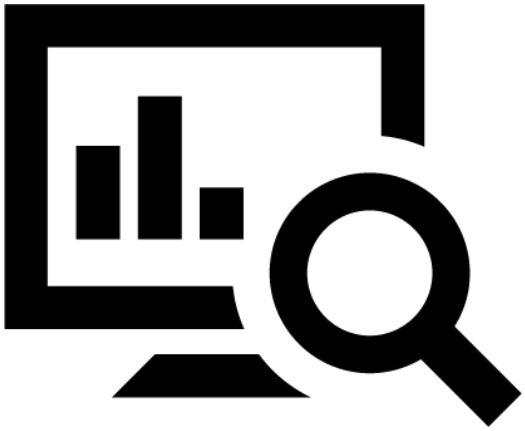
Measuring supplier performance

Introducing a supplier performance measurement system at Odin Groep



University of Twente
Master Thesis
Industrial Engineering & Management

Author
H.G. Broeze

Supervisory Committee
University of Twente
Dr. Ir. L.L.M. van der Wegen
Dr. Ir. F. Schotanus

Odin Groep
H. Scheper

December 4, 2018

Summary

This research looks into supplier performance measurement at the Purchasing and Logistics Department of Odin Groep.

Introduction

Currently, supplier performance measurement at Odin Groep is unstructured and based on gut feeling. Therefore, Odin Groep does not know her suppliers' performance, cannot develop her suppliers and is unable to meet demands from certifications. To overcome these problems, Odin Groep wants to professionalize her process. This leads to the following research question:

> *How can Odin Groep implement a system to continually measure supplier performance using key performance indicators (KPIs) in order to ensure Odin Groep is working with the best suppliers, and to further develop these suppliers?*

This research question is answered through six sub questions on the available literature, goals and requirements, which KPIs to use and the measurement of these KPIs, how the performance measurement system (PMS) can be implemented and what the PMS should look like.

Literature

A KPI is a measure that shows how to increase performance (Parmenter, 2007). The characteristics of a good PMS and its KPIs are (Neely, Richards, Mills, Platts & Bourne, 1997; Parmenter, 2007; Eckerson, 2009):

- A good KPI is simple, relevant, measurable, comparable, trustworthy, independent and validated, and has an objective, target and impact;
- A good PMS uses a few balanced KPIs, distributes responsibility, ensures KPIs are measured frequently and gives the possibility to zoom in on underlying performance indicators (PIs).

Analysis and the development of KPIs

The goals and requirements from Odin Groep came to light through the use of an interdepartmental Delphi Study (Dalkey & Helmer, 1963). Additionally, Odin Groep should adhere to the requirements from certifications on quality- (ISO 9001), environmental- (ISO 14001), and information security management (ISO 27001 and NEN7510). Important input from the interviewees are the categories to base the KPIs on. These are: quality, financial, delivery, communication, safety and sustainability. The KPIs have been prioritized through distinguishing between KPIs, Key Result Indicators (KRIs) and PIs. The KPIs should meet all characteristics of a good KPI and the objectives of Odin Groep. Lastly, the measures for the KPIs have been developed. When multiple options exist, the most insightful method, given its benefits outweigh the costs, is chosen. With similar gains, the method with the lowest cost is chosen. The KPIs that Odin Groep is advised to use, and how they can be measured are:

1. Product quality – % of returned products;
2. Invoice errors – % of invoices with an error;
3. Carrier delivery errors – % of deliveries with an error;
4. (*) Rescheduling quota – average number of delivery date changes;
5. On time, in full – % of deliveries that are on time and in full;
6. Lead time – average time between order and delivery;
7. Communication – number of information channels;
8. Problem solving capabilities – % of problems solved and the average time this takes;
9. Information security standards – score from the information security survey;
10. Environmental sustainability – CDP score on environmental sustainability.

With the introduction of a new ERP system, the rescheduling quota (KPI 4) becomes measurable, and measurements from KPIs 2 and 3 (invoice- and carrier delivery errors) can be improved.

Implementing the PMS
Change management shows which actions to take in the implementation of the PMS. The five main steps that need to be taken in the implementation of the PMS are:

- Data gathering: the project team should create exports from the systems, retrieve online reports and document other data. Afterwards, the data should be prepared for usage;
- Developing the initial dashboard: the project team and development team should work together to develop the dashboard both visually and functionally and test its functionalities;
- Testing the PMS: after data gathering, the project team must validate the dashboard and create a user manual. if necessary, the development team improves the dashboard;
- Implementing the PMS: the project team should introduce the PMS to its users. and educate and encourage those users to use the PMS. The manager Purchasing and Logistics should provide feedback to the suppliers on how they have performed;
- Evaluation: the PMS' progress towards the goals should be measured. Missing and unnecessary KPIs should be pointed out, and the PMS should be improved with this data.

After the new systems (ERP, CRM, bookkeeping) are installed at Odin Groep, the PMS needs to be updated with the new KPI measures (for KPIs 2, 3, and 4) and the new data sources. After validation of the new PMS, this can be used and should also be evaluated and maintained. Maintenance of the PMS includes adding and removing of KPIs and updating and improving data sources.

The implementation of the PMS is expected to take fourteen weeks. After the implementation of the PMS, data collection and feedback will take around one and a half hour per supplier per year. These time investments are similar compared to what they currently are, but, the PMS is believed to give more valuable insight in supplier performance in relation to the time investment. The PMS' dashboard has a starting page showing all suppliers, where the user can filter on the type, purchasing value, number of order lines and performance. Based on these filters, the important suppliers can be selected, and their performance can be measured in the supplier dashboard. Here, some supplier data is available, along with all KPIs with their current status and performance.

Conclusion and discussion
Odin Groep can professionalize her supplier performance measurement process by following the implementation plan as explained above. The problems leading to this research are solved, and Odin Groep is able to improve her suppliers, which might decrease costs and / or increase quality. An additional benefit is the increased bargaining power after supplier evaluation. As an IT company, Odin Groep also faced the trend to move to "as-a-service", making it more difficult to measure quality objectively. In that case, subjective measures, using an objective process, are valuable to use. A yearly time investment of one and a half hour per supplier is necessary, however, this time is currently spent as well. How many suppliers to evaluate should be based on the available time. Odin Groep will use the number of order lines to select the suppliers for evaluation. This differs from most companies, who use the Kraljic matrix (profit and risk). This quantitative focus of Odin Groep does not need to pose problems. It is advised to look at the qualitative side, for example the risks, as well. Another important remark is that some categories, although mentioned in literature, are mostly valuable for the selection of suppliers and not for performance measurement. These are for example innovation and product development.

Recommendations
It is recommended that Odin Groep continues to follow the implementation plan from Section 5.2, such that Odin Groep can measure her suppliers' performance objectively. The first steps of the implementation plan have already been performed during this research. Odin Groep should determine how many suppliers to evaluate using the PMS, based on the time available. Moreover, Odin Groep needs to ensure that all departments develop the PIs needed to look further into the KPIs.

Samenvatting

Dit onderzoek gaat over het meten van de leverancierssprestatie op de afdeling Inkoop en Logistiek van Odin Groep.

Introductie
Momenteel wordt de leverancierssprestatie gemeten op een ongestructureerde manier, door middel van onderbuikgevoelens. Hierdoor weet Odin Groep niet wat de prestatie van leveranciers is, kan ze haar leveranciers niet verder ontwikkelen, en worden de eisen van certificeringen niet behaald. Om deze problemen op te lossen, wil Odin Groep haar proces professionaliseren. Dit geeft de volgende onderzoeksvraag:

> *Hoe kan Odin Groep een systeem implementeren, met gebruik van "key performance indicatoren" (KPI's), om de prestatie van leveranciers continu te meten, en er voor te zorgen dat er gewerkt wordt met de beste leveranciers, en deze verder te ontwikkelen.*

De onderzoeksvraag wordt beantwoord door zes sub vragen over: literatuur, doelen en eisen, welke KPI's gebruikt kunnen worden, hoe deze KPI's te meten zijn, hoe een prestatiemeetsysteem (PMS) kan worden geïmplementeerd, en hoe dit PMS eruit komt te zien.

Literatuur
Een KPI is een maatstaf die laat zien hoe de prestatie verbeterd kan worden (Parmenter, 2007). De karakteristieken van een goed PMS en KPI's zijn (Neely et al., 1997; Parmenter, 2007; Eckerson, 2009):

- Een goede KPI is simpel, relevant, meetbaar, vergelijkbaar, betrouwbaar, onafhankelijk, gevalideerd, en heeft een doel, streefwaarde en impact;
- Een goed PMS gebruikt weinig KPI's, verdeeld verantwoordelijkheid, zorgt ervoor dat KPI's frequent worden gemeten, en geeft mogelijkheden om in te zoomen om onderliggende prestatie indicatoren (PI's).

Analyse en ontwikkelen van de KPI's
De doelen en eisen van Odin Groep kwamen aan het licht in een Delphi studie (Dalkey & Helmer, 1963). Daarnaast moet Odin Groep voldoen aan eisen van certificeringen op het gebied van kwaliteit (ISO 9001), milieu (ISO 14001) en informatiebeveiliging (ISO 27001 en NEN7510). Belangrijke input uit de Delphi studie zijn de categorieën voor de KPI's. Dit zijn: kwaliteit, financieel, levering, communicatie, veiligheid en duurzaamheid. De KPI's zijn geprioriteerd door onderheid te maken tussen KPI's, resultaat indicatoren (KRI's) en PI's. De KPI's moeten daarnaast voldoen aan alle karakteristieken van een goede KPI en bijdragen aan de doelen van Odin Groep. Als laatste is gekeken hoe de KPI's gemeten worden. De methode die de meeste inzichten geeft wordt gebruikt. Indien de inzichten gelijk zijn wordt de methode gebruikt met de laagste kosten. De KPI's, en hoe deze gemeten kunnen worden zijn:

1. Product kwaliteit – % geretourneerde producten;
2. Factuur fouten – % facturen met een fout;
3. Leveringsfouten van vervoerders – % leveringen met een fout;
4. (*) Herschik quotum – gemiddeld aantal wijzigingen in de leverdatum;
5. Volledig op tijd – % leveringen dat volledig en op tijd is;
6. Doorlooptijd – gemiddelde tijd tussen de order en de levering;
7. Communicatie – aantal informatiekanalen;
8. Probleemoplossend vermogen – % opgeloste problemen en gemiddelde tijd hiervoor;
9. Informatiebeveiliging standaarden – score van de informatiebeveiliging enquête;
10. Duurzaamheid (milieu) – CDP score voor milieuvriendelijkheid.

Met de introductie van een nieuw ERP systeem kan KPI 4 worden gemeten, en kunnen KPI's 2 en 3 worden verbeterd.

Implementeren van het prestatiemeetsysteem
Verander management laat zien welke acties moeten worden ondernomen tijdens de implementatie van het PMS. De vijf hoofdstappen voor de implementatie voor het PMS zijn:

- Data verzamelen: het projectteam haalt exports uit het systeem, verkrijgt online rapporten en documenteert andere data. Daarna wordt de data voorbereid voor gebruik;
- Ontwikkelen van een eerste dashboard: het project- en ontwikkelteam werken samen om een visueel en functioneel werkend dashboard te ontwikkelen, welke vervolgens wordt getest;
- Testen van het PMS: nadat de data is verzameld moet het dashboard gevalideerd worden en een handleiding worden geschreven. Indien nodig moet het dashboard worden verbeterd;
- Implementeren van het PMS: het projectteam introduceert het PMS en geeft training aan de gebruikers. Daarnaast wordt er aangemoedigd het PMS te gebruiken en voorziet de manager Inkoop en Logistiek de leveranciers van feedback;
- Evaluatie: er wordt gekeken of de doelen van het PMS zijn behaald. Daarnaast wordt geïnventariseerd of er KPI's missen of onnodig zijn, en wordt het PMS verbeterd.

Wanneer de nieuwe systemen (ERP, CRM, boekhouden) zijn geïnstalleerd, kan het PMS worden geüpdatet met de nieuwe KPI maatstaven (KPI's 2, 3 en 4) en de nieuwe bronnen. Nadat het nieuwe PMS is gevalideerd kan het weer worden gebruikt. De vervolgstappen zijn de evaluatie en het onderhoud (i.e. het verwijderen, toevoegen en updaten van KPI's en databronnen) van het PMS.

De implementatie van het PMS duurt ongeveer veertien weken. Na de implementatie kost het verzamelen van data en geven van feedback ongeveer anderhalf uur per leverancier per jaar. Deze investering in tijd is soortgelijk als in de huidige situatie. Echter wordt verwacht dat het PMS meer waardevolle inzichten biedt in relatie tot de investering in tijd. Het PMS' dashboard heeft een startpagina met alle leveranciers. Hier kan worden gefilterd op type, inkoopwaarde, aantal orderlijnen en prestatie. Afhankelijk van deze filters worden de, voor Odin Groep, belangrijkste leveranciers geselecteerd. Hun prestatie wordt gemeten in het dashboard. In het leveranciers dashboard zijn alle KPI's zichtbaar, met de bijbehorende status en waarden.

Conclusie en discussie
Odin Groep kan haar leveranciersbeoordelingsproces professionaliseren door het implementatieplan, zoals hierboven uitgelegd, uit te voeren. De problemen die de start van dit onderzoek betekenden worden daarmee opgelost en Odin Groep kan haar leveranciers verbeteren, wat kan leiden tot lagere kosten en/of een hogere kwaliteit. Daarnaast wordt de onderhandelingspositie versterkt. Als een IT bedrijf heeft ook Odin Groep te maken met de verschuiving naar "as-a-service" producten, wat het lastiger maakt om kwaliteit objectief te meten. Wanneer een KPI niet objectief gemeten kan worden, is een subjectieve maatstaf met een objectieve methode, ook waardevol. De jaarlijkse investering van anderhalf uur per leverancier wordt momenteel ook gespendeerd. Het aantal leveranciers om te evalueren is afhankelijk van de beschikbare tijd. Odin Groep gebruikt het aantal orderlijnen voor de selectie van leveranciers. Dit is anders dan de meeste bedrijven, die de Kraljic matrix (winst en risico) gebruiken. De kwantitatieve focus van Odin Groep hoeft niet voor problemen te zorgen. Het wordt wel geadviseerd ook naar de kwalitatieve zijde te kijken, bijvoorbeeld naar de risico's. Een andere opmerking is dat sommige categorieën, bijvoorbeeld innovatie en productontwikkeling, hoewel ze genoemd worden in de literatuur, vooral waardevol zijn voor de selectie van leveranciers. Niet voor de prestatiemeting zelf.

Aanbevelingen
Het is aanbevolen om het implementatieplan uit Sectie 5.2 te volgen zodat Odin Groep haar leveranciers objectief kan beoordelen. Odin Groep zou moeten uitzoeken hoe veel leveranciers ze wil evalueren met het PMS, wat afhangt van de beschikbare tijd. Daarnaast moet Odin Groep er voor zorgen dat alle afdelingen de PI's ontwikkelen die nodig zijn voor het PMS.

Preface

This master thesis is written as part of the master programme Industrial Engineering and Management at the University of Twente. I followed the specialization Production and Logistics Management, which has given me a broad knowledge about the entire supply chain. This knowledge has proved to be helpful while writing this thesis about supplier performance measurement systems (PMS).

I would like to thank Odin Groep, and especially Harm Scheper, for this opportunity and their support during this research. I am proud to say that I am currently implementing this research in practice, through the actual development of the PMS. Furthermore, I would like to thank my supervisors, Leo van der Wegen and Fredo Schotanus. Their constructive feedback really helped to improve this thesis

Finally, I would like to thank my family and Nick Nijmeijer for their continuous support, and express my gratitude for the opportunities presented to me during my student life.

Heleen Broeze
Enschede, December 2018

Table of Contents

List of abbreviations

Notation	Description
3PL	Third party logistics
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
Avg	Average
BI	Business Intelligence
BSC	Balanced Scorecard
BTO	Build To Order
BU	Business Unit
CE	Conformité Européene (European conformity) (FRA)
CRM	Customer Relationship management
CSF	Critical Success Factor
ELECTRE	Elimination Et Choix Tradusant La Réalite (Elimination and Choice Translating Reality) (FRA)
ERP	Enterprise Resource Planning
FTE	Full-Time Equivalent
GDPR	General Data Protection Regulation
ICT	Information and Communication Technology
ISO	International Organization for Standardization
IT	Information Technology
KPI	Key Performance Indicator
KRI	Key Result Indicator
MCDM	Multi-criteria decision making
MDF	Marketing Development Funds
PI	Performance Indicator
PMS	Performance Measurement System
RI	Result Indicator
RMA	Return Materials Authorization
SCC	Supply Chain Council
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
SLA	Service Level Agreement
SMART	Specific, Measurable, Achievable, Realistic, Timely
USP	Unique Selling Proposition

1. Introduction

This chapter introduces the components of this master thesis. Section 1.1 addresses the motivation for performance measurement. In Section 1.2, Odin Groep, the company of interest is introduced. The current situation and the complication of Odin Groep are described in Section 1.3. The components that add to literature (i.e. academic relevance) are discussed in Section 1.4. Section 1.5 follows with the problem description and the research objective. In Section 1.6 the research question is stated, along with the sub questions and the methodology. Lastly, in Section 1.7 the structure of the remainder of the report is presented.

1.1 Motivation

Measuring performance is not a new topic, however, it stays relevant. There are multiple definitions of performance measurement, mostly referring to the process or activity of evaluating the performance of an entity (Liebetruth, 2017). Here we use a general definition (Liebetruth, 2017) that is frequently used (Moullin, 2007; Taticchi, Tonelli & Cagnazzo, 2010) from Neely, Mills, Platts, Gregory and Richards (1996, p.424): "*The process of quantifying the efficiency and effectiveness of action*".

Measuring supplier performance is important to stay competitive (Da Silva & Borsato, 2017), as this can be used to assess how the activities are performed compared to competitors. Performance measurement evaluates qualitative and quantitative measures and, therefore, analyses and reduces risks and maximizes value (Zeydan, Çolpan & Çobanoğlu, 2011). The most important factors in measuring performance are quality, delivery and costs (Ho, Xu & Dey, 2010). To measure these factors, two of the most occurring problems in organizational performance need to be overcome. These problems are poor management of the supply chain and poor data availability (Da Silva & Borsato, 2017). To actually measure performance, companies need a supplier measurement system that fits the organization, is efficient, reliable, flexible and easy to adopt. From this, companies can provide feedback to the suppliers on how they can improve their performance (Dey, Bhattacharya, Ho & Clegg, 2015).

1.2 Company Odin Groep

Odin Groep is a versatile IT company, employing over 470 people. The company operates in the service industry, providing both IT services and goods. The company uses a holding structure, with supporting departments that enable the companies - Previder, Heutink ICT, Web2Work and Winvision - to focus on their core activities (Odin-groep.nl, 2018). More information about Odin Groep (including the organization chart) is presented in Appendix A.

The performance measurement research is executed at the supporting department Purchasing and Logistics. This department is amongst others responsible for purchasing goods and services, handling the purchased goods and maintaining the relationships with suppliers.

1.3 Situation and complication

Odin Groep is continually growing and needs to professionalize her processes. The past three years, supplier performance measurement has become a more and more important topic. Five years ago ISO 9001 (quality management) started demanding performance measurement. The past two years, however, ISO has increased their demands for performance measurement, leading Odin Groep to fail to meet these demands. Also, management policy and the Purchasing Department ask for a supplier performance measurement system. Firstly the quality of performance determines whether or not to buy at that supplier. As prices and conditions are different, changing suppliers might cost Odin Groep money. Secondly, a system to measure performance is an important step in creating shared and clear definitions in the overall process. Thirdly, the manager of Purchasing and Logistics has experienced

that suppliers show more commitment in case they are “appreciated” through a performance report. This is supported by Prahinski and Benton (2004), as they show that supplier commitment can grow through enhanced communication and relationship development. At the same time, Zhou, Benton, Schilling and Milligan (2011) see this as a good sourcing practice.

