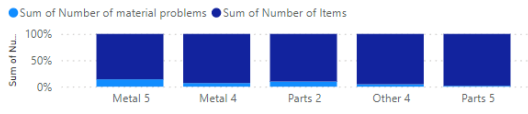
Dashboard Inkoop Kwaliteit

Clear all slicers

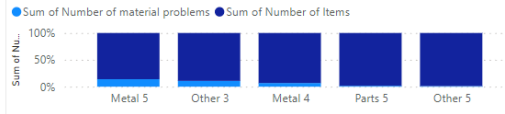
Refreshed on: 26/04/24 13:00

Refresh

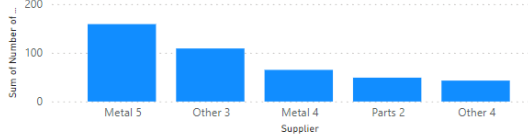
Leveringskwaliteit top 5



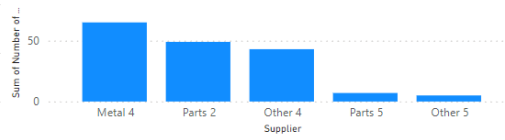
Leveringskwaliteit bottom 5



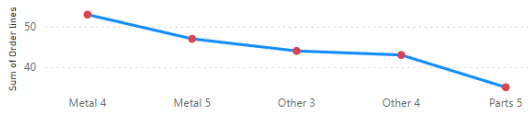
Aantal afwijkingen top 5



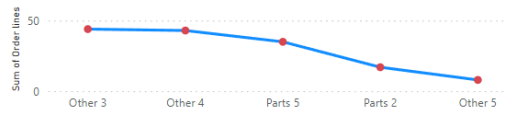
Aantal afwijkingen bottom 5



Aantal Order Lines



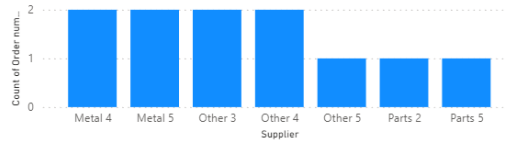
Aantal Order Lines



Aantal orders top 5



Aantal orders bottom 5



Date: 1/1/2022
 9/24/2025

Supplier: All

Number of Items: 400 - 500

Spent: 0 - 50000

Order lines: 0 - 36

Figure 33: Dashboard investigating outliers