Currently there is a mechanism in place to measure supplier performance, however, knowledge and skills fall short to work with it and the internal systems do not provide the information needed to feed the measurement mechanism. The departments Purchasing, Marketing and Sales currently determine whether a supplier is “good” or not by awarding a score (excellent, good, sufficient or insufficient) for all factors (e.g. price, delivery time, quality and environment) on a performance measurement sheet. This sheet is mostly filled based on gut feeling. The current measurement sheet is shown in Appendix B. Key Performance Indicators (KPIs) have been mentioned to solve this problem, however, there are no KPIs defined yet and it is not known how to use these to measure supplier performance.

At Odin Groep no sound supplier performance assessment tools are present and there is not a sound control system in place to measure the quality of suppliers. The only thing present is the measurement sheet as explained before and shown in Appendix B. The manager Purchasing and Logistics has set new value propositions for 2018 (Odin Groep, 2018), among them are optimzing processes and supplier performance management. Likewise, Odin Groep is thinking about replacing non-strategic suppliers (i.e. suppliers that are not partners) for new ones, which then will need to be evaluated too.

1.4 Academic relevance

Balfaqih, Nopiah, Saibani and Al-Nory (2016) performed a literature review, and found that, although supply chain performance measurement systems have been researched a lot, there are still elements that need attention. Amongst these elements are the incorporation of safety-related and sustainability measures (Balfaqih et al., 2016). At Odin Groep, sustainability is receiving increased attention. A project group has been formed which created the first sustainable entrepreneurship yearly report over 2017. This report (Odin Groep, 2017) focusses on all aspects of the triple bottom line: people, planet and profit, and also incorporates safety. Measures for sustainability and safety are needed, and are an addition to the existing literature on this topic.

Another element is the determination of KPIs and their validation (Balfaqih et al., 2016). Kucukaltan, Irani and Aktas (2016) looked into identification and prioritization of KPIs and found that more research on the interdependencies between KPIs is needed, as in real-life scenarios not all indicators are completely independent of each other. At Odin Groep, it is still unknown which KPIs will be chosen and how to prioritize them. These chosen KPIs will need to be validated and checked for interdependencies. How to do this adds to the existing literature for others to build on.

1.5 Problem description

The problem follows the situation and complication from Section 1.3. There is no structure in measuring supplier performance. Part of this problem is that there are no KPIs defined, and it is not clear how to use KPIs. This problem also causes other problems:

- The most important problem it causes is the inability to measure performance and thus know whether the current suppliers are the best options, or if a replacement would be better;
- Odin Groep is unable to suggest the supplier to make adjustments in order to further develop the supplier, improve the relationship and increase revenue;
- Odin Groep is unable to meet the demands by certifications such as ISO and NEN;
- Lastly, as there is no structure in measuring supplier performance, it is assumed that the commitment of suppliers is lower.

The problem description leads to the following objective:

Developing a system to continually measure supplier performance in order to create the ability to know whether Odin Groep is working with the "best" suppliers, and to further develop the suppliers Odin Groep is doing business with.

1.6 Research questions

The research question is deducted from the problems and objective of Section 1.5. This section addresses the research question, sub questions and the methodology. The research question is:

How can Odin Groep implement a system to continually measure supplier performance using KPIs in order to ensure Odin Groep is working with the best suppliers, and to further develop these suppliers?

The first step to answer the research question is breaking it down into manageable parts and firstly answer these sub questions. After answering these sub questions, the research question can be answered. This answer will contain the implementation plan and a prototype of the dashboard to monitor the KPIs.

1. *What are the characteristics of a good performance measurement system (PMS) and its KPIs?*

It is important to know what a good PMS looks like, and to define good KPIs that can be used in this system. Therefore, this sub question answers what the requirements are of a good PMS and KPIs, and which pitfalls to take into consideration when developing a PMS and KPIs. This sub question is answered through a literature study, using online scientific libraries such as Scopus and Science Direct. Snowballing and reverse snowballing are methods used to find other articles by looking at the reference list and the "cited by" list of a known article (Sayers, 2007). This method also helps to identify the key words to use next. Key words used are: "Performance measurement system", PMS, "key performance indicator", KPI, performance, measure and "performance management".

2. *Which KPIs are currently used to measure supplier performance?*

The KPIs that others use to measure supplier performance could also be relevant for Odin Groep. Although Odin Groep operates in the service industry, most suppliers deliver tangible products. There are also suppliers delivering intangible (virtual) products (e.g. licenses) but they are treated similarly. This sub question makes sure that no important KPIs are forgotten. Although probably not all KPIs can be found in literature, a literature study answers this question, using the keywords: KPI, "key performance indicator", "service industry", supplier, "supplier performance" and "supplier evaluation" in online scientific libraries. The snowballing technique (Sayers, 2007) is used here as well. Another source to look for possible KPIs is the KPI library[1], which contains thousands of KPIs in an online database. Afterwards, duplicates in the list of KPIs are merged and irrelevant KPIs (i.e. KPIs that do not meet the characteristics of a good KPI) are marked as such. To make sure all KPIs important for Odin Groep are identified, the data found here is combined with Sub question 3.

3. *What are the goals and requirements posed by Odin Groep to build the PMS and determine the KPIs needed to measure supplier performance?*

In order to find out which KPIs are relevant for Odin Groep, the goals of implementing this system firstly need to be clear. The requirements for the KPIs (including the characteristics of a good KPI and PMS) and the usability of the dashboard are listed. Also requirements from quality management norms

[1] http://kpilibrary.com

such as NEN and ISO are taken into account. If measurement systems in other departments are used, these are used as a reference as well. This sub question is answered using nine interviews with managers from Purchasing, Marketing, Finance and Sales, the Quality Officer, Product Manager and one of the Managing Directors and by looking into internal documents. Because the interviewees will probably not agree on all topics, the Delphi method is used. This method is developed to obtain consensus amongst a group of people through a series of questionnaires and controlled opinion feedback (Dalkey & Helmer, 1963).

4. *Which KPIs should Odin Groep use?*

As the goals and requirements from Odin Groep, and the characteristics of a good KPI are known, it is possible to determine which KPIs Odin Groep should use. There will probably be a lot of possible KPIs connected to the objectives. To check whether all important topics have been covered by the developed KPIs, the list of KPIs from Sub question 2 is used. In case there are too many KPIs, choices have to be made. Firstly the distinction between KPIs and PIs is made, then the KPIs are checked for interdependencies and measurability. When still too many KPIs are present, Gonçalves, Dias and Machado (2014) found that multi criteria analysis is an effective tool to select KPIs.

5. *How to measure the selected KPIs*

After determining which KPIs Odin Groep should use (Sub question 4), the next question: "How to measure these?" should be answered. Some measurements are deducted from Sub question 2, others can be developed using general knowledge. In case multiple measurement options exist, the costs of obtaining the data are set off against each other and the "cheapest" option is chosen as the measurement to use for the KPI. To determine the availability of data, internal documents are studied and a number of representatives from Purchasing and Logistics are questioned to gain additional insight.

6. *How to implement a system to measure supplier performance using KPIs?*
    a. *How should Odin Groep implement the system?*
    b. *What should the PMS look like?*

In order to efficiently measure supplier performance, Odin Groep should know how to use and implement KPIs in a supplier PMS. To answer this question, the data from Sub questions 4 and 5 are used. For the implementation plan, only a list of KPI outputs is not useful as not all KPIs are equally important. Secondly, norms should be developed for the KPIs. Lastly, the implementation plan should indicate a step-by-step instruction on how to implement the system. With a PMS, powerful decision making could be the result. To generate an effective system, a prototype of the PMS is included too.

1.7 Structure of the report

Chapter 2 contains a literature study, which answers Sub questions 1 and 2 and gives some additional context to the research. Chapter 3 contains the analysis and answers Sub question 3. Chapter 4 shows which KPIs Odin Groep should use, and how to measure these (i.e. Sub questions 4 and 5). Chapter 5 shows how to implement the PMS at Odin Groep, and thus contains the answer to Sub question 6. Chapter 6 concludes and discusses this research, gives recommendations and shows the limitations.

2. Literature study

This chapter contains the literature used throughout this research. Section 2.1 introduces performance measurement systems. This is followed by an introduction on key performance indicators in Section 2.2. Section 2.3 shows the characteristics of a good KPI and answers Sub question 1. Sub question 2, about the KPIs that are currently used, is answered in Section 2.4. In Section 2.5, the design of a PMS is explained. In the last section, Section 2.6, this chapter is concluded and Sub questions 1 and 2 are answered.

2.1 Performance measurement systems

A performance measurement system (PMS) is a set of performance measures that can be examined at different levels: the individual measure, the system of measures and the relationship of the system with its environment (Neely et al., 1996). "*A Performance measurement system is the set of metrics used to quantify the efficiency and effectiveness of actions"* (Neely et al., 1996 pp.424).

Balfaqih et al. (2016) performed a literature review on PMSs used in the supply chain and observed that, in the past two decades, most authors focussed on the balanced scorecard (BSC) and supply chain operations reference (SCOR) frameworks. These frameworks do take into account the human factor, which is essential in performance (Galar, Stenström, Parida, Kumar& Berges, 2011). Firstly the history of PMSs is addressed, then the BSC and SCOR frameworks are explained.

2.1.1 Critiques on early performance measurement systems

With the industrial revolution in the early 1900s, PMSs based on cost accounting were first used (Khan & Shah, 2011). These systems focussed only on financial measures, and due to the identification of shortcomings (Ljunglöf & Nisser, 2017), the globalization and start of the "world economy" (Khan & Shah, 2011), interest for a renewed performance measurement system started to grow in the 1970's (Ljunglöf & Nisser, 2017; Khan & Shah, 2011). The main critiques on the "old" system were:

- Short-terminism (Kaplan, 1984; Khan & Shah, 2011; Ljunglöf & Nisser, 2017);
- Not aligned with strategy (Khan & Shah, 2011; Ljunglöf & Nisser, 2017);
- Historically focussed (Khan & Shah, 2011; Ljunglöf & Nisser, 2017);
- Focus on results instead of the means (Khan & Shah, 2011);
- No external focus (Khan & Shah, 2011; Ljunglöf & Nisser, 2017).

2.1.2 Balanced performance measurement systems

To overcome these critiques, balanced performance measurement systems were developed, starting in 1970, but receiving most attention starting in the 1990s (Taticchi et al., 2010; Neely, 2005). The most cited and well know PMS of this era is the balanced scorecard (BSC) by Kaplan and Norton (1992), which is explained in Section 2.1.3 (Taticchi et al., 2010). Among the other balanced systems are the results-determinants framework from Fitzgerald, Johnston, Brignall, Silvestro and Voss (1991) where they distinguish between the success of the chosen strategy (results) and the determinants of competitive success (determinants), the performance pyramid by Lynch and Cross (1991), where corporate strategy is translated to objectives using operational measures and KPIs, and the performance measurement matrix by Keegan, Eiler and Jones (1989), where a distinction is made between cost and non-cost, internal and external. These balanced systems have a lot in common. They focus on integrated measures instead of only financial measures, have a strategic perspective, and focus on multiple stakeholders (Yadav & Sagar, 2013).

2.1.3 Balanced scorecard (BSC)

The BSC shows how results are achieved by looking at four important perspectives, combining financial measures with operational measures on customer satisfaction, internal processes and innovation and

learning (Kaplan & Norton, 1992). The BSC focusses on the most critical measures and centralizes strategy and vision. It designs its measures such that people will adopt the necessary behaviour and take the actions needed to meet the accompanying goals (Kaplan & Norton, 1992). Later Kaplan and Norton (1996) found how to link the short-term actions with long term strategy. The BSC is depicted in Figure 1.

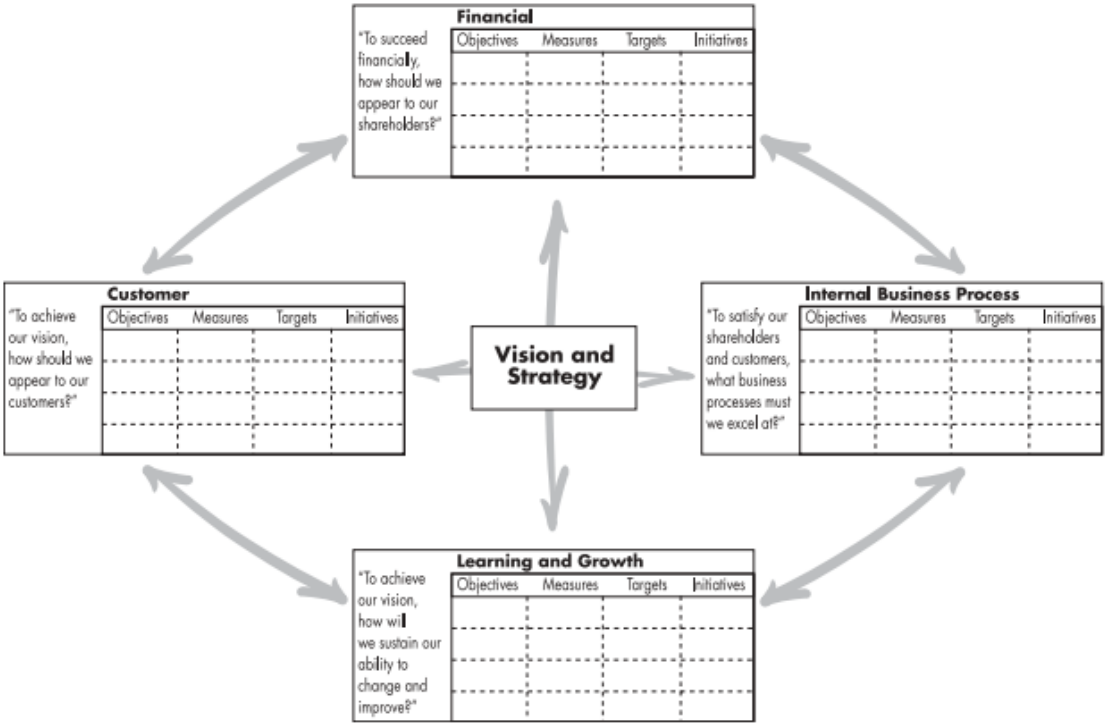


Figure 1: balanced scorecard (Kaplan & Norton, 1996)

From the four BSC perspectives, "customer" is the only one relevant for supplier performance measurement. The other perspectives are based on the company itself.

2.1.4 Supply chain operations reference (SCOR)

Another framework is the SCOR model. In order to evaluate and compare performance and activities within the supply chain, the Supply Chain Council (SCC) developed the SCOR model in 1996, (Supply Chain Council, 2012). This model has four sections: performance, processes, practices and people (Supply Chain Council, 2012). As we are interested in PMSs, we focus on the section performance, which focusses on five attributes: reliability, responsiveness, agility, costs, and assets (efficiency), and their corresponding metrics (Supply Chain Council, 2012).

SCOR uses six scopes: plan, source, make, deliver, return, and enable (Zhou et al., 2011; Supply Chain Council, 2012). When looking at supplier performance, source and deliver are most important. The other scopes are less relevant for supplier performance measurement. In Section 2.4, the SCOR model is amongst the sources used to determine the categories to base KPIs on.

2.2 Key performance indicators

One of the challenges of balanced PMSs is the identification and prioritization of KPIs (Kucukaltan et al., 2016). These KPIs are valuable, as they support planning, enable goal setting and the comparison of planned and achieved results, and are the basis for decision making (Meier, Lagemann, Morlock & Rathmann, 2013). *A KPI is a measure that shows how to increase performance* (Parmenter, 2007).

2.2.1 Different types of performance measures

A lot of companies use "KPIs", however, many of them are working with the wrong measures (Badawy, El-Aziz, Idress, Hefny, & Hossam, 2016). These companies measure performance indicators (PIs) that tell you what to do, but these PIs do not increase performance (Badawy et al., 2016). According to Parmenter (2007) there are three types of performance measures, that show how the indicator can be used:

- Key performance indicators (KPIs), which show what to do to increase performance (e.g. % decreased costs on the key line);
- Key result indicators (KRIs), which show how you have performed (e.g. net profit);
- Performance indicators (PIs), which show what to do (e.g. net profit on key line).

KRIs and PIs are often mistaken for KPIs. Although they are important to see whether you are moving in the right direction (KRIs), or to show financial statistics (PIs), they do not indicate how to increase performance (Parmenter, 2007).

These KRIs, PIs and KPIs can be linked to the distinction of absolute (independent) numbers from relative numbers (Meier et al., 2013) Absolute numbers only gain significance when compared to other indicators and can be seen as KRIs. Relative numbers on the other hand contain information through (Meier et al., 2013):

- Quotas, which relate the ratio of a single indicator to the entire entity;
- Reference numbers, which are ratios of equal indicators with different content;
- Index numbers, which compare over time.

2.2.2 Strategic alignment

Performance measures, or KPIs, should be linked to the organisation's Critical Success Factors (CSFs) and corporate strategy (Parmenter, 2007; Bauer, 2005). "*Critical success factors are, for any business, the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization."* (Rockart, 1979).

An effective PMS passes corporate strategy on towards the lowest levels in the organisation to signal expectations and the desired behaviour towards employees (Cousins, Lamming, Lawson & Squire, 2008). The goal is to create alignment between strategy, objectives, performance measures and actions. Figure 2 shows strategic alignment as visualized by Bauer (2005). Parmenter (2007) agrees to this, as he said that the organisation's values, vision and mission are the foundation for the CSFs, which are the basis for the KRIs, PIs and KPIs (Parmenter, 2007).

Figure 2: strategic alignment pyramid (Bauer, 2005)

The CSFs (areas to focus on), or the categories, are thus an important part in developing KPIs. The success factors may be critical for one department, but not for another (Hey, 2017). CSFs give focus in determining KPIs (Hey, 2017), as these KPIs are the quantifiable measures of CSFs (Mbugua, Harris, Holt & Olomolaiye, 1999). When a concept higher in the pyramid, for instance, the objectives, is not well defined, it becomes more difficult to determine the KPIs (Slack, Chambers & Johnston, 2010).

2.2.3 Challenges in the design of a KPI

PIs and KPIs are mostly quantitative information designed to show structures and processes of a company (Meier et al., 2013). KPIs are often designed for one business area, and used for that area alone. This isolation results in no alignment and sometimes even in conflicting KPIs (Da Silva & Borsato, 2017). Designing a good KPI is more than specifying a formula. KPIs are influenced by corporate strategy, and further based on the interrelation between a lot of criteria (e.g. efficiency, quality, productivity and profitability) and are thus not the same for all organisations (Bhatti, Awan & Razaq, 2014). This is explained by the pyramid of strategic alignment in Figure 2. A performance measure can even result in dysfunctional behaviour if the measure is not good (i.e. individuals take inappropriate action to influence the KPI) (Neely et al., 1997). But, what are the characteristics of a good KPI?

2.3 What are the characteristics of a good KPI?

Neely et al. (1997) posed a framework using ten elements to specify twenty-two recommendations for a good performance measure. Parmenter (2007) defined seven characteristics of KPIs from analysis and discussions during KPI workshops, and Eckerson (2009) defined ten characteristics to keep in mind while creating KPIs, although he also stated: "The key to creating effective KPIs is as much art as science." (Eckerson, 2009, p. 18). The lists of recommendations (Neely et al., 1997) and characteristics (Parmenter, 2007; Eckerson, 2009) are displayed in Appendix C. Following the definition by Parmenter, Neely's recommendations are for both PIs and KPIs.

The characteristics of a good KPI by Neely et al., (1997), Parmenter (2007) and Eckerson (2009) are explained in Table 1. They are supplemented by other authors. To show which of Neely et al.'s (1997) recommendations (Appendix C) are linked to which element, Table 1 shows this between brackets ()* in the first column.

Characteristic	Explanation
Simple *(Title - 2, 9, 21)**	A good KPI is unambiguous and understandable (Meier et al., 2013), has a clear title that explains itself and its importance (Neely et al., 1997). This way, employees know what is being measured (Eckerson, 2009), and understand both the measure itself and the corrective actions that are required to take (Parmenter, 2007; Badawy et al., 2016).
Relevant *(Purpose - 7, 14)**	It is questionable to introduce a measure with no purpose. The measure should be relevant (Neely et al., 1997).
Balanced	Although Parmenter (2007) argues for non-financial measures, a balance of both financial and non-financial measures defines a good set of KPIs (Badawy et al., 2016). A way to balance the KPIs is to use the perspectives of the BSC (Eckerson, 2009). Sometimes a KPI drives behaviour in a direction that needs to be balanced by a second KPI.
Objective *(Relates to - 1, 6, 7, 11)**	It is questionable to introduce a measure with no relation to business objectives. Therefore, these objectives should be identified (Neely et al., 1997) and the organizational goals should be clear to all (Fortuin, 1988).
Target *(Target - 4, 6, 7, 8, 11, 14, 20)**	An appropriate and SMART target should be recorded for each measure. This target depends on the requirements of owners and customers, as well

	as the abilities of competitors (Neely et al., 1997). The target should be challenging but realistic, and updated once met (Fortuin, 1988).
Measurable *(Formula - 2, 4, 5, 9, 15, 16, 21, 22)**	The KPI should be measurable (Meier et al., 2013), and it makes no sense to measure something over which there is no control (Neely et al., 1997). How the KPI is measured (the formula) affects behaviour, as a bad formula may result in problems, whereas a good formula induces good business practice (Neely et al., 1997). A good KPI drives desired outcomes and is tested to ensure a positive impact on performance (Badawy et al., 2016).
Measurement frequency *(Frequency - 3, 12, 13, 18, 20)**	The frequency to measure performance depends on the importance of the KPI and the volume and availability of data (Neely et al., 1997). A good KPI is measured frequently (Parmenter, 2007). Badawy et al. (2016) define frequently as 24/7, daily, or weekly. Important is that the KPIs are available on time and that people have agreed on its frequency (Fortuin, 1988).
Responsibility *(Who measures? - 4, 7)**	A good KPI makes sure an individual or a team is responsible for it (Parmenter, 2007; Badawy et al., 2016). Questions answered are: Who should collect the data? And who should report the data? (Neely et al., 1997).
*(Who acts on the data? -4, 6, 10, 20)**	KPIs have an owner (Badawy et al., 2016). Usually two: a business owner responsible for the meaning and value of the KPI, and a data owner, responsible for populating the KPI with data (Eckerson, 2009). The CEO and senior management team act on the KPI (Parmenter, 2007; Badawy et al., 2016). The question asked here is: who should take action based on the reported data? (Neely et al., 1997).
Comparable *(Source of data - 15, 16, 17, 18, 19, 21)**	A good KPI is comparable (Meier et al., 2013). To compare performance over time, a consistent data source should be used. Therefore, it is important to specify this source (Neely et al., 1997).
Impact *(What do they do? - 4, 6, 10, 20)**	The KPI is derived from a quantity that can be influenced by the user (Fortuin, 1988). Individuals know how to affect the outcome of a good KPI (Badawy et al., 2016; Eckerson, 2009). A good KPI has a significant (Badawy et al., 2016; Parmenter, 2007) and positive impact (Parmenter, 2007), and the outcome is acceptable or unacceptable. What action to take given the value of a KPI should be defined, so performance can be improved (Neely et al., 1997). KPIs have a limited time span and need to be re-evaluated to see if they still correlate with the desired outcome (Eckerson, 2009).
Few KPIs	One of the most occurring problems is having too many performance indicators (Kucukaltan, 2016). The 10-80-10 rule suggests ten KRIs, eighty PIs and ten KPIs and argues that most companies could do with less than suggested (Parmenter, 2007). The fewer KPIs the better (Badawy et al., 2016), as the maximum focus of people is five to seven items at once, this should be the limit (Eckerson, 2009).
Zoom-in on underlying PIs	With a good system of KPIs, users can drill into detail (Badawy et al., 2016). Strategy can be reflected with only a few KPIs, however, to monitor processes you need the PIs underlying these KPIs as well (Eckerson, 2009).
Trustworthy	Users do not use data they do not trust (Eckerson, 2009). The KPIs need to be accepted as measures (Fortuin, 1988). To increase trust, the data has to be perceived as accurate. One way to do this is to provide references about the data with the formula, date of update, owners and other relevant details (Eckerson, 2009).

Independent	It is important that different KPIs do not undermine each other (i.e. people improve one KPI, while drastically decreasing another) (Eckerson, 2009). The KPIs should thus be independent (Kucukaltan, 2016).
Validated	A good KPI is tested to ensure that the outcome cannot be affected by other than the required actions, so employees cannot "game" the system (Eckerson, 2009). This is especially important when monetary incentives are attached to KPIs (Eckerson, 2009).

(*) The recommendations between brackets ( ) correspond with the numbers (#) of Neely et al. (1997) in Appendix C.
Table 1: characteristics of a good KPI

In summary, the characteristics of a good KPI and PMS are:

- A good KPI is simple, relevant, measurable, comparable, trustworthy, independent and validated;
- A good KPI has an objective, a target and impact;
- A good PMS uses few and balanced KPIs and distributes responsibility;
- A good PMS makes sure the KPIs are measured frequently;
- A good PMS gives the possibility to zoom in on underlying PIs.

In the remainder of this report, the term PI is used as "an indicator on a level below the KPI". This follows the definition of Eckerson (2009) (Section 2.3). Parmenter's (2009) definition of a PI: "What to do" (Section 2.2.1) is not used throughout the remainder of this report.

Now we know the characteristics of a good KPI and PMS. The next section looks at the KPIs that are currently used to measure supplier performance. Do these meet the characteristics of a good KPI and PMS?

2.4 Which KPIs are currently used to measure supplier performance?

A company's business is affected by her suppliers (Pikousová & Průša, 2013). Therefore, it is important to determine the "right" KPIs to measure supplier performance. This evaluation of quantitative information reduces risk and maximizes value (Zeydan et al., 2011), and can also be used to assess competitiveness (Da Silva & Borsato, 2017). Supplier performance evaluation systems are company specific, as they depend on strategy, size and philosophy (Pikousová & Průša, 2013), and should be aligned with customer requirements (Selviaridis & Spring, 2018). Another aspect to take into account is that people fear negative results, which leads to a perceived punitive aspect in all performance measurement processes (Galar et al., 2011).

2.4.1 Categories as a basis for KPIs

Categories (criteria, attributes) are used to classify and select KPIs (Balfaqih et al., 2016). The most important categories in measuring performance are quality, delivery and costs (Ho et al., 2010). However, these are not the only categories supplier performance is based on. The categories are:

- Financial (Pikousová & Průša, 2013; Bai & Sarkis, 2014; Choy, Bun Lee & Lo, 2004; SCOR; Balfaqih et al., 2016);
- Quality (Pikousová & Průša, 2013; Bai & Sarkis, 2014; Choy et al., 2004; SCOR; Balfaqih et al., 2016);
- Delivery (Pikousová & Průša, 2013; Choy et al., 2004);
- Flexibility (Bai & Sarkis, 2014; Choy et al., 2004; SCOR; Balfaqih et al., 2016);
- Time (Bai & Sarkis, 2014; SCOR; Balfaqih et al., 2016);
- Innovation (Bai & Sarkis, 2014; Balfaqih et al., 2016);
- Product Development (Choy et al., 2004);
- Customer (service) (Choy et al., 2004; Balfaqih et al., 2016);

- Environmental (Bai & Sarkis, 2014; Balfaqih et al., 2016).

The category "organization culture" by Choy et al., (2004) is another name for flexibility. Therefore, this is added under "flexibility". Pikousová and Průša (2013) distinguish between quality and claims, where the claims are the cost of poor quality, undelivered goods or wrong spare parts. According to Bai and Sarkis (2014) and Choy et al. (2004) these claims are part of "quality" and, therefore, not written down separately. The SCOR model (Supply Chain Council, 2012) distinguishes three attributes that are relevant here: reliability, responsiveness and agility. These, however, are categorized under quality, time and flexibility, respectively. Balfaqih et al. (2016) listed more categories, however, as their research is based on the entire supply chain, not all categories are relevant for supplier performance measurement. It is important to design performance measures for suppliers and reward and penalize accordingly (Selviaridis & Spring, 2018). The categories to base performance measures on are the basis for developing KPIs. These KPIs can then provide feedback to the suppliers on how they can improve their performance (Dey et al., 2015) and positively affect the company's business.

Besides these formal controls, there are also informal controls, which are not designed explicitly. An important informal control instrument is trust (Pernot & Roodhooft, 2014). Sako (1992) distinguishes between three types of trust: contractual trust (i.e. expectation that the supplier keeps promises and complies with agreements), competence trust (i.e. expectation that the supplier has the competences necessary to deliver) and goodwill trust (i.e. expectation that the supplier shares commitment, and the willingness to perform activities, even though it is not in the suppliers interest nor in the contract). Whether a supplier keeps promises or has the competences needed are measurable and could be included as a category. Goodwill on the other hand is more difficult to measure and include as a category (Pernot & Roodhooft, 2014). According to Bai and Sarkis (2014), these informal controls (trust and partnership) are part of "quality".

2.4.2 KPIs used to measure supplier performance

There are different sources to look into while searching for the KPIs that are currently used to measure supplier performance. Here a literature study is conducted and the KPI library has been consulted in order to find an extensive list (probably still incomplete) of KPIs used.

Literature

Although companies should select their performance indicators with caution, Meier et al. (2013) have formulated a list of KPIs that could be used as a starting point for companies in the service industry. These are based on the service processes of the organization that are delivered to the organization's customers. However, when considering Odin Groep the customer, these KPIs can be used to measure Odin Groep's suppliers. A second group based their KPIs on the SCOR model. According to earlier versions of this model, a company's supply chain is represented by four processes: plan, source, production and delivery. Later, they added return and enable (Zhou et al., 2011). This view of the processes can be useful to identify KPIs (Chae, 2009). Chae (2009) proposed some KPIs for all four initial SCOR processes, whereas Bai and Sarkis (2014) created a list of KPIs to evaluate the process "sourcing" alone. They developed both business and environmental KPIs (Bai & Sarkis, 2014). Others determined KPIs using case studies. Selviaridis and Spring (2018) evaluated KPIs to measure supplier performance in case studies, where the KPIs are linked to payment mechanisms and performance incentives. The KPIs were updated and improved during the study as well (Selviaridis & Spring, 2018). Pikousová and Průša (2013) defined performance as the ability to deliver the agreed quality on time in their case study, and specified four KPIs accordingly. A third case study used four KPIs to measure supplier performance (Choy et al., 2004). To define KPIs for informal controls (i.e. trust), Pernot and Roodhooft (2014) identified certain factors that contribute to goodwill trust: shared norms and values, willingness to be indebted, bond of friendship, goal setting, trustworthiness, reputation and a long term

relationship. There are, however, no actual KPIs mentioned in this paper. Literature is not the only way to find KPIs that are used in practice. Another source is the KPI library.

KPI Library

The KPI library[2] is an online database filled with thousands of KPIs and their explanation (ServiceNow, 2018). Anyone can subscribe to this library, add KPIs to it and rate the KPIs that others have added. KPIs can be selected by industry, process or framework in this library (ServiceNow, 2018). To find KPIs that are applicable to supplier performance measurement, the following filters are used:

- Business process >> Supply chain, inventory & logistics >> Logistics; Order fulfilment; Supply chain;
- Business process >> Procurement, suppliers & outsourcing >> Suppliers; Procurement;
- Business frameworks >> SCOR | supply chain.

Useful KPIs

A literature study and a search in the KPI library resulted in a list of KPIs (Appendix D), of which the useful KPIs are displayed in Table 2. The initial list contained a lot of duplicates, either exactly the same, or different names for the same indicator. These have been merged into a single KPI in both Appendix E and Table 2. Some "KPIs" in this list are not KPIs, but KRIs (result indicators) by the definition of Meier et al. (2013), who mentioned that absolute numbers only gain significance when compared to other indicators and can be seen as KRIs. There are also KPIs that look at production, which is irrelevant for this research because Odin Groep does not produce items, and it is of no importance how the supplier produces for their supplier performance. Also, some KPIs are internally focused (Supply Chain Council, 2012) and are, therefore, irrelevant. Others are informal and, therefore, difficult to quantify (Pernot & Roodhooft, 2014). A last group of metrics contradict the most important characteristics of a good KPI. Appendix E gives the explanation why certain "KPIs" are not KPIs and/or why they are not relevant. In Table 2 are still some KPIs that do not fulfil all characteristics of a good KPI, however, these KPIs are expected to give a good insight in the "KPIs" used by others to measure supplier performance.

Category	KPI	Reference
Delivery	Accuracy of sailing list when using multiple carriers [%]	5
Financial	Invoice errors [%]	7
Communication	Escalated orders [%] (involving someone more important or higher in rank in a situation or problem (Cambridge dictionary, n.d.))	7
Communication	Uninterrupted orders [%] (automated orders that are not returned by the supplier) (opposite: re-opened orders)	7
Communication	Information timeliness [%] (Is the info present before needed?)	3
Delivery	Cancellation ratio [%] (measure of the number of originally ordered (confirmed) goods that are not delivered) (opposite: order fill rate / delivery security)	4, 6, 7
Delivery	On time delivery (in full) [%] (proportion of items/complete orders delivered on time)	1,2, 3, 4, 5, 7, 8
Delivery	Rescheduling quota [%] – Number of delivery processes that were rescheduled after the customer has been notified or after required resources have been booked in relation to the total number of delivery processes (opposite: acceptance rate [%])	2, 7
Delivery	On-Time shipment [%]	4, 7
Delivery	Product availability [%] (opposite: % of backorders)	4, 5, 7
Delivery	Orders without damage [%]	3, 5, 7

[2] http://kpilibrary.com

Delivery	Delivery errors [%] (wrong supplier delivery)	3,5,7
Delivery	Supplier rejection rate [%]	3
Delivery	Delivery reliability [%]	3
Environment	Waste generated from products and materials [%]	3
Environment	Recycled material [%] (as a percentage of used materials)	3
Environment	Carbon emissions reduction [%] (compared to the previous year)	5
Financial	Total logistics costs as % of sales	5, 7
Financial	Reduction of supply chain costs [%] per time	5
Financial	Total transport cost as % of delivered sales	5, 7
Financial	Cost variance from expected costs	3
Financial	Purchasing price variance (difference between amount paid and amount budgeted (Business Dictionary, n.d.))	7
Flexibility	Upside Supply Chain Adaptability - maximum sustainable % increase in quantity delivered	8
Flexibility	Downside Supply Chain Adaptability - % reduction of quantities ordered without inventory or cost penalties	8
Quality	Buyer-supplier partnership level	3
Quality	First time fix rate (FTF) [%] - Proportion of service delivery processes that could be completed at the first attempt	2
Quality	Orders with correct documentation [%]	7
Quality	Incorrectly assigned orders [%]	7
Time	Variability in lead time [%]	7
Time	Process stability [%] – The operating time for all delivery processes of the same type minus the average standard deviation of the operating time in relation to the operating time	2
Time	Supplier lead time against industry norm	3

Table 2: list of possible KPIs

The references corresponding to the numbers in the column “references” in Table 2 are:

1. Choy et al. (2004)
2. Meier et al. (2013)
3. Bai & Sarkis (2014)
4. Chae (2009)
5. Selviaridis & Spring (2018)
6. Pikousová & Průša (2013)
7. ServiceNow (2018)
8. Supply Chain Council (2012)

You cannot simply copy KPIs from others due to, amongst others, strategic alignment. These KPIs can, however, be used as a reference. The list of possible KPIs in Table 2 is used to make sure no KPIs and categories are forgotten in the development of KPIs for Odin Groep in Chapter 4.

2.5 Design of a performance measurement system

The design of a PMS has multiple phases (Eckerson, 2009; Neely, Mills, Platts, Richards, Gregory, Bourne & Kennerley, 2000; Balfaqih et al., 2016). Neely et al. (2000) developed a process to design PMSs, based on the theory and practice available at that time. Eckerson’s (2009) research is based on practice (surveys and interviews) alone, whereas Balfaqih et al. (2016) have based their recommended steps on an extensive literature review (not including Eckerson (2009) and Neely et al., (2000)). The scope of these three methods to design a PMS is similar, however, the order of the steps are not.

According to Eckerson (2009), firstly the strategy should be set and senior employees should be engaged in the project. Second, the project needs to be framed (i.e. scope and KPI development team). The third step is to create the KPIs themselves (Section 2.5.1), followed by prioritizing and normalizing

(i.e. giving a unique label) the KPI. The fourth step is collecting the data for the KPIs. After receiving the first data, the dashboard can be developed. Step six is marketing the project, so the PMS is actually used. Lastly, keep monitoring and revising KPIs, and teach users how to interpret the KPIs. When following Neely et al. (2000), creating KPIs is the first step, as opposed to step three in Eckerson's (2009) method. Afterwards you ensure that all important categories for measurements have been covered. Secondly, the performance measures are integrated and checked for appropriateness in the firms environment. The third step is to determine how to maximize performance given the set of performance measures. Step four is to institutionalize the PMS. Lastly, similar to Eckerson (2009), you maintain the system (i.e. revise, add and delete KPIs). The recommendations by Balfaqih et al. (2016) start the same as in Eckerson (2009), however, instead of developing the dashboard and marketing the project, they firstly modify the PMS based on stakeholders feedback and make sure to achieve consensus on the PMS. After gaining consensus the PMS is demonstrated to all stakeholders.

When combining these three methods, the following steps should be taken to design a PMS:

- Determine the corporate strategy and scope of the project;
- Create KPIs (ensure all important categories are covered);
- Integrate KPIs and check for appropriateness;
- Prioritize and normalize KPIs;
- Collect initial data, request feedback from stakeholders and modify the PMS;
- Develop the dashboard for monitoring KPIs and establish consensus on it;
- Use the PMS (market and institutionalize the system);
- Monitor and revise the KPIs (teach users how to interpret KPIs).

Some of these steps require additional information to executed them. The steps important to this research that need additional information are: create KPIs, prioritize KPIs, and the development and implementation of the PMS. These topics are addressed in the sections below.

2.5.1 Creation of KPIs

A PMS is company specific (Pikousová & Průša, 2013), therefore, KPIs cannot be copied from others and used immediately. Eckerson (2009) determined ten steps needed to create a KPI that fits the organization:

- Determine the strategic objectives;
- Develop questions based on the strategic objectives;
- Determine a measure for each question;
- Determine targets, goals and benchmarks for the measures;
- Create a diagram showing how to answer the questions;
- Determine the drivers for each measure;
- Check the data for availability and correctness for each measure;
- Make sure that the definitions are the same across the organisation;
- Ensure the desired outcomes are achieved by the measure;
- Determine who is responsible for the measure.

An addition based on Neely et al. (2000) is to add a cost-benefit analysis to ensure "high pay-off measures" are identified. Another concept to take into account is strategic alignment, which is explained in Section 2.2.2.

Creating consensus using the Delphi method

In the first steps, the objectives are determined. When multiple people are involved, their objectives might not be the same. There are multiple ways to create consensus: classical dynamic consensus approaches, time modelling consensus approaches, dynamic environment consensus approaches, and adaptive consensus approaches (Pérez, Cabrerizo, Alonso, Dong, Chiclana, & Herrera-Viedma, 2018). Given the limited timeframe of this research, the time modelling- and dynamic environment methods

are not feasible. The classical dynamic approach is an iterative and dynamic process where experts can modify their preferences until consensus is reached (e.g. change of preferences technique). The Adaptive approach is similar to the classical approach, extended by a feedback mechanism to generate recommendations (e.g. the collective consensus level technique) (Pérez et al., 2018). A frequently used technique to obtain consensus is the Delphi method from Dalkey and Helmer (1963) (Hsu & Sandfort, 2007).

The Delphi method uses multiple rounds of questionnaires and controlled opinion feedback to generate consensus amongst a group of people, while preventing the individuals in the group from direct confrontation with one another (Dalkey & Helmer, 1963). The number of rounds possible is unlimited, however, three iterations is mostly sufficient to reach consensus (Hsu & Sandfort, 2007). The first round usually contains an open ended questionnaire, but, could also already be a structured questionnaire depending on the amount of information already present. The second round is based on the first round, and aims to find agreement and disagreement. The third round asks for reasons for remaining outside consensus and the next rounds share remaining items and minority opinions (Hsu & Sandfort, 2007). Different scholars have different opinions in a measure for consensus (Hsu & Sandfort, 2007), however, when looking at percentages, these usually lie between 70% and 80%. Others mention the importance of the stability of the respondents' answers (Hsu & Sandfort, 2007). Following the majority, 75% of agreement is defined as "consensus" throughout this report.

2.5.2 Choice of KPIs

In case too many KPIs are created (i.e. more than 10 per business unit [Section 2.3]), you have to decrease the number of KPIs to use. There are two methods to decrease the number of KPIs based on an initial set of candidate indicators: aggregation and selection (Podgórski, 2015). Aggregation is to combine multiple indicators into a higher-level performance indicator, and selection is to prioritize the KPIs based on criteria (Podgórski, 2015). According to Podgórski (2015), the PMS can be kept much simpler with the selection method. Gonçalves et al. (2014) found that multi criteria analysis is an effective tool to rationally, explicitly and efficiently select KPIs based on objectives and strategies.

There are multiple multi criteria decision making (MCDM) methods (Podgórski, 2015; Kumar, Sah, Singh, Deng, He, Kumar & Bansal, 2017), of which AHP is the most frequently used (Podgórski, 2015) and applied in logistics and engineering (Kumar et al., 2017). Another method is ANP, which can actually work with interdependencies (Ha & Yang, 2017), and is the most outstanding technique following the comparison study by Couger (1995). However, ANP has limited application in the logistics and supply management domain (Kucukaltan et al., 2016). The MCDM method ELECTRE has been applied in logistics and engineering before (Gonçalves et al., 2014).

When performing a multi criteria analysis, a choice for the method needs to be made first. Then weights and rankings of importance have to be determined for the criteria, depending on the decision to be made (Bhushan & Rai, 2004). A lot of the criteria can be derived from the characteristics of a good KPI (Eckerson, 2009). However, this list is not exhaustive. Another important criterion is decomposability. Decomposability ensures that the performance of attribute A can be judged without considering the performance of attribute B (Goodwin & Wright, 2004).

2.5.3 Implementation of the PMS

Designing a PMS is challenging, however, implementing it is the most difficult task (Neely et al., 2000). Implementation fails for different reasons (Bourne, Neely, Mills & Platts, 2003a). Good KPIs are of no value if you fail to implement the PMS. First of all, change management is an important factor in implementing a PMS (Bourne, Neely, Mills & Platts, 2003b). Although general, the literature does provide a good checklist to address when implementing the PMS, mostly based on the phases of change by Lewin (Bourne et al., 2003b). Lewin (1947) defined three steps of change: unfreezing,

moving and refreezing. This last step, refreezing, is found by some to be obsolete as, especially in technology, the rate of change is too high to refreeze (Bourne et al., 2003b). Secondly, there are some barriers to implement a PMS.

Implementation barriers
Few authors addressed the barriers to implement a PMS (Bourne et al., 2003a). Bourne et al. (2003a) summarized the difficulties faced when implementing a PMS. These are:

- Corporate strategy is not actionable;
- Failure to link strategy to objectives;
- Metrics are poorly defined;
- Difficulties to identify true "drivers";
- Goals are negotiated and not based on requirements;
- Time and costs;
- The number of measures and how to quantify these;
- Striving for perfection.

When these barriers have been overcome, the PMS can be implemented. When an organisation succeeds in implementing the PMS, there are still some aspects to consider. The usage and maintenance of the PMS require ongoing attention (Neely et al., 2000).

Successful implementation
Parmenter (2007) defines four foundation stones for the successful implementation of KPIs: partner with stakeholders, empowerment, integration, and strategic alignment. After implementation, the organisation has to make sure their employees have the skills required to interpret and analyse the data. When these people are not around, the PMS becomes less and less valuable, and more complex (Neely et al., 2000). This is because the PMS needs to be maintained by these employees. New measures should be added and obsolete measures deleted (Neely et al., 2000).

Lewin's change management model
A change is frequently short lived, as life soon returns to the old situation (Lewin, 1947). Lewin's change management model (1947) can also be used for software maintenance and software changes (Hanafi & Abdel-Raouf, 2014). The implementation of the actual PMS is in fact a piece of software to develop and to get adopted. The three stages, and how they are related to software changes are explained:

- **Unfreeze** or breaking the habit. This is the stage where planning and preparations take place;
- **Move** or the actual change. Here the software is developed;
- **Refreeze** or stabilize the organization in its new state. This is where the software passes all tests, and where users accept the new software for stable usage.

Although some say the refreezing step is obsolete, this is thus not the case for software changes and development, following the steps from Hanafi and Abdel-Raouf (2014).

2.5.4 Developing the dashboard

The dashboard is the front-end interface of the PMS (Vallurupalli & Bose, 2018). A generic definition of a dashboard is: *"A graphical user interface that contains measures of business performance to enable managerial decision making."* (Yigitbasioglu & Velcu, 2012, p.44).

Dashboards help to identify patterns, anomalies and trends (Yigitbasioglu & Velcu, 2012). The first step is to identify the purpose to enable a functional fit, then the users and dashboard features need to be designed (Yigitbasioglu & Velcu, 2012). The PMS shows multiple KPIs, which should be presented in such a way, that the recipient can quickly interpret the information offered (Fortuin, 1988; Eckerson, 2009), which should preferably be on a single page (Parmenter, 2007). The dashboard features enable

a cognitive fit, and enable visualization and decoding of information by the users (Yigitbasioglu & Velcu, 2012). A poor visual design may lead to confusion and distraction (Yigitbasioglu & Velcu, 2012). In order to effectively analyse and interpret the data, the dashboard needs to be clear. When you want to assess progress, time comparison needs to be incorporated, and a target should be displayed to keep track of the objective (Fortuin, 1988).

Although tables are a good method to present data, these are more difficult to interpret for the human brain than graphs (Wolf, 2016). Therefore, a graphical interface is suggested. Multiple types of graphical interface to present the KPIs exist, for example: time diagram, histogram, speedometer, et cetera (Fortuin, 1988). Developing a dashboard is all about the presentation (Wolf, 2016). It is important to select an appropriate graph type for each KPI, to ensure the correct message is communicated (Parmenter, 2007) to the right person. Although there are many types to choose from, it is wise to be consistent, thus choose one or two types to use (Wolf, 2016). This way, users do not have to adjust perception for each KPI. Likewise, you should put numbers in context and develop different dashboards for different audiences (Wolf, 2016). Developing a dashboard is an iterative process, where feedback is asked from the users to improve the dashboard (Wolf, 2016). The dashboard is never perfect, and depending on the users, should be improved and updated regularly.

2.6 Conclusion

PMSs have been around since the 1900s. The first systems were criticized, which lead to the development of balanced PMSs such as the balanced scorecard and the supply chain operations reference. One of the key challenges of a PMS is the development of KPIs. There are different types of KPIs: KRIs, PIs and KPIs. For the development of a KPI, it is important to look at strategic alignment (i.e. strategy, objectives and KPIs should be aligned). Designing a KPI is not an easy task, and incorrect KPIs could even result in dysfunctional behaviour. This leads to the answer of the first Sub question:

Sub Question 1: What are the characteristics of a good PMS and its KPIs?

Many authors have given characteristics of a good KPI and PMS, either from theory, or from practice. Ten characteristics of a good KPI are defined. These are:

- A good KPI is simple: it is understandable, unambiguous and clear;
- A good KPI is relevant: it makes no sense to introduce a measure without purpose;
- A good KPI is measurable: the formula should measure something controllable;
- A good KPI is comparable: to compare over time, you need a consistent data source;
- A good KPI is trustworthy: if the data is not trusted, it will not be used;
- A good KPI is independent: KPIs should not undermine each other;
- A good KPI is validated: it is tested to ensure the outcome is the result of the desired actions;
- A good KPI has an objective: the KPI should relate to business objectives;
- A good KPI has a target: a SMART target should be present for each KPI;
- A good KPI has impact: people take action as it is known how to influence the KPI.

Five characteristics of a good PMS are defined as well. These are:

- A good PMS uses a small number of KPIs;
- A good PMS uses balanced KPIs: both financial- and non-financial methods, sometimes a KPI needs to be balanced by a second KPI to drive correct behaviour;
- A good PMS distributes responsibility: someone has to be responsible for the KPI, data needs to be collected, and someone should take action based on the KPI output;
- A good PMS makes sure the KPIs are measured frequently: depending on the importance of the KPI and the availability of data you have to measure frequently;
- A good PMS gives the possibility to zoom in on underlying PIs: although strategy can be reflected with few KPIs, to monitor processes you need underlying PIs as well.

These characteristics can be used to determine whether the KPIs as proposed in literature are actually good KPIs. As PMSs are company specific, one cannot simply use the KPIs that others use. Now the second sub question can be answered.

Sub question 2: Which KPIs are currently used to measure supplier performance?

KPIs are usually categorized. The most important categories are: finance, quality and delivery. Other frequently used categories are: flexibility, time, innovation, product development, customer service and the environment. Besides these formal categories, there are also informal categories such as trust and goodwill. However, which KPIs do others use for these categories?

From the literature and the KPI library followed a long list of possible KPIs, of which some were duplicates, irrelevant or did not fit the characteristics of a good KPI as determined in Section 2.3. In Table 2, the list of useful KPIs is shown. This list will be used to check if no important KPIs and/or categories are forgotten in the development of KPIs for Odin Groep (i.e. Sub question 4).

Now that the theoretical background is present, it is important to know how a PMS is designed. Combining the ideas from different scholars leads to a plan with eight steps: determine strategy, create KPIs, integrate KPIs, prioritize, collect data, develop the dashboard, use the PMS, monitor and revise. For the creation of KPIs, multiple steps are needed and strategic alignment needs to be taken into account. Also consensus on the objectives needs to be obtained, which can be done using multiple methods. The Delphi method (i.e. multiple rounds of questionnaires with controlled opinion feedback) is a suitable and frequently used method to do this. In case there are too many KPIs, a choice needs to be made. This can be done by either aggregation (i.e. combining KPIs) or selection (i.e. selection based on criteria). Multi criteria analysis is seen as the most promising method here. After the selection of the KPIs, the PMS needs to be implemented. This is the most difficult step in the development of the PMS. You have to take into account different implementation barriers, change management and you have to look at the future to ensure the PMS can be used and maintained correctly. When you implement the PMS, the dashboard becomes visible. The data on this dashboard should be quickly and easily interpreted in order to enable decision making. Depending on the required information, different types of interfaces (ideally graphical) can be used, as long as the dashboard remains clear and concise.

3. Analysis

This chapter starts with a description of the current situation at Odin Groep in Section 3.1. Section 3.2 shows the goals and requirements Odin Groep poses for the PMS, its KPIs and the categories to base these KPIs on. This is followed by an introduction of the requirements posed by certifications in Section 3.3. Section 3.4 compares the goals and requirements from Odin Groep with the literature from Chapter 2. The next section, Section 3.5, contains a summary of the Delphi study, the changes made to personal opinions and the choices made in terms of categories. Lastly, Section 3.6 concludes this analysis and answers Sub question 3.

3.1 Current situation

Nine interviews with representatives of the departments responsible for supplier performance measurement have gained insights in the current situation at Odin Groep. Appendix F shows the departments of the interviewed representatives (managers and team leaders) and the assigned reference. This reference is used to show from whom the opinion in the analysis below is.

3.1.1 Background

Supplier performance measurement is an increasingly important topic at Odin Groep. However, can all suppliers be treated similarly? Are there already other performance measurement systems in place which can be learned from? And is customer demand shared with suppliers?

Different types of suppliers

At Odin Groep, there are different types of suppliers. First of all a distinction could be made between vendors and distributors (who sell the items of multiple vendors). Suppliers that supply tangible products, virtual products (e.g. licenses) or services. Suppliers that supply services exist in multiple forms: firstly the carriers, that move the goods from the supplier to Odin Groep, which is always a third party (A1). Secondly, there are suppliers that pick up goods, and thirdly, there are the suppliers that fulfil a service to one of Odin Groep's customers. The representatives of Odin Groep do not agree whether there is a difference between these or not. Some say there is no difference at all (A1) or no difference between products and services (A3; A4). This is because all products could deal with damages and errors (A1), whether they are sold as a license or in a box (A5). Others say there is a difference between suppliers that deliver supplies, suppliers that pick up items (e.g. garbage) and suppliers in the 3PL sector (A4), between products that are pushed to you by the supplier and products that you have chosen yourself (i.e. pull) (A3), or between products and services (A5; A8). Products and services differ in the ease of measurement, as you cannot measure a service in advance (A8), and because of the use of SLAs for services (A5). On the other hand, SLAs could also exist for products (A1).

Other performance measurement systems

At Odin Groep, some departments already use PMSs and KPIs. Management determines the financial KPIs for the businesses, based on the business plans (A5). Marketing uses analytics for the website and a marketing automations tool (A2). The Sales Department uses a sales app to extract information about, for example, the percentage of tenders won, turnover and the order book (A3). Back office and Logistics built a dashboard in Excel to measure waste, working hours, financial KPIs and many more (A4). Finance also uses an Excel, as other reporting tools present are too slow and unreliable (A6).

Sharing customer demand

The demand from the customer is usually "translated" before it is passed on to the supplier (A1; A3). The exception are tenders, where the demand is automatically passed on (A3). And questions from customers, which are sometimes literally escalated (through e.g. support tickets) to suppliers to engage the supplier to be part of the solution (A7). There is room for improvement in the usage of the suppliers' knowledge to solve customer demand (e.g. presales departments) (A7).

3.1.2 Performance measurement system

Currently suppliers are rated subjectively. There is not really a system in place that rewards good suppliers and penalizes bad ones (A2; A3; A4; A5; A6; A7; A8; A9). Good suppliers do receive more business already (A3; A4). There is a good connection between Odin Groep and those suppliers, resulting in fulfilling mutual needs. The supplier needs a good customer that pays in time, Odin Groep needs a supplier that is stable and delivers the right products of the right quality and quantity at the right time (A5). Contrarily, bad suppliers are penalized with less, or even no business depending on the availability of substitutes (A1). If there is a substitute, it is relatively easy to stop doing business with a bad performer. Otherwise, Odin Groep has to work hard to increase the cooperation (A1).

Supplier performance is not consistently measured. Only the five most important suppliers have their performance evaluated once a year (A1), using the sheet in Appendix B. Previder (one of Odin Groep's companies) uses SLAs to "measure" supplier performance (A7). However, only few things (e.g. availability) are measured (A7). Most departments do not measure supplier performance at all (A2; A3; A4; A6; A8), either it is not possible to gather the required information from the systems (A4), or there are unmonitored SLAs in place with suppliers (A7). Another reason is that the supplier needs to be new to do a creditworthiness check (A6), which does not happen often as Odin Groep works mostly with known, reliable suppliers (A6). Most suppliers are from Europe, but there are also suppliers from China, whose performance is hard to measure, because what they say and what they do does usually not match (A9). Performance of the Chinese suppliers is always checked, through end checks by a third party (DEKRA) based on a "golden sample" (A9). DEKRA then writes a report on which Odin Groep reacts. It is told to the Chinese if they are doing good or not, and what they have to improve.

3.1.3 Information availability

Although there is no sound PMS in place, Odin Groep already gathers some information. Most documented information is financial (A2; A5; A6), however, also marketing activities are documented (A2). Undocumented, there is a lot of data, either in the brains of employees (A3; A5) through communication (A9) or hidden in the online portals of the supplier (A2). There is not much data documented, as it takes a lot of time to do this by hand (A4), because there is not a good system in place to do it (A1; A5) or because the data simply is not there. Somewhere in the systems (BI tooling) there is information, but to use this it firstly needs to be extracted.

3.2 Goals and requirements from Odin Groep

The same nine interviews and references as referred to in Section 3.1 are used to establish which goals and requirements Odin Groep has for the PMS. Firstly the reasons for a PMS are given, then the goals are discussed, followed by the requirements for the PMS and lastly the requirements for KPIs.

3.2.1 Reasons for a PMS

A PMS gives the possibility to: structurally measure performance (A7), have substantiated meetings with suppliers to make agreements (A7), keep suppliers sharp (A2) and show what they are doing good, what not and how they can improve (A1; A2; A7). Ensuring quality is the most important aspect here (A1; A2; A5; A7), for both products (A3; A8) and delivery. Products need to work as intended and should be reliable (A3). This is so important, even customers ask how quality is ensured (A7). Suppliers are more and more part of the strategic products and solutions Odin Groep sells to her customers. Therefore, the supplier has to be able to meet the continuity, speed and stability that Odin Groep agrees on with her customer in SLAs (A5). Suppliers do thus set the standard for SLAs towards customers. Next to ensuring quality, the measurement results can be used to negotiate new contracts with the suppliers (A1). If Odin Groep is the problem (e.g. incorrect orders) then the supplier cannot get the blame (A1). Measuring supplier performance could thus also increase the performance at Odin Groep, as mistakes will come to light.

3.2.2 Goals

The main goal is that Odin Groep wants to ensure quality and improve her suppliers. As all suppliers have their plusses and negatives, what to improve is different per supplier. The bottom line is that they deliver the right quality and quantity in time (A8). There are some aspects that most suppliers can improve on. These are collaboration, communication, SLAs and pricing.

Collaboration is the first aspect (A3; A4). Because Odin Groep moves towards more and more recurring business (instead of one-off handling), suppliers become more important as part of Odin Groep's services (A5). Therefore, Odin Groep has a problem when her supplier has a problem, which leads to the need to work closely together, and have a more intense connection (A5). To create this connection, Odin Groep could connect systems to simplify order processing, however, the current system has issues translating (A1). There are multiple aspects of collaboration: contacts (A3; A4), customer orientation (A4), qualitative reports (A4), trust (A4), continuity (A4), innovativeness (A4), strategy (A4), acknowledging mistakes and problem solving (A7), or sitting together to discuss the go-to-market of suppliers and find out the advantage for Odin Groep (A5). Another aspect is communication (A3). As Odin Groep does not choose for a new vendor each year (A1), the vendors usually do not communicate with Marketing, leading to: the inability to understand that Odin Groep cannot participate in every proposed activity (A2), and pushing products in the spotlights, even if they do not really fit Odin Groep's market (A2). With the Chinese suppliers, speed and honesty in communication are very important (A9). Currently they have the tendency to keep Odin Groep in suspense (A9). A third aspect that could be improved are SLAs. Odin Groep should use the SLAs she has with her customers to determine the SLAs with her suppliers (A7). Of course, you cannot ask from a supplier to improve what is not discussed or written down in an SLA. When asking for a SLA, some suppliers add a lot of unnecessary things (A7), making it difficult to come to an agreement. The last aspect is pricing, which is already quite good in some cases (A9), however, could most of the time be better (A5).

3.2.3 Requirements for the PMS

There are multiple topics that contain the requirements of a PMS. Should it work with other systems? Who will use the system? And: What will the dashboard look like?

System

The PMS could be a stand-alone system (A4; A8; A9), as there are no suitable tools present anyway (A9). However, it would be nice to integrate the system with the ERP system so that the PMS extracts data from the ERP system (A1; A2; A3; A5; A6; A7), and does not become an island (A5). Other systems that need to be connected are the marketing automations system (A2), the CRM system (A1; A3) and the service management system (A1; A7).

Users

The Purchasing Department is leading in the usage of the PMS, because: supply management is part of Purchasing (A7), Purchasing has most contacts with the suppliers (A9), the task is already at Purchasing (A6) or without a specific reason given (A1; A4; A5; A8). Next to Purchasing and Logistics, team leaders and managers of the departments Sales (A1; A2; A7), Marketing (A1; A2; A5) Finance (A2; A5), Quality Management (A5) Service & Support (A7) and Product Management (A1; A9) should be able to generate reports and see the data, whereas Management (A1; A8; A9) should be informed (A5).

An important aspect to take into account here is that the more people see the reports, the more people have an opinion about it (A1). Therefore, it is crucial to create personalized dashboards (A7), where certain tabs that are invaluable to the user are disabled. Another aspect is the question who should use the system. Team leaders can directly take action (A7), however, managers could signal the problem and forward it to the team leader (A1). It all comes down to the autonomy to make decisions. It might not be the same person who detects the deviation and who takes action (A1; A7).

Rewarding suppliers
As a PMS gives Odin Groep the possibility to objectively measure supplier performance, Odin Groep could reward and penalize suppliers. Reactions to this differ. Some are against, because suppliers simply have to deliver what they promised, and should be happy they can do business (A6), because it would not make a difference for suppliers (A9), or because it is unknown how this would work for Odin Groep (A5). Others are in favour (A8) as it would look fancy if Odin Groep shows her appreciation as well (A9), also taking into consideration that suppliers reward Odin Groep already (A8; A9).

During the interviews, the idea to give the suppliers a status (e.g. silver, gold, platinum) emerged (A1; A2; A7; A8). This is already used by suppliers to give their customer a status (A1). This could increase competition between suppliers because they want at least the same status (A2), it could also increase communication from suppliers on how they can improve (A7) and it could help create a professional look for Odin Groep (A8). As a growing organization, there are already preferred suppliers, but measuring their performance on Odin Groep's standards will show professionalism, increase services from suppliers, which in turn increases the services from Odin Groep to the customer (A8). A footnote here is that not all suppliers are sensitive to receiving a supplier status (A5). It will not happen that Odin Groep starts to just give away money to good suppliers (A5). Another idea, however, not for rewarding, is a cards system similar to ISO (A4). A yellow card is a point for improvement. A red card indicates the company stops doing business with you, or you should drastically improve.

Number of KPIs
A PMS consists of multiple KPIs. These KPIs need to be relevant (A1; A5). A general remark here is the fewer KPIs, the better (A1; A5; A7; A8) as you cannot focus on a lot of KPIs at the same time (A3). The representatives wanted an average of four KPIs for a department, where the answers ranged from two KPIs (A4) to ten KPIs (A5). The total system can have more KPIs (A1; A3) with multiple departments having on average four KPIs, this soon adds up to a maximum of around twenty KPIs.

Dashboard
Firstly it is important that you can select a supplier on the dashboard (A1; A8). The data necessary on the dashboard are the KPIs (A3; A4; A6), represented graphically (A4; A5; A7; A9). As all departments need different inputs, a main dashboard with the overall grade would be nice (A1; A2). There should also be pages specific for a department (e.g. Marketing, Sales, Purchasing) where the main KPIs for the department are shown. When a value on the dashboard is below the target value, there should be a possibility to zoom in further (A1; A2; A7; A9), either to the data (A9) or first to other PIs (A7). Filling a screen with too many meters is not desirable, management by exception on the other hand is desirable (A1; A7). For the graphical representation, some of the suggestions given are: round counter (A4), beam from red to green (A4), smileys indicating good or bad (A7) and a pie chart with all KPIs (A9).

3.2.4 Requirements for KPIs
There are not many KPIs present yet to measure supplier performance, as the departments that do not measure also do not have KPIs for it (A2; A3; A4; A6; A8). The few departments that do measure supplier performance do this mostly based on intuition, and thus do not have KPIs for it either (A1; A5). Others do measure more objectively, but in the case of China, there is an external company that measures the supplier performance (A9). One department has some KPIs, based on the SLAs. However, these are not used and monitored (A7).

There is some consensus on the characteristics of a good KPI. First of all, a good KPI needs to be SMART (A2; A7; A8), where one of the aspects, measurable, is the most important characteristic according to the interviewees (A1; A3; A4; A6; A9), as you cannot use something you cannot measure. The KPI should have a target value (A1; A4), should be simple (A5; A9), realistic (A3), reliable (A6) and specific (A6). The system should also work in practice (A5), meaning it can deal with exceptions (A5) and

interpret data correctly (e.g. late payment because of a dispute is not actually late) (A9). The data should be pure and from a reliable and consistent source (A6) to make sure you make the right decisions (A6).

Target values
Each KPI measures a specific aspect of the suppliers' performance. To determine whether performance is good or bad, a target value is needed. The target value of a KPI should depend on the expectations of Odin Groep (A3; A8) and should be relative to earlier scores (A9). Therefore, it is important to start analysing data before setting targets (A1). Important to take into account are that targets are attainable (A1), and that internal KPIs are not competing with supplier performance (A1). Targets should also depend on the type of product and service and the type of supplier (A4; A5), for example: you can expect next-day delivery from a broadline distributor, but not from smaller suppliers (A5). You should also distinguish in the number of deliveries, as a percentage in a dozen boxes changes quicker than when thousands of boxes have been delivered (A4). After the targets have been set, these should be communicated with suppliers (A1), so they know them as well.

Information about the KPIs
KPIs could be documented in different ways. You could choose to show the name of the KPI, the description, formula and output. Another way is to document more information. Not every interviewee is in favour of additional information about the KPIs. Some simply assume a KPI is correct when it is put to use (A3; A5). If this assumption is incorrect, making decisions based on the KPI becomes difficult (A3). That is why Odin Groep firstly needs to make sure that the values cannot be interpreted wrongly or give distortions (A5). Others desire additional information about the KPI, however, they do not all require the same. Necessary data that was mentioned are: the input of the KPI with the underlying data (A4; A8; A9), the meaning of the score (A8), the norm (A8), an overview of the progress (A6), who developed the KPI (A7), and the exceptions, so you can determine whether it is a real "exception" or a structural problem at the supplier (A8). A direct link to the information in partner portals of suppliers (A2) could also give additional information.

Categories
The different departments need different information about suppliers. Therefore, the categories they are interested in differ. Apart from that, there is a large portfolio of suppliers (A7), and although it is unclear whether Odin Groep needs to differentiate between groups of suppliers, it comes down to the right product, at the right quality, at the right quantity and at the right time (A8).

Communication is an important category (A1; A3; A5; A6; A9). Information needs to be communicated about, for example, the backlog (A1) and marketing options (A3). Communication should be fast, honest and accurate (A9). Secondly, suppliers should have clear contacts, preferably one (A3), who is well informed about Odin Groep and the agreements in place (A3; A5). Thirdly, the suppliers' contacts should be proactive in sharing valuable information (A1; A3; A5). Lastly, suppliers should not send out automated messages when they do not have their own systems fully functional (A6). It happens quite often that, mistakenly, a message that Odin Groep has not paid yet is sent out by the supplier, while the supplier's system is the problem (A6). Other categories are creditworthiness (A6), fit with corporate strategy (A2), partnership and cooperation (A3; A4) (i.e. sharing knowledge and company visits) (A7), ease-of-doing business (i.e. good account management, easy systems, easy ordering, on time invoices) (A5) but also whether the expectations match (A9), quality (A1; A4; A5; A7), reliability (A1; A3), delivery (A1; A7), support (A7), relevance (A2), certifications (A7) and SLAs (A7).

Sustainability
"Sustainable entrepreneurship is to strive for both a high efficiency and to utilize opportunities for a better environment, and more wellbeing for our employees and society" (Odin Groep, 2017).

As Odin Groep is increasing in size, sustainability has been put higher on the agenda (A2). Sustainability is something that comes from the heart (A5). Recently a project group started on sustainable entrepreneurship (A1) and created the first annual report on this topic (Odin Groep, 2017). This report measures the sustainable performance of, for example, processes, housing and purchasing (A1). Sustainability is important (A5; A7; A8), however, Odin Groep has not made the environment her USP (A5). Price and quality are most important, then sustainability is taken into account (A5; A7; A8).

Odin Groep focusses on three pillars of sustainability (Odin Groep, 2017), of which the factors that are important for supplier performance measurement are highlighted below:

- People: Odin Groep puts effort in developing sustainable relationships with suppliers;
- Planet: Odin Groep bundles her orders for transportation through efficiency planning in order to decrease CO2 emissions;
- Profit: Odin Groep strives to purchase as many products and services as possible locally.

When Odin Groep finds out one of the suppliers is a polluter, she will look for alternatives (A5). In the Chinese factories there are social audits to ensure there is no child labour (A5). It is not only about what the supplier does, but also whether it fits the requirements from Odin Groep (A1). The goal is to only purchase from a supplier who has it "in order" (A7). Next to Odin Groep's own requirements, ISO 14001 (A7; A8; A9) and customers (A3; A7) demand to look at the environment. In tenders, however, customers tend to exaggerate, making it more about paperwork than actually about sustainability (A3).

Safety

Safety should be a checkbox (A2; A5). The responsibilities towards the customers and staff are something you would expect a supplier to take into account (A2). Most products are certified (e.g. CE) and when Odin Groep knows the product is unsafe, it will not be purchased (A5). Considering virtual security, this is basically the right to exist for an IT company (A8). On the other hand, when selling products to a classroom full of kids (Heutink ICT), the products should be extra safe (A9). If something would happen there, the impact is enormous (A9).

Services are judged on security risks (A10). In case a supplier processes personal data, a processor agreement is in place, which describes how to take the technical and organisational security measures necessary (A10). Odin Groep does not do extensive safety checks on her products. Except for the Predia line, where Odin Groep has supplier responsibility (A5). A third party does the final quality and safety checks in the factories. When many mistakes are made, there are also intermediate checks (A9).

Suggested concepts as a basis for KPIs

Some suggestions for concepts to base the (key) performance indicators on were given by the interviewees. These have been categorized by the categories from Section 2.4:

- Financial – Marketing funding (amount and ease of use) (A2);
- Quality – Damages (A4); Number of incidents (A7; A8); Percentage of fall outs (A3); Availability (A2; A7); Number of questions/remarks on products received (A1);
- Delivery – Percentage of deliveries late (A6); Number of changes of delivery date (A1; A4); First-time-delivery (i.e. how quick and complete) (A1; A5; A6); Magnitude of delivery date changes (e.g. day, week, month) (A1); Maximum delivery time in a product group (A4); Delivery conform SLA (A7); Percentage of incorrect deliveries (A6);
- Flexibility – Going the extra mile (A1; A5); Marketing campaign availability and freedom (A2);
- Time – Response times (failures) (A7); Problem solving times (A7);
- Innovation – Creativity (A5);
- Customer service – Customer service performance (A7); Availability of contacts (A2);
- Other – Visitation from supplier (i.e. usefulness of the visit) (A7); Reporting (i.e. how often and quality of reports) (A7); Goodwill (trust) (A1).

3.3 Requirements from certifications

There are five certifications Odin Groep should take into account (A8): ISO 9001, for quality management, ISO 14001 for environmental management, and ISO 27001, DigiD (personal data) and NEN7510 (healthcare) for information security management. Of these five, DigiD is not as important for the PMS (A8).

Quality (Nederlands Normalisatie-instituut, 2015a)
ISO 9001 are the requirements for quality management systems. These also comprise some sections about "external providers" (suppliers). In Appendix G, the five topics important for supplier performance measurement are displayed. These requirements are about performance evaluation, supplier influence on the company, and the requirements from the company towards the supplier.

Environment (Nederlands Normalisatie-instituut, 2015b)
The requirements for and guidance to use environmental management systems are incorporated in ISO 14001. Although mostly internal, four topics are important for supplier performance measurement. These are displayed in Appendix G. These are about communication towards suppliers, changes from suppliers, and the environmental performance of suppliers.

Information security (Nederlands Normalisatie-instituut, 2017)
Information security management is documented in ISO 27001. The measures in this document are deducted from both NEN7510 (the healthcare specific variant, based on the more general ISO 27001) and ISO 27001 itself. These norms include five sections about suppliers. Specifically about risk reduction, agreements, supplier monitoring and changes of supplier. These five sections are displayed in Appendix G.

3.4 Comparison with literature

This section compares the individual opinions of the interviewees with the findings from literature. There are three parts where such a comparison is helpful: the characteristics of a good KPI, the characteristics of a good PMS and the categories to base a KPI on.

Characteristics of a good KPI
In Section 2.3, the characteristics of a good KPI are summarized. During the interviews, the question for each characteristic of a KPI that was asked is: "Do you think this characteristic is not important (-), important (+) or very important (++)?". The answers are shown in Table 3. A score is added depending on the answers given, for every (+) one point, for every (++) two points, no points for a (-). Using this method it is clear which of these characteristics deserve most attention according to representatives of Odin Groep. Table 3 is sorted such that the highest scores are on top of the table.

Characteristics	A1	A2	A3	A4	A5	A6	A7	A8	A9	SCORE
Relevant	++	++	++	++	++	++	++	++	++	18
Measurable	++	++	++	++	++	++	++	++	++	18
Simple	++	++	++	++	++	++	++	+	++	17
Trustworthy	++	++	++	++	++	++	++	+	++	17
Has an objective	++	++	++	++	++	+	++	+	++	16
Has impact	++	++	+	++	+	+	++	+	+	13
Comparable	+	+	+	++	+	+	++	+	++	12
Validated	++	+	+	++	++	-	++	+	+	12
Has a target	++	+	++	++	+	-	++	++	-	12
Independent	+	+	-	++	+	-	-	-	++	7

Table 3: characteristics of a good KPI

From Table 3, it follows that a KPI has to be simple, relevant, measurable and trustworthy, and it should have an objective. Other aspects are either less important, or not important to everyone. Some remarks on simple are that it should also be easy to read (A6) and understandable (A8). Comparability is one of those characteristics that everyone thinks is important, but not critical. In the first place you want to measure the supplier itself, and compare with for example earlier years (A9), however, later you may also want to compare suppliers to each other (A7). The same case for impact, it also depends on the meaning: if the supplier needs to take action on its own, then it is not an important characteristic, however, If you work with the supplier to set up improvement actions, then it is (A8). There are also characteristics where opinions vary. Looking at "independent" some say it is crucial, and others do not mind at all, this difference might be caused by the type of PIs a department already uses (e.g. financial PIs are usually not independent). Validity is seen as important by everyone except the Finance Department, although it was earlier mentioned by that same person that the data should be pure and correct (A6). The last factor where there is disagreement between the interviewees is that a KPI has a target. First you need to acquire data, then you can determine the targets (A1; A2; A5). Targets are thus seen as the next step to take (A5). Targets should match with SLAs (A8) and be visible in the dashboard (A7). In certain cultures targets would not change anything, according to A9.

Characteristics of a good PMS

Next to the characteristics of a good KPI, the characteristics of a good PMS are summarized in Section 2.3. These scores are deducted from the answers on more open questions. In Table 4, it is shown if there was agreement with the suggested characteristic (+) or not (-). In case it is not agreement, nor disagreement (0). The score here is the number of (+) showing agreement.

Characteristics	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**SCORE**
Few KPIs	+	+	+	+	+	+	+	+	+	9
Distributes responsibility	+	+	+	+	+	-	+	+	+	8
Zoom in on underlying PIs	+	+	-	+	-	-	+	+	+	6
Measured frequently	+	0	0	+	0	0	+	0	0	3

Table 4: characteristics of a good PMS

From Table 4, it follows that having few KPIs and a distributed responsibility are the most important characteristics. The measurement frequency has not been addressed much, but in the interviews it was, there is agreement on the fact to measure more frequently (currently it is measured once a year). Zooming in on underlying PIs is important for most departments, but for some it does not matter. This might have to do with the use of the PMS, as the departments Marketing, Finance and Management will mostly use it to watch reports and are not in the position to take action when performance drops.

Categories

In Section 2.4.1, the categories to base a KPI on were summarized. During the interviews, the question asked for each category is: "Do you think this category is not important (-), important (+) or very important (++)?". The answers are shown in Table 5. A score is added depending on the answers given, for every (+) one point, for every (++) two points, no points for a (-). Using this method it is clear which of these categories deserve most attention according to representatives of Odin Groep.

Category	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**SCORE**
Financial	++	++	++	++	++	++	++	++	-	16
Quality	++	++	+	++	++	-	++	++	++	15
Delivery	++	+	+	++	+	-	++	+	++	12
Flexibility	++	+	+	++	++	-	++	+	+	12
Customer service	++	++	++	++	+	-	++	+	-	12

Safety [3]	+	++	++	+	+	-	-	++	++	11
Time	++	+	++	+	++	-	-	+	+	10
Product development	+	++	++	++	-	-	-	+	++	10
Innovation	+	++	++	++	-	-	-	-	++	9
Environment	++	+	-	+	+	-	+	++	+	9

Table 5: categories used to classify KPIs

From Table 5, it follows that the financial and quality categories deserve most attention when developing KPIs. It should be noted that some interviewees based the importance of a category on their own function alone (A6; A9) whereas others took other departments into consideration as well. The environmental (sustainability) and safety categories are already discussed in Section 3.2. Other comments on the categories are: quality is hard to measure (A1; A3; A8) and needs to be communicated clearly. It is important to share the norm (A8). When looking at innovation, Odin Groep is a follower, and if there is a need to have additional information, it will be found by someone in house (A5). On the other hand, it would be nice to have a supplier that is innovative but not necessary (A8). Product development is very important in IT products, mostly concerning (safety) updates (A8). Also the development of products for Odin Groep (e.g. Predia) (A1; A9) is taken into account. Not all departments need customer service from a supplier. However, some are dependent on it to solve customer problems (A7), need their complaints to be heard (A8) or value the quality of communication (A1). This should be a selection category for suppliers (A8).

3.5 Delphi study

The Delphi method as explained in Section 2.5.1 is used to gain consensus amongst the interviewees. The initial interview can be viewed as the first round. The second round is used to determine agreement and disagreement between the topics where this was not yet clear. The third round asks the respondents whether they agree or disagree with a statement and how strong their opinion is. In general, consensus is established when 75% of the respondents agree on a topic, however, if this 75% excludes Purchasing and General Management, it will be seen as “no consensus”, as these are the two most important stakeholders. With no consensus, the topic will appear in the next round as well. In Section 3.5.1, the answers from the first round are summarized and merged with the outcomes of the subsequent rounds of the Delphi study. The items where there was consensus after the first round are briefly incorporated in this summary too.

Second round

The input for the second round consists of a summary of the answers given in the interviews. Which answer belonged to whom was not shared, to ensure there is no direct confrontation between the respondents. More specific (closed) questions were asked about the topics and the respondents were asked to motivate their answers. One of the interviewees decided to not further participate in the Delphi study because he never makes agreements with suppliers (A9). Respondent A8 was absent during the second round, and therefore did not participate. The interviewees from interview A7 both participated in the second round individually, leading to a total of eight filled surveys.

Third round

On some topics, there is still no consensus after two rounds. A new summary, with the arguments pro and con, on these topics alone, is sent out to the respondents. The questions asked are yes/no questions, and it was asked how strongly the respondent feel about these opinions. This round also asked the respondents to rank the categories to base the KPIs on. A total of eight respondents filled out the survey. A7A did not participate in the third round without a specific reason given.

[3] Safety is added because it is of academic relevance, not because it was found in Section 2.4.1 as a category.

3.5.1 Summary

There are different types of suppliers at Odin Groep, that basically all supply products (A1). However, some KPIs might be relevant for a certain type of supplier, whereas other KPIs might not (A7B; A8). Currently supplier performance is measured once a year, subjectively, where good suppliers are rewarded with more business.

Goals

Odin Groep wants a PMS to structurally measure supplier performance in order to make more substantiated agreements, negotiate new contracts, keep suppliers sharp, and improve them.
The goal is to ensure suppliers deliver the right product at the right quality and quantity in time. Other goals are: improving collaboration and communication and receiving the best price.

Requirements for the PMS

Although the PMS could be a stand-alone system, after the second round of the Delphi study, a clear preference for an integrated system appeared. This because data is already easy to use from other systems (A3; A5), which reduces errors (A4; A5) and contamination (A6). Both managers and team-leaders should be able to use the PMS, because they are the conversation partner (A3) and steering factor (A3). The PMS creates openness (A5) and helps to monitor (A4). Purchasing and Logistics should fill the PMS, which has multiple personalized dashboards. There is disagreement whether or not to reward and penalize suppliers. Although not all suppliers are sensitive to a status (A5; A6), giving a status to suppliers is a good idea. It shows extra appreciation (A1; A7B) for free. Monetary rewards, however, are a bridge too far. Costs should be monitored (A8) and the PMS should be practically executable (A5). The interviewees agreed on the number of KPIs: the fewer the better, where different departments need different KPIs. The dashboard should include a filter for the supplier, graphical representations of the KPIs and the possibility to zoom in on underlying PIs.

Requirements for the KPIs

A good KPI is SMART, simple and should deal with exceptions. The target value should depend on Odin Groep's expectations, relate to earlier scores, and should be shared with the suppliers (A2; A4). As there are standards in the industry (A1), SLAs (A7B), experience from the past (A4; A5), and internal targets (A2; A4), you do not need initial data to set a target. This data can be used to modify the targets. Targets can be generic (possibility to rank suppliers (A7A)) and specific (A1; A2) for a specific group of suppliers (A5; A6; A7A) or for a specific product (A7B). It is important to document additional data for the KPI (A1; A7B) to reduce debate (A2). You need the description, formula, data, norm, progress and who developed the KPI. Purchasing and Logistics should work with this information (A2; A3; A6; A7A), answer questions and update others about the KPIs (A2; A3). These KPIs could be derived from different categories (Table 5). Sustainability and safety receive increasing attention from Odin Groep. Product safety should be a checkbox. Most products are certified and Odin Groep has social responsibility towards her customers for some products (A1; A4). Virtual safety is more difficult, but the right of existence for an IT company. The new European regulation concerning processing personal data, the GDPR, is also an important topic here (A1).

Requirements from certifications

The most important certifications for Odin Groep in the development of the PMS and its KPIs are: ISO 9001 (quality), ISO 14001 (environment), and ISO 27001, and NEN 7510 (information security).

Comparison with literature

The interviewees agreed on most of the characteristics of a good KPI, but, not on all. The target appeared to be important as you cannot reach a goal if there is no target (A3; A4; A7B). However, the target does not need to be rock solid (A5). Customer service was also discussed in the second round. It is important to have customer service (not necessarily a separate department, an account manager

will suffice too (A1)), as problems from Odin Groep and her customers need to be addressed by the supplier (A3; A6; A7). The characteristics of a good PMS did not gain much attention in the initial interview. Measurement frequency is still a point of discussion after the third round. It depends on the type of product, the type of supplier (A7B; A8), and the frequency of deliveries (A1; A8). That is why not everything is measured at the same frequency. It is also important to look at the cost (time) of measurement (A5). In the second round of the Delphi study, zooming-in appeared to be important (mostly for the Purchasing and Logistics Department), but not to everyone (A2; A3; A5; A6). It is seen as a good way to see in detail where the problem is (A4; A7A). There was disagreement on the categories to base a KPI on, the choice for these categories is further explained in Section 3.5.2.

3.5.2 Choice of categories

In the third round of the Delphi study, the respondents were asked to rank the categories from 1 to 19 (where 19 is most important). These categories came from the literature in Chapter 2 and from the answers the respondents gave during earlier rounds of the Delphi study (◆). The outcome is shown in Table 6 (where each respondents' "top5" is coloured). A5 used very important, important and less important to score the categories. To give A5 the same "weight" as the other respondents, three scores (2, 6, and 14) were given multiple times.

Category	A1	A2	A3	A4	A5	A6	A7B	A8	SCORE
Reliability	19	18	18	19	14	1	16	18	123*
Quality	17	19	17	18	14	2	19	17	123
Financial	15	15	9	13	14	18	18	15	117
Delivery	18	17	15	17	14	8	12	16	117
Communication	14	16	19	15	14	10	13	13	114
Time	16	13	16	16	14	9	14	14	112*
Ease-of-doing business ◆	11	14	4	6	14	19	9	4	81*
Customer service	7	3	10	9	14	11	17	9	80*
Flexibility	8	7	13	11	14	6	11	5	75
Creditworthiness ◆	1	10	6	8	6	17	8	19	75*
Partnership	12	12	14	10	14	3	7	3	75*
SLAs ◆	4	1	8	2	14	14	15	8	66
Fit with strategy ◆	13	11	5	12	6	5	10	2	64
Safety	5	5	3	14	6	16	1	10	60
Certifications ◆	3	6	7	3	6	13	6	12	56
Product development	10	8	12	5	2	7	4	7	55
Innovation	9	9	11	7	2	4	3	6	51
Sustainability	6	4	1	1	6	15	2	11	46
Relevance ◆	2	2	2	4	2	12	5	1	30

◆ These categories have been mentioned by representatives from Odin Groep. Other categories have been adopted from Chapter 2.

Table 6: importance ranking of categories

The score of the categories in Table 6 is the sum of the scores from the eight respondents. If the score indicates that the category is, on average, in the top 10 of the respondents (i.e. >80 points), the category is selected. Some of the categories in Table 6, however, have overlap with other categories. These categories are indicated with an asterisk (*) in the column "SCORE". It follows from Chapter 2 that "Reliability" and "Partnership" are part of "Quality". The categories "Communication" and "Customer Service" overlap each other. Although "Communication" can be seen as a part of "Customer Service", "Customer Service" could also be seen as one of the forms of "Communication". Therefore, "Customer Service" will be considered part of "Communication" and not considered a category on its own. The category "Creditworthiness" is part of the category "Financial". The categories "Ease-of-doing business" and "Flexibility" are also similar, therefore, the first is incorporated in the latter. Lastly,

although “Time” and “Delivery” are separate categories in Section 2.4, these are rather similar. All sources in Section 2.4 mentioned one of the two, however, none mentioned both. Choy et al. (2004) even mentioned that “Compliance with due date” is part of “Delivery”. Therefore, “Time” is part of “Delivery”. Considering the scores and overlapping categories (which are removed from the list of remaining categories), five categories remain. The inclusion of “Flexibility” might seem odd, however, “Ease-of-doing business”, which is part of it, has scored 81 points in Table 6. Two categories, “Safety” and “Sustainability”, are added to the remaining categories. Although they are scored low by the respondents, they are of high importance due to ISO requirements and corporate policy.

The seven remaining categories (coloured in column “SCORE” of Table 6) and their definitions are given below. Since the papers referred to in Section 2.4 do not include definitions for the categories, these are created for the purposes of this research. The Cambridge Business Dictionary provided good definitions for these categories:

- Quality: how good or bad something is;
- Financial: relating to money or the way money is managed;
- Delivery: the act of taking goods to a place;
- Communication: the process of sharing information, especially when this increases understanding between people or groups;
- Flexibility: the ability to change or be changed easily according to the situation;
- Safety: the condition of not being likely to cause damage or harm;
- Sustainability: the idea that goods and services should be produced in ways that do not use resources that cannot be replaced and that do not damage the environment.

The list of remaining categories is similar to the list of categories in Chapter 2. In Chapter 2, the category “Customer Service” is used, where this research uses “Communication”. Similarly, Chapter 2 uses the category “Environmental”, while this research uses the broader term “Sustainability”. The category “Safety” is a new category, which did not appear in Chapter 2. Two categories mentioned in Chapter 2, “Product Development” and “Innovation”, are not used further in this research, because other categories have shown to be more important for Odin Groep.

3.6 Conclusion

A Delphi study gained insight in the current situation, the goals from Odin Groep and the requirements they have for KPIs and the PMS. The first round consisted of open interviews, the second and third round consisted of surveys. After three rounds, enough consensus was reached and the third sub question answered.

> *Sub question 3: What are the goals and requirements posed by Odin Groep to build the PMS and determine the KPIs needed to measure supplier performance?*

The main goals from Odin Groep for the PMS are:

- Ensure suppliers deliver the right product at the right quality and quantity in time;
- Improve suppliers (collaboration, communication);
- Structurally measure supplier performance;
- Make substantiated agreements / contracts.

The requirements for the PMS posed by Odin Groep are:

- The PMS should meet requirements from ISO 9001 (quality), ISO 14001 (environment) and NEN 7510 / ISO 27001 (information security);
- The PMS should be an integrated system;
- Managers and team leaders should be able to use the system;
- The dashboards should be personalized;

- The PMS should have few KPIs;
- The dashboard should be graphical and include the possibility to zoom-in on underlying data;
- The KPIs should be measured frequently;
- It is a nice to have if the system includes the possibility to add a supplier status (i.e. based on the performance, the supplier is e.g. silver partner).

These requirements are similar to the requirements found by literature. However, it should also include requirements from ISO 9001, 14001, and 27001 and NEN 7510 certifications.

According to Odin Groep, the requirements for the KPIs are:

- A KPI should be SMART and simple;
- A KPI should work in practice (similar to the characteristic: validated);
- A KPI should have a target;
- Additional information of the KPIs should be documented (e.g. description, formula, data);
- The KPIs should be based on the categories important to Odin Groep.

These are similar to the requirements from literature. However, Odin Groep thinks independence is not as important.

There was a lot of disagreement at first as to which categories are most important to Odin Groep. From the question to all representatives to rate these categories, a good order was found. Sustainability and safety are, although their lower scores, very important to Odin Groep in meeting ISO demands. The categories that are most important to Odin Groep are: quality, financial, delivery, communication, flexibility, safety and sustainability.

4. Developing KPIs

Following Section 2.5.1, there are multiple steps to take when developing KPIs. The objectives have been determined in Chapter 3. Following these objectives, questions (KPIs) need to be determined, which is done in Section 4.1. How to measure these KPIs is discussed in Section 4.2. In Section 4.3, the details about the targets, data availability, definitions and responsibilities of these measures are worked out, as well as the underlying PIs. Lastly, Section 4.4 concludes the chapter and answers Sub questions 4 and 5.

In this chapter, the KPIs for the main dashboards are all developed. Due to time limitations, the underlying PIs are worked out for a single department: Purchasing and Logistics. This department is chosen, because it deals with suppliers the most and because other departments mentioned that Purchasing and Logistics has to make the decisions regarding the choice of suppliers. Nevertheless, other departments also need PIs, which they can develop themselves.

4.1 Creating KPIs

Following strategic alignment (Section 2.2.2), the KPIs depend on the CSFs (the areas to focus on, or categories) which depend in turn on the objectives from Odin Groep. As the objectives and categories have been established in Chapter 3, we can now create the measures themselves. The objective is *to develop a system to continually measure supplier performance in order to create the ability to know whether Odin Groep is working with the "best" suppliers, and to further develop the suppliers Odin Groep is doing business with.*

For the seven categories that are considered important to Odin Groep (Section 3.5.2), questions and indicators are developed. The questions are derived implicitly from the answers given during the Delphi study by representatives from all main departments at Odin Groep. To answer these questions, indicators are developed. These categories, questions and indicators are shown in Table 7. To ensure no important topics are forgotten, the list of developed KPIs is compared with the list from Sub question 2 (Table 2). An asterisk (*) shows a KPIs that is adopted from Table 2. Some of these KPIs are interesting to Odin Groep, whereas others are not. Reasons why KPIs are not interesting to Odin Groep are: they are by definition not applicable or it is unknown what is meant by the KPI (too vague). Appendix H shows why certain KPIs are not useful to Odin Groep. The KPIs that are useful, are added to Table 7. Table 7 does not show the category "flexibility", because no useful KPIs were found. Therefore, this research continues with six categories.

As not all found indicators are equally important, they have been prioritized and combined to create good KPIs. The first step was to look into the list of KPIs and determine if some KPIs might be KRIs or underlying PIs to another KPI. The second step was to see if the KPI could help reach the objective. The third step was to determine decomposability (Section 2.5.2). If a KPI cannot be measured, it is not in Table 7. If there are still too many KPIs (>10 per BU), KPIs can be combined into a single KPI. Lastly, a multi criteria analysis can reduce the list of KPIs to the desired number of KPIs. These last steps were, however, not necessary, as the number of KPIs already had been reduced to ten.

In the fourth column of Table 7, it is shown whether the indicator is a KPI, KRI or PI, and the number in the last column shows which KPI or KRI (indicated with R#) it is, or which KPI the PI belongs to. An [x] after PI indicates that the PI is used in the formula for the KPI. Only PI means that the PI is an underlying PI for the KPI, and thus will be elaborated on in Section 4.3. The KRIs are important to Odin Groep, as they show how the supplier has performed in the past. It, however, does not show what the supplier can do to increase performance. As this research does not focus on KRIs, the KRIs from Table 7 are further explained in Appendix J.

Category	Question	Indicator	KPI?	#
Quality	How is the quality of the product?	What is the quality of the product? [% of returns]	KPI	1
		# of products returned from customer	PI[x]	1
		# of complaints about the product	PI	1
	Does the supplier meet the quality standards?	Is the supplier ISO 9001 certified? [y/n]	KRI	R1
	Do the products have the necessary safety certificates?	Safety certificates [y/n]	KRI	R2
	Is the supplier willing to go the extra mile?	(*) Partnership level [scale]	KRI	R3
	Is the supplier proactive?	Is the supplier proactive? [y/n]	PI[x]	R3
Financial	Has the supplier its financials in order?	Creditworthiness [number]	KRI	R4
	-	(*) % of invoices with an error [%]	KPI	2
Delivery	How many errors were made?	(*) % of carrier deliveries without errors [%]	KPI	3
	How many items are damaged?	(*) % of deliveries that contain damaged products [%]	PI[x]	3
	How often is the time of delivery changed?	(*) Rescheduling quota [%] (# of delivery time changes per order/# of orders)	KPI	4
	Is the delivery correct?	(*) On time, in full [%]	KPI	5
	How reliable is the delivery? (are there many cancellations?)	(*) % of orders cancelled [%]	PI[x]	5
	Delivery reliability	(*) % orders delivered in time [%]	PI[x]	5
	-	(*) % of orders shipped on time [%]	PI	5
	Are ordered items available at the supplier? If not, they are backorders	(*) Product availability [%]	PI	5
	How consistent is the supplier with the deliveries in terms of quality?	Partial deliveries [# of deliveries / order]	PI	5
		Average delivery time deviation [days]	PI	5
	How quickly is delivered?	(*) Supplier lead time [days]	KPI	6
	-	(*) Variability in lead time (standard deviation) [%]	KPI	6
Communication	How easy can we contact the supplier in order to receive the information necessary	Number of communication methods available for information gathering [#]	KPI	7
	Do we receive the information in time?	(*) % of information available in time [%]	PI	7
	Do we receive confirmations? Where?	Are confirmations received? [y/n]	PI	7
		Are the confirmations received at correct location? [y/n]	PI	7
	How often is the supplier available to us? / how long does it take to receive a response?	Phone call availability [%]	PI	7
		Email response time [days]	PI	7
		Number of visits per year [#]	PI	7
	How transparent is the supplier with inventory?	Accessibility of inventory information [number]	KRI	R5

	-	How good is the supplier at solving problems? [% and days]	KPI	8
	How quickly are problems solved?	Problem solving time [days]	PI[x]	8
	How much effort does it take to get the problem solved?	% of problems solved by type [currently used at Odin Groep - credit note, repair, swap] [%]	PI	8
Safety	Does the supplier meet information security standards as set by Odin Groep?	Score on the information security standards survey [#]	KPI	9
	Does the supplier meet information security standards?	Is the supplier NEN 7510 / ISO27001 certified? [y/n]	KRI	R6
Sustain-ability	How polluting is the supplier?	How polluting is the supplier? [score]	KPI	10
	-	(*) Recycled material [%] (% of total used materials)	PI	10
	-	(*) Carbon emissions reduction [%] (compared to previous year)	PI	10
	Does the supplier meet environmental standards?	Is the supplier ISO 14001 certified? [y/n]	KRI	R7

Table 7: questions and KPIs per category

Most KPIs can be judged without considering the performance of another KPI (decomposability). Only KPI 7 is based on two separate parts, lead time, and lead time variability. After measuring the KPIs in Section 4.2, KPIs 2, 3, and 4 appeared to not be measurable with the current software. However, other measures can be used, and with the new systems, these might be measurable.

4.2 Measuring KPIs

From Section 4.1, it follows what Odin Groep wants to measure. The next step is to determine how to measure these KPIs. For some KPIs, there might be multiple measures that can be used. To determine which measure is the best, a cost-benefit analysis is performed, comparing the costs of obtaining the data to the benefits of using that specific measure. In this case, the benefit is usually the same. If the data cannot be obtained, the measure cannot be used.

1. Product quality

Part of the objective for the PMS is the ability to know whether Odin Groep is working with the “best” suppliers. An important KPI for this is product quality. Product quality can be measured in multiple ways. You could look into the major factors of product quality (appeal, functionality, durability and reliability) and score them for each product separately. As Odin Groep has around 30,000 unique products, it would take a lot of time to measure the quality of each individual product using this (subjective) method. Considering the time it would take to do this, and the fact that a subjective method’s output depends on the person scoring the factors, this is not a good measure for this KPI.

The quality of the product could also be measured from existing data. Odin Groep could look into the complaints about products or the returned products. Complaints and returns could indicate poor quality. However, there might be other reasons for complaints or returns. These reasons should also be documented for this KPI to be valuable. This author expects the returns to provide the most valuable insight, because the products that are returned to Odin Groep by the customer have either a defect, or do not meet the quality as expected. Complaints might also be about rather meaningless topics, such as the colour and speed, and multiple complaints about the exact same product might be logged.

Therefore, the quality of suppliers' products can be measured as the percentage of returned items. The formula:

*# of products returned / # of products shipped * 100%*

Currently the number of returns and complaints are both available from the service management system. The reasons for the return are documented using a drop down menu with categories. These reasons can be extracted from the service management system as well, and should be used as a PI. The complaints also generate valuable information, and should be used as an underlying PI as well.

2. Invoice errors

Invoices can have multiple errors. It depends on the type of error whether an invoices can still be used, or if the Finance Department has to wait for a corrected invoice. In case of, for example, deviating amounts or quantities, the invoice cannot be used. This KPI can be used to decrease the number of invoices send by the supplier. Odin Groep can show them the mistakes made, in order to decrease the number of mistakes and thus the percentage of invoices with an error. Invoices with an error are those invoices that cannot be used before a correction is made. The formula is:

*Invoices with an error / # of invoices * 100%*

Currently, all correct invoices are documented in a bookkeeping system. However, the invoices with an error are not documented until the error is resolved. Therefore, currently, this KPI cannot be measured from the systems. That does not mean this KPI is not measurable. The Finance Department could add a code to show the invoice was incorrect. When this code (or different codes, to be able to distinguish between the type of error) is in the systems, it can be used to measure the number of errors. As a new bookkeeping system will be implemented soon, it might not be worth the effort to make changes to the current system. In the new system Odin Groep should embrace the option to add codes which indicate errors. Until the new bookkeeping system is implemented, the invoice errors can be documented using a spreadsheet. As the number of invoices received can be tracked from the ERP systems, using this (temporary) method, the formula can already be used.

3. Carrier delivery errors

All deliveries arrive at Odin Groep through a carrier. This carrier (which supplies a service) should make sure all products arrive at Odin Groep as agreed. The carrier could create errors when delivering the products. Too many, too few, or damaged items can be delivered. Products can move (or fall) during transportation and the processes of loading and unloading, which can lead to damaged boxes, and even damaged products. In order to develop suppliers, such that they make fewer mistakes, the errors need to be documented. With the percentage of errors documented by Odin Groep, the supplier can take action to improve. The deliveries with an error are those deliveries where the packaging of at least one product is broken, where too many items are delivered, or where too few items are delivered. This leads to the following formula for deliveries without an error:

*100% - (# of deliveries with an error / # of deliveries * 100%)*

Currently, the damaged deliveries (i.e. broken packages) are photographed, and reported to the supplier with the order number. This information is, however, currently unavailable in the systems. To use this KPI, the damages need to be documented at Odin Groep. This can be done by manually listing all errors in a spreadsheet. This way, the formula can be used. The spreadsheet could, if needed, also be updated with other information required for optional PIs. As this KPI is about the carriers, this should thus only be used for this type of supplier.

4. Rescheduling quota
Deliveries that are confirmed for a specific date are regularly rescheduled. As a result, the logistics department needs to reschedule, and scheduled shipments to- and installations at customers of Odin Groep might need rescheduling as well. Rescheduling of the supplier thus poses a threat to the internal processes of Odin Groep. The fewer rescheduled deliveries, the better. The goal of this KPI is to decrease the number of rescheduled deliveries, through increasing supplier commitment and improving the supplier itself, as a lower percentage of rescheduled deliveries is both beneficial for Odin Groep and the supplier. There are multiple methods to determine the rescheduling quota. Odin Groep can look at the total number of changed delivery times compared to the number of deliveries, or look into the percentage of deliveries that have been rescheduled. These are both valuable measures. However, the average number of times a delivery date is changed gives most insight. The other metric (the percentage of changed delivery dates) can be used as a PI. An histogram showing the number of changes in delivery date per order might also give a lot of insight, and should thus be used as a PI. To measure the rescheduling quota, the average number of changes in delivery data should be measured. The formula to do this is:

# of times the delivery time is changed / # of deliveries

Currently this information is not available in the systems. It is already known that all scheduled dates will be saved in the new ERP system. This KPI can thus be measured and used when the new systems are in use. As the delivery date is simply "changed" in the current system, it is hard to determine the number of changes, as the delivery date needs to be continually monitored to document all changes. Therefore, it is suggested to start measuring this KPI when the new ERP system is in place.

5. On time, in full (OTIF)
Not all deliveries arrive on time, and some deliveries do not contain all items confirmed. This KPI shows if Odin Groep is working with the "best" suppliers. A low OTIF percentage indicates that there are possibilities for the supplier to improve. What the reasons for these errors are, is important for Odin Groep, as sometimes a partial delivery is preferred. There could thus be circumstances where the supplier cannot be blamed for a delivery that is on time, but not in full. Therefore, the data also needs to be documented, showing the deliveries delivered on time, and the deliveries delivered in full. These are PIs underlying OTIF. The formula to measure the OTIF percentage is:

100% - (% of orders late + % of orders cancelled + % of orders with incorrect items that were delivered in time)

where the three factors are measured using the following formulas:

*% of orders late = # of orders late / # of orders * 100%*
*% of orders cancelled = # of orders cancelled / # of orders * 100%*
*% of orders with incorrect items that were delivered in time = # orders with incorrect items that are delivered in time / # of orders delivered in time * 100%*

The information to fill these formulas is currently available in the systems, and will be available in the new systems as well. The KPI value can thus be calculated easily from the system output.

6. Supplier lead time and its variability
An important KPI that indicates whether Odin Groep is working with the "best" suppliers is the lead time, or how long it takes for the supplier to deliver an order. Not only the lead time itself is important. Its standard deviation is a good indicator of the stability of the lead time, and how Odin Groep can use the supplier's lead time in the best way possible. The lead time is a fairly easy KPI to measure, and one of few KPIs that is relevant for most companies. As Odin Groep does not work with timeslots for

deliveries, the delivery could be anywhere during the day. This makes that looking at the exact time of delivery gives a distorted image. The lead time should thus be documented in days. The formula for the lead time (in days) is:

$$\frac{\sum_{deliveries}\ (date\ of\ delivery - date\ of\ order)}{\#\ of\ deliveries}$$

The standard deviation is usually a build in function in spreadsheet software, and therefore easy to use. What is does is firstly compute the average, then measure, for each value, the difference between the average and the actual delivery time, square these values, sum those square values and divide by the number of entries in the list. To measure the standard deviation, lastly the square root is taken. This leads to the following formula:

$$\sqrt{\frac{\sum_{lead\ times}(actual\ lead\ time - average\ lead\ time)^2}{\#\ of\ lead\ times}}$$

In the current system, and probably the new system as well, the order time and delivery time are documented. As the lead time can be calculated, so can its standard deviation. The different types of suppliers need different targets for this KPI. Lead time depends on the type of items ordered and where these items are ordered. Noteworthy is that, when you expect a delivery the next day, you probably have to send the order before a specific timeslot.

7. Communication of contacts and information

Communication consists of two major parts: information availability and contact availability. Contacts are usually the easiest and fastest way to gather information, however, there are other means of information gathering, such as online portals and search engines. How easy it is to contact a supplier depends on the number of methods to use for contact. This could, for example, be through phone calls, emails, online chat or face-to-face. This KPI can be used to improve communication with the supplier, and thereby increase the feeling of supplier commitment. The formula to measure the communication used here is the number of methods to contact a supplier's representatives and all other information sources. The formula is:

Number of information channels available at the supplier

Another part of communication is the response time of suppliers, which includes whether the requested information is received in time. This could be measured, however, it would take a lot of time to log every email, phone call, web-search et cetera. Therefore, this measure is not advised.

The number of information channels could be counted by Odin Groep's employees, or given by the supplier through a survey. As the response times highly depend on the number and type of information channels, a PI with a list of the types of information channels should be used. Attempts could be made to measure the response time through a PI, however, this will probably not be worth the effort.

8. Problem solving capabilities

The suppliers problem solving capabilities consist of two factors: whether or not the problem is solved, and the time it takes to solve the problem. If a problem occurs, the goal is to solve it as quickly as possible. The most important part is that the problem is solved. The objective for this KPI is to improve the supplier. If the supplier knows that it takes too long to solve a problem, action can be taken to resolve problems more quickly. This has an advantage for both Odin Groep and her supplier. The first formula shows how the percentage of problems solved can be measured:

*# of problems solved / # of problems * 100%*

The second formula shows how to measure the problem solving time. It is important to not include problems that have not been solved (yet), as this might lead to an average problem solving time that is much longer than that it actually is. This is because, when a problem is not solved, you cannot know whether it will actually be solved, or not. Therefore, the average problem solving time (in days) is calculated through calculating all problem solving times, and divide those by the number of solved problems using the formula:

$$\frac{\sum_{solved\ problems}\ (moment\ the\ problem\ is\ solved - moment\ the\ problem\ is\ posted)}{\#\ of\ solved\ problems}$$

The problem solving time is currently not documented. However, the data needed to calculate this is available. The moment the problem is solved is in the system as "Solution RMA", and the moment the problem is shared with the supplier is in the system as "Start RMA". For the first measure, the percentage of problems solved, Odin Groep should know if a problem cannot be solved. This is not automatically updated in the RMA process. Therefore, a timeframe after which the problem becomes "unsolved" could be used, or employees should mark problems as "unsolved" manually.

9. Information security standards

For Odin Groep, ISO certifications and the GDPR, it is important to look at the supplier's information security standards. If the supplier scores low on security standards, Odin Groep can help the supplier improve, while meeting the demands from ISO and NEN certifications. This data is not available in Odin Groep's systems. However, through a survey, a lot of data can be gathered about the security standards. As the security officer at Odin Groep has already developed a survey to measure information security, this survey could be used for the supplier PMS as well. In this survey, some boxes have to be checked (or the supplier should improve), other factors are less strict. The information security can be measured through the information security survey in Appendix K. The formula is:

Score on the "Survey Information security"

This survey has proven that it works (A10). Therefore it is advised Odin Groep continues to use this survey. Appendix I clarifies the numbers given for each answer option in the survey.

10. Environmental sustainability

Sustainability is an important topic for Odin Groep and, after price and quality, an important criterion for the selection of suppliers. The three pillars (people, planet and profit) all receive attention. However, sustainable relationships and the location of the office cannot be (easily) controlled by the supplier and should thus not be used to measure the supplier's performance. Environmental sustainability is controllable by the supplier, and therefore a KPI to measure the supplier's performance. The goal is to help the supplier decrease pollution while making it easier to meet demands by the ISO certification. Environmental sustainability has multiple factors. Well known factors are, for example, recycling and CO2 emissions. There is an online tool, CDP[4], where scores (ranging from A – very good, to F – poor) on environmental information can be found, if submitted by the supplier. Most vendors already use this tool, but, most distributors do not. This data could also be gathered through a survey to the supplier, however, if the data is already present in the tool, this method does not make sense, as it would increase the workload for both Odin Groep and the supplier. Both methods require the supplier to submit the information, which slightly reduces the reliability of the data. Because no objective tools are available, and because the CDP tool is the easiest (least time

[4] https://www.cdp.net/en

consuming) way to gather the data on pollution of the supplier, this method is preferred to measure supplier pollution. The formula is:

Score of the CDP tool

If the supplier is not in the CDP database, there are three things Odin Groep can do. The easiest option is to leave this KPI blank, however, this is not desirable. Another relatively easy option is to oblige the supplier to submit the data to the CDP database. A more time consuming, but feasible option is to request data on CO2 emissions and recycled material percentages from the supplier using a survey. The best solution here is to request the supplier to use the CDP tool. If the supplier chooses not to use this tool, the pollution score should be determined manually using the following formula:

*0.5 * Recycle + 0.5 * CO2*

where the factors for Recycle and CO2 are measured as follows:

*Recycle = Recycled material / total used materials * 100%*
*CO2 (reduction %) = (Carbon emissions this year – carbon emissions last year) / carbon emission last year * 100%*

The data for this formula should be requested from the supplier using a survey. The scoring is similar to the CDP tool, and therefore can be compared. If the supplier does not respond, it receives an F. For disclosure, but nothing more, the supplier receives a D. When the supplier is aware of its footprint, it receives a C. In case of management or leadership, the supplier receives a B or A respectively. For the percentages of Recycle and CO2 leading to these scores, please refer to Appendix I.

4.3 KPIs for Odin Groep

Following the requirements from Odin Groep and the suggestions made by scholars in Sections 2.3 and 2.5, additional information about the KPIs needs to be documented. This section displays each of the ten KPIs with the required information.

The formulas and their definitions are derived from Section 4.2 and the purposes from Sections 3.2.2 and 3.3. The targets should be reasonable and based on past performance and the minimum acceptable situation. Therefore, firstly the minimum acceptable situation should be determined, and then the targets can be set, such that the performance is expected to increase. Benchmarking is a good exercise to use in setting targets. For Odin Groep, a “Good” supplier scores at least 7.5/10 (or the equivalent in another scale) (A1). It should be noted that there are cases where the equivalent of 7.5/10 is around 99% (i.e. not around 75%). The measurement frequency is based on the ease of measuring the KPI and the need for frequent measures to monitor the KPI. The data source follows from the formula used. The responsibilities depend on other factors. Who measures the KPI depends on the data required and the person that acts on the data should have the authority to do this. What action to take when the KPI shows a “bad performance” depends on the type of KPI. If there are PIs, the first step to take is look into the PIs. In both cases, with and without PIs, it is a good idea to start the conversation with the supplier, in order to help the supplier improve. If there is no improvement after three cycles, the business with that supplier should be terminated (if possible). The PIs are shown for each KPI if they are present. Some of the PIs are marked with an asterisk (*), as they are derived from Table 7 (Section 4.1). The PIs are only given for KPIs that are specifically for the Purchasing and Logistics Department. Therefore, KPIs 2, 9, and 10 do not have any PIs. KPI 2 is for the Finance Department, whereas KPIs 9 and 10 are important for Odin Business Support and General Management. Although these three KPIs are more important for other departments, the Purchasing and Logistics Department will use these KPIs too. The other departments have to develop the PIs

themselves. The departments that will use the KPI are displayed, and in case extra information is needed, some comments are shared.

KPI 1 – Product quality	
Formula	Quality of suppliers' products = % of items returned = # of products returned / # of products shipped
Definition	This KPI measures the percentage of items that are returned from customers, which indicates the product quality. A high percentage indicates poor quality, whereas a low percentage indicates good quality (and good performance).
Purpose	The purpose of this KPI is to ensure quality and know whether the supplier is amongst the "best". Its other goal is to meet demands by ISO and NEN.
Target	Vendors have their own "defect percentages". This is the minimum acceptable situation. The target itself is: to have a lower percentage of returns than the vendors' "defect percentage".
Measurement frequency	Continually
Data source	Service management system
Responsibilities	Purchasing Department
What do they do?	Firstly look into the PIs. In case the reasons for a return indicate poor quality from the supplier, Odin Groep should start the conversation to help the supplier improve. In case of other reasons for a return, Odin Groep should firstly investigate those.
PIs	• % of complaints about the product; • List with reasons of complaint / return.
Departments	Purchasing and Logistics; Sales
Comments	-

KPI 2 – Invoice errors	
Formula	% invoice errors = Invoices with an error / # of invoices * 100%
Definition	This KPI measures the percentage of invoices with an error that needed correction before the invoice could be used. A low percentage indicates few errors, whereas a high percentage indicates many errors. Good performance thus shows a low percentage.
Purpose	The purpose of this KPI is to decrease the number of errors. This can be done through the improvement of suppliers. With fewer errors, it is also easier to ensure quality.
Target	The target is to have no errors at all.
Measurement frequency	Continually
Data source	Currently: manually in a spreadsheet Ideally: new bookkeeping system
Responsibilities	Finance Department. The Purchasing Department should be informed.
What do they do?	Look into the PIs if the score is lower than the target. Show the supplier where they make most errors and start the conversation on how to improve.
Departments	Finance, Purchasing and Logistics
Comments	*Currently only the manual option is possible. In the future the data can be extracted from the bookkeeping system.*

KPI 3 – Carrier delivery errors	
Formula	% of error free deliveries = 100% - (# of deliveries with an error / # of deliveries * 100%)

Definition	This KPI measures the percentage of deliveries of which the carrier has not damaged anything. This means that no packaging of the delivery is damaged. Also, not too many items or too few items have been delivered. A high percentage indicates good carrier performance. A low percentage of error free deliveries shows that there are a lot of errors with the delivery.
Purpose	The purpose of this KPI is to decrease the number of errors. This can be done through the improvement of suppliers. With fewer errors, it is also easier to ensure quality
Target	The target is to have no errors at all.
Measurement frequency	Continually
Data source	Spreadsheet where the errors are documented
Responsibilities	Purchasing Department
What do they do?	Look into the PIs if the score is lower than the target. Is it caused by damages? Why are the items damaged? Why are too few or too many items delivered? And is the carrier culpable? Or is there another reason?
PIs	• (*) % of damaged products delivered [%]; • % of deliveries where too few or too many items are delivered; • Quality of packaging [subjective – number].
Departments	Purchasing and Logistics
Comments	*This KPI is only for the supplier type: carrier*

KPI 4 – Rescheduling quota	
Formula	Rescheduling quota = # of times the delivery time is changed / # of deliveries
Definition	This KPI indicates the average number of delivery time changes per delivery. A low number indicates good performance (few changes in delivery time on average), whereas a higher number indicates many rescheduling and thus poor performance on this KPI.
Purpose	The purpose of this KPI is to decrease the number of reschedules. This can be done through the improvement of the communication with the supplier, and through an increase in supplier commitment.
Target	There should be as few rescheduling as possible. Per delivery, the number of changes should not exceed 3. On average, the rescheduling quota should not exceed 1.2 (A1).
Measurement frequency	Continually
Data source	New ERP system
Responsibilities	Purchasing Department
What do they do?	Look into the PIs if the score is lower than the target. Does the supplier have a good reason for the rescheduled delivery? Has Odin Groep asked the supplier to deliver parts? Start the conversation with the supplier on how to improve.
PIs	• Rescheduling quota (% of changed deliveries); • Overview of the number of changes in delivery date per order; • % of reschedules due to no inventory at supplier; • Availability of transportation to deliver the order.
Departments	Purchasing and Logistics, Sales
Comments	*Not possible in the current systems. Will be possible in the new ERP system*.

KPI 5 – On time, in full	
Formula	OTIF = 100% - (% of orders late + % of orders cancelled + % of orders with incorrect items that were delivered in time)
Definition	This KPI shows the percentage of deliveries that arrive on time and in full. The measure starts with 100% and deducts the percentages of the orders that arrive late, that are cancelled, and those that have incorrect items. It is checked that orders that are both incorrect and late/cancelled are not counted twice. A high percentage thus indicates good performance.
Purpose	The purpose of this KPI is to deliver the right quantity in time. This way, Odin Groep is able to see whether she is working with the "best" suppliers. If the supplier is not part of the "best" suppliers, the purpose is to improve performance so she can be.
Target	The supplier should deliver everything that is available. This might mean more partial deliveries, however, the more items that arrive in time, the better. The goal is thus 100% in time deliveries. The main goal is 100% OTIF.
Measurement frequency	Continually
Data source	ERP system
Responsibilities	Purchasing Department
What do they do?	Look into the PIs if the score is lower than the target. What is the reason for the low percentage? Not delivered on time is much worse than not delivered in full. Start the conversation with the supplier on how to improve.
PIs	• % of partial deliveries; • % of orders shipped in full; • (*) % of orders shipped / delivered in time; • Delivery time deviation.
Departments	Purchasing and Logistics, Finance, Sales
Comments	*Sometimes, Odin Groep asks the supplier to deliver partial orders instead of wait for the full order. It is important to take this into account.*

KPI 6 – Lead time	
Formula	Lead time = $\frac{\sum_{deliveries}\ (date\ of\ delivery - date\ of\ order)}{\#\ of\ deliveries}$ Standard deviation = $\sqrt{\frac{\sum_{lead\ times}(actual\ lead\ time - average\ lead\ time)^2}{\#\ of\ lead\ times}}$
Definition	This KPI shows the average lead time in days through measuring the lead time for each delivery, summing the lead times, and divide by the number of deliveries. Its standard deviation also depends on the individual lead times, and indicates the deviation of the expected lead time. The lower the lead time, the better. Likewise, the lower the standard deviation, the better.
Purpose	This KPI shows if Odin Groep is working with the "best" suppliers. The purpose is to deliver the right quality and quantity in time, and to improve SLAs.
Target	For the "common goods", the target is next day delivery. For enterprise- and BTO- goods the target is "conform factory agreement". For other goods, the target is two weeks.
Measurement frequency	Continually
Data source	ERP system
Responsibilities	Purchasing Department

What do they do?	Look into the PIs if the score is lower than the target. Start the conversation with the supplier to determine the reason for the long lead times and help the supplier improve.
PIs	• Average time of order when delivered next day; • Latest time of order when delivered next day.
Departments	Purchasing and Logistics Maybe Sales and Odin Business Support
Comments	*There is a lot of difference between different types of supplier and/or products. Therefore this KPI has multiple targets.*

KPI 7 – Communication (Information availability + contact availability)	
Formula	Communication score = the number of information channels
Definition	This KPI counts the number of information channels available. The more information channels available, the better.
Purpose	The purpose of this KPI is to improve the suppliers communication and collaboration. This way, Odin Groep can better ensure quality, and supplier commitment might increase as well.
Target	The supplier should have at least an email address, phone number and web portal. Everything else is nice to have. The number of communication channels should thus exceed three. The goal is to have more.
Measurement frequency	Yearly
Data source	An employee has to count the number of channels
Responsibilities	Purchasing Department
What do they do?	Look into the PIs if the score is lower than the target. Which channels are available? Could the supplier add a communication channel easily? Advise the supplier on the type of information channel to add.
PIs	• List of the available information channels; • (*) % of information that is available in time; • % of phone calls where you get an agent on the line; • Number of visits per year; • (*) Are confirmations received?; • (*) Are the confirmations received at correct location?; • (*) Response times [compared to average].
Departments	Purchasing and Logistics, Finance, Marketing, Sales
Comments	-

KPI 8 – Problem solving capabilities	
Formula	% of problems solved = # of problems solved / # of problems * 100% Average problem solving time = $\frac{\sum_{solved\ problems}\ (moment\ the\ problem\ is\ solved - moment\ the\ problem\ is\ posted)}{\#\ of\ solved\ problems}$
Definition	This KPI shows the percentage of problems solved. This is measured by dividing the number of solved problems by the total number of problems. The second part shows the average problem solving time, through measuring all problem solving times, add those times (of the solved problems) and then divide by the number of solved problems. Good performance is indicated by a high percentage of problems solved, and a low problem solving time.

Purpose	The purpose of this KPI is to ensure quality, through quick problem solving. At the same time, this KPI improves the supplier's communication and collaboration.
Target	The problem solving time should not exceed two weeks. And all problems should be solved.
Measurement frequency	Continually
Data source	ERP system
Responsibilities	Purchasing Department
What do they do?	Look into the PIs if the score is lower than the target. Start the conversation with suppliers and try to figure out if there is a specific type of problem that poses problems to the supplier to solve.
PIs	• (*) % of problems solved by type of problem solving method [%] (Currently used at Odin Groep = credit note; repair; swap); • List with the types of problems and their status solved.
Departments	Purchasing and Logistics
Comments	*Unsolved problems do not count towards the average problem solving time*

KPI 9 – Information security standards	
Formula	Information security standards = Score on Survey "Information Security"
Definition	This KPI is measured through a survey on information security. This survey contains both "demands" and "wishes". The demands must be met to get a positive score. The number of wishes that are met indicate the actual score. A good performance is indicated by a high score.
Purpose	The purpose of this KPI is to meet demands by ISO and NEN, improve the supplier and ensure quality.
Target	The supplier has to meet all demands, and score at least 80% on the additional questions (this is currently used by the Security Officer). The target is to score 100% on the additional questions.
Measurement frequency	Yearly
Data source	Odin Groep Standards Survey "Supplier performance measurement for information security" (Appendix K)
Responsibilities	Security Officer
What do they do?	Start the conversation with the supplier if the score is lower than the target. Check if this has to do with the "demands" part or the "wishes" part, and help the supplier improve.
Departments	Purchasing and Logistics, Finance, Sales
Comments	-

KPI 10 – Environmental sustainability	
Formula	Number for pollution = Number based on the score of the CDP tooling
Definition	This KPI indicates the pollution of the supplier. The CDP tooling gives a score from A (good) to F (bad).
Purpose	The purpose is to meet the demands by ISO and NEN, as well as help the supplier decrease pollution.
Target	The supplier should at least have thought about sustainability (and have the documents available). Following the CDP definitions, the supplier thus needs to score at least a C. The goal still needs to be determined. However, should be higher than a C.

Measurement frequency	Yearly
Data source	Report from CDP tool
Responsibilities	Quality Officer
What do they do?	Start the conversation with the supplier if the score is lower than the target. Does the supplier have documents available about sustainability or not? Give suggestions to the supplier on how to improve.
Departments	Purchasing and Logistics
Comments	*If the supplier is not in the tooling, a "manual" method should be used (Section 4.2). The supplier should be moved to add their environmental information to the CDP tool, but cannot be obliged as Odin Groep is not in the CDP tool herself.*

After developing these KPIs, the representatives from the different departments were asked through a survey for each KPI whether they think it is a good KPI and if they would use it. This information was used to further update the KPIs. The survey has been filled out by A1, A2, A4, A6, A7, and A8. One KPI was not considered a good KPI by A6. Although this was one representative, it received attention and led to this KPI being downgraded into the PI "partial deliveries" for the KPI "OTIF".

4.3.1 Usage of the KPIs

The representatives were asked if they would use the KPI, maybe use it or not. In Table 8, these are displayed respectively as "Y", "?" and "N". In the table, the values "Y" are coloured to improve readability of the table, and easily show the number of respondents that will use the KPI.

Department	1	2	3	4	5	6	7	8	9	10
Purchasing and Logistics	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Purchasing and Logistics 2	Y	N	Y	Y	Y	Y	Y	Y	N	N
Marketing	?	N	N	N	N	N	Y	N	N	N
Sales	Y	N	?	Y	Y	?	Y	?	Y	N
Finance	N	Y	N	N	Y	N	Y	N	Y	N
Odin Business Support	?	?	?	?	?	?	?	?	?	?

Table 8: usage of KPI per department

Notable is that in three instances, two representatives of the same department (Purchasing and Logistics) do not agree. KPIs 2, 9, and 10 are important for the organization, but not necessarily for the Purchasing and Logistics Department. Another surprising outcome is that, although KPI 10 is very important to Odin Groep, only one representative will use this KPI. However, this is not different from what was found earlier.

4.3.2 Data sources

There are multiple data sources for the KPIs. The distinction between KPIs that can be measured from the systems, and thus can be measured continually, and KPIs that cannot be measured from the systems is of importance here. Currently, KPIs 1, 5, 6, and 8 can be measured from the systems, and will also be measurable from the future systems. KPIs 2, 3, and 4 cannot be measured from the current systems. However, they might be measurable from the future systems. This is still unknown.

The KPIs that cannot be measured from the systems can be measured through an online report (KPI 10), through a survey to the supplier (KPI 9) or through input from employees from one or more departments (KPI 7).

4.4 Conclusion

This chapter has shown the development of the KPIs and PIs for Odin Groep's supplier PMS. Firstly, based on the categories from Chapter 3, the questions and KPIs were developed. After development, the KPIs were prioritized and the fourth sub question could be answered. Afterwards, measurement for the KPIs (Sub question 5) were selected and the additional information added. Lastly, the underlying PIs for the Purchasing and Logistics Department were determined. The answers to Sub questions 4 and 5 are combined in a single answer.

> *Sub question 4: Which KPIs should Odin Groep use?*
> *Sub question 5: How to measure the selected KPIs?*

The KPIs Odin Groep should use, and how to measure these, are listed here. KPIs marked with an asterisk (*) cannot be measured yet. KPIs with a diamond shape (◆) cannot be measured from the systems yet, but, they can be measured through a rather cumbersome method. The KPIs and their measurement are:

1. Product quality – % of returned products;
2. ◆ Invoice errors – % of invoices with an error;
3. ◆ Carrier delivery errors – % of deliveries with an error;
4. (*) Rescheduling quota – average number of delivery date changes;
5. On time, in full – % of deliveries that are on time and in full;
6. Lead time – average time between order and delivery;
7. Communication – number of information channels;
8. Problem solving capabilities – % of problems solved and the average time this takes;
9. Information security standards – score from the information security survey;
10. Environmental sustainability – CDP score on environmental sustainability.

Odin Groep should thus use the eleven KPIs as shown above. The formula for the measurement can be found in Sections 4.2 and 4.3. Some of these KPIs (KPIs 2, 3, and 4) cannot be measured from the systems yet. However, for KPIs 2 and 3, the data can be documented manually. KPI 4 should be re-evaluated when the new systems are in place.

For all information about the KPIs and their PIs, Section 4.3 should be consulted. Now the KPIs are developed, the next step is the implementation of the PMS. This is addressed in Chapter 5.

5. Implementing the PMS

This chapter, the implementation plan for the PMS, is based on the results of Chapters 2, 3, and 4. The basis for the implementation plan is set by combining the literature on how to implement a PMS (Section 2.5.3) with the goals and requirements from Odin Groep (Chapter 3) and the developed KPIs (Chapter 4). To complete this plan, a prototype dashboard is developed as well. With the implementation plan, Odin Groep will be able to successfully develop the dashboard and implement the PMS in order to measure supplier performance. Following Section 2.5.3, we firstly have to unfreeze the organization, then move, and lastly refreeze (Section 5.1). Section 5.2 contains the actual implementation plan (Sub question 6a). Section 5.3 explains the prototypes of the dashboard (Sub question 6b). Lastly, this chapter is concluded in Section 5.4.

5.1 Change management

This section follows the change management theory by Lewin (1947), and the implications of this theory for software maintenance (Hanafi & Abdel-Raouf, 2014). Firstly the organisations needs to unfreeze, then it needs to move, and lastly it needs to refreeze.

The first step is to unfreeze the organisation. This research has already performed the first step to change: planning and preparation. Section 1.3 introduced the current situation at Odin Groep, and thus what needs to be changed. Section 1.5 addressed the problems and with it the objective, thus the need for change. The sense of urgency is created. During the Delphi study in Chapter 3, the doubts and concerns came to light from people in the guiding coalition. The vision and strategy became clear as well, and is aligned with the objectives. The next step is to actually make the change: develop the PMS. The stakeholders need to be involved, employees need to be empowered, and short-term wins need to be celebrated. Odin Groep needs to take multiple steps in the development of the PMS. The steps to take are worked out in Section 5.2. Lastly the change has to refreeze. Although some say this step is obsolete, this is not the case for the implementation of the PMS according to the definitions for software changes by Hanafi and Abdel-Raouf (2014). The PMS needs to be implemented: the PMS needs to pass all tests and needs to be stable in its use.

It is also of importance to maintain the system, and thus make sure employees have the skills to do so. Maintenance tasks are to add and delete measures, but also to ensure that the data is still correct (interpreting and analysing data). These relatively small changes mean a whole new cycle of change: planning and preparation, changing the software, and implementing the new version.

5.2 Implementation plan

The implementation plan contains all information necessary to actually implement the PMS. The plan describes the activities to execute for both the “physical” implementation of the system, and the behavioural implementation for employees.

Background

Professionalizing processes is important to Odin Groep. Although there is a “system” in place, supplier performance measurement has gained limited attention in the past. Multiple departments work with suppliers, of which the Purchasing and Logistics Department is most important. For more background information, see Section 1.3.

Goal

The goal of the implementation of the PMS is to be able to “*continually measure supplier performance in order to create the ability to know whether Odin Groep is working with the ‘best’ suppliers, and to further develop the suppliers Odin Groep is doing business with”.* The demands by ISO and NEN certifications also need to be taken into account.

Expected result
It is expected that, after implementing the PMS, Odin Groep is able to measure supplier performance professionally, and meet the demands from ISO and NEN certifications. As supplier performance can be measured, Odin Groep is also able to contact suppliers about their performance and help them improve. Secondly, Odin Groep can determine which suppliers are the "best" suppliers. Lastly, employees know how to work with the PMS and take decisions based on the performance.

Project team
The project team consist of three people working in the department Purchasing and Logistics:

- Manager Purchasing and Logistics;
- Team leader Logistics;
- Graduate intern.

Activities and milestones
The implementation starts with the KPIs to use (Section 4.3) and the explanation of the dashboard (Section 5.3). With this data, the actual dashboard can be developed and the PMS can be implemented. There are five separate steps necessary to implement the PMS. Firstly, the data needs to be gathered, secondly, the dashboard needs to be developed, then the PMS and its dashboard need to be tested, the PMS needs to be implemented, and lastly, the PMS needs to be evaluated. These steps are useless, unless the data for the KPIs is gathered. As Odin Groep is planning to move towards new systems (ERP, CRM, Bookkeeping), firstly a simple, temporary dashboard is developed in Excel. After the new systems have been implemented (when this will happen needs to be determined), the PMS should be integrated with the new systems and further improved. Table 9 shows, for each phase, what needs to be done in each step, who should do it and how much time it takes. A flag (⚑) represents a milestone.

What	**Who**	**Time**
Data gathering		
Create exports from the systems to be able to use the data (KPIs 1, 5, 6, and 8)	Project team	1 day
Determine values for the data that is not in the systems • CDP report (KPI 10) • Supplier survey (KPI 9) • Input from employees (KPI 7) • Documentation from employees (KPIs 2 and 3) • *KPI 4 cannot be measured yet*	Project team	1 hour / supplier + time to document
Prepare the data for usage in the PMS	Project team	2 days
Developing the initial dashboard		
Share objectives and functionalities for the dashboard with the development team	Project team / development team	1 hour
Share the KPIs and its targets from Section 4.3 with the development team so they know what to program as input and output.	Project team / development team	1 hour
Develop the dashboard (both visually and functionally)	Development team	1 week
Test the functionalities of the dashboard	Development team	1 week
Improve the dashboard	Development team	1 week
⚑ **- Working dashboard, ready for testing**		

Testing the system		
Gather the data which is the input for the system	See individual KPIs	-
Create a user manual	Project team	1 week
Validate the dashboard with the gathered data	Project team	1 day
If necessary, improve the dashboard	Development team	-
If necessary, improve the data (gathering, preparation)	Project team	-
Validate the improved dashboard with the improved data	Project team	1 day
– Validated dashboard		
Implementing the system		
Educate the users on the objectives of the PMS	Project team	1 hour
Introduce the PMS	Project team	1 hour
Educate users on how to use the PMS	Project team	1 hour
Distribute a user manual	Project team	-
– First usage of the PMS		
Share the targets with the suppliers	Manager Purchasing and Logistics	-
Encourage users to use the PMS	Project team	-
Encourage users to suggest improvements	Project team	-
Provide feedback to the suppliers on how they can improve their performance	Manager Purchasing and Logistics	30 min. / supplier
Evaluation		
Measure the progress towards the goals	Project team	1 week
– Goals are (partly) met		
Is there data missing?	Users	-
Are KPIs unnecessary?	Users	-
Improve the system with the suggestions given	Project team / development team	1 day – 1 week
– Initial PMS is fully functional		
Plan a new moment for evaluation	Project team	1 hour
– ISO audit awards a "good" towards supplier performance measurement	ISO auditor / Quality Officer	
Integrating the PMS with the new ERP, CRM and bookkeeping systems		
Add the KPI that could not be measured in the "old" systems to the PMS (KPI 4) Modify the data source of KPIs 2 and 3	Project team / development team	1 week
Create exports from the systems to be able to use the data (KPIs 1, 2, 3, 4, 5, 6, and 8)	Project team	1 day
Prepare the data for usage in the PMS (earlier data exports might still be usable)	Project team	2 days
Update the data sources of the already existing KPIs	Project team	1 week
Validate the dashboard	Project team	1 day

If necessary, improve the data or dashboard	Project team / development team	1 week
⚐ **– Full PMS is in place**		
Evaluation		
Measure the progress towards the goals	Project team	1 week
Are KPIs unnecessary?	Users	-
Is there need for additional KPIs?	Users	-
⚐ **– The PMS is fully functional**		
Maintain the PMS (add- and remove KPIs, edit data sources)	Project team	-

Table 9: activities and milestones

Timeframe

The activities and milestones in Table 9 are in order. When to do what is shown in Table 10. A coloured block in the row of the activity shows that that activity is performed in that week. The time needed for each step is based on one FTE and scheduled broadly to make sure the expected timeframe will be achievable. The system should be working (i.e. the milestone "working dashboard" (but ideally "validated dashboard") should have been reached) when the ISO audit is executed. This is scheduled in Week 51 (end of December 2018). The system cannot be evaluated immediately, therefore, in Table 10, the evaluation is planned after half a year of data gathering to ensure enough data is present to evaluate. As Barr (2018) mentioned, you need five KPI data points to establish a baseline. And even more to declare a small change. This is also the reason why the first feedback towards suppliers is scheduled for half a year after data gathering.

As the ISO audit is a fixed date, Odin Groep should start the implementation by the end of October (Week 43), or move faster than the time path indicates to have validated the dashboard before the audit. To have a working dashboard, Odin Groep needs to start halfway November (Week 47). Since it is unknown when the new systems will be implemented, no starting date is added for the second part of the implementation. However, this will probably be somewhere in 2020, when the project team will have been reduced to two members, the manager and team leader of Logistics.

Costs

The PMS does not only have benefits. To reach those benefits, costs need to be made. The project- and development team need to invest time to get the system to work properly. A user manual needs to be written, and multiple meetings will be held.

- Time investments project team: around five weeks divided between the three members;
- Time investments development team: around six weeks divided between the members;
- Time investments others: one day throughout the entire implementation for the users;
- Printing user manuals.

Next to the costs of developing the system, there are also costs in the usage of the system, that have to made every year:

- Data collection: about one hour per supplier. In the initial PMS, the data for two KPIs also needs to be documented, which will result in more time;
- Providing feedback to suppliers: about thirty minutes per supplier;
- Maintenance: at least one week every year (after supplier feedback).

Note that not all suppliers' performance will be measured. The number of suppliers to measure depends on one thing: The time available from the staff managing the suppliers (Gordon, 2010).

	Current systems - weeks																				New systems - weeks											
What	1	2	3	4	5	6	7	8	9	10	11	12	13	14		26	27	28	29		1	2	3	4	5	6		26	27	28	29	30	31
Data Gathering																																
Create exports from the systems to be able to use the data (KPIs 1, 2, 6, 7, and 9)																																
Determine values for the data that is not in the systems (KPIs 3, 4, 8, 10, 11)																																
Prepare the data for usage in the PMS																																
Developing the initial dashboard																																
Share objectives and functionalities for the dashboard with the development team																																
Share the KPIs from Section 4.3 with the development team (input and output)																																
Develop the dashboard (both visually and functionally)																																
Test the functionalities of the dashboard																																
Improve the dashboard																																
Testing the system																																
Gather the data which is the input for the system																																
Create a user manual																																
Validate the dashboard with the gathered data																																
If necessary, improve the dashboard																																
If necessary, improve the data (gathering, preparation)																																
Validate the improved dashboard with the improved data																																
Implementing the system																																
Educate the users on the objectives of the PMS																																
Introduce the PMS																																
Educate users on how to use the PMS																																
Distribute a user manual																																
Encourage users to use the PMS																																
Encourage users to suggest improvements																																
provide feedback to the suppliers on how they can improve their performance																																
ISO audit - *when start implementation in week 43 / 47*					51				51																							
Evaluation																																
Measure the progress towards the goals																																
Is there data missing?																																
Are KPIs unnecessary?																																
Improve the system with the suggestions given																																
Plan a new moment for evaluation																																
New ERP, CRM and bookkeeping systems are implemented																																
Integrating the PMS with the new ERP, CRM and bookkeeping systems																																
Add the KPI that could not be measured in the "old" systems to the PMS (KPI 5)																																
Modify the data source of KPIs 3 and 4																																
Create exports from the systems (KPIs 1, 2, 3, 4, 5, 6, 7, and 9)																																
Prepare the data for usage in the PMS (earlier data exports might still be usable)																																
Update the data sources of the already existing KPIs																																
Validate the dashboard																																
If necessary, improve the data or dashboard																																
Evaluation																																
Measure the progress towards the goals																																
Are KPIs unnecessary?																																
Is there need for additional KPIs?																																
Maintain the PMS (add KPIs, remove KPIs, edit data sources)																																

Table 10: timeframe for the implementation of the PMS

5.3 Dashboard

In Section 2.5.4, the literature on developing the dashboard of a PMS is discussed. The dashboard for Odin Groep is developed using the suggestions from the literature, and the demands and wishes from representatives of Odin Groep. As creating the dashboard is an iterative process, the dashboard will be reviewed by Odin Groep and improved continually. To answer Sub question 6b, the prototypes of the dashboard (overview of all suppliers and full dashboard) are shown in Appendix L. The dashboards show the KPIs useful for the Purchasing and Logistics Department. The dashboards for other departments will look similar, but will show other KPIs. Both dashboard views are explained below.

Overview of suppliers

The overview of suppliers is the first screen of the PMS. In this screen, the user can see all suppliers, with their type, purchasing value, the number of order lines, and overall performance. The user also has the ability to filter only a specific type of supplier, to filter on the performance, to look at the suppliers above or below a certain purchasing value and filter on the number of order lines. The user could also select which timeframe to look at, for example: The past year, past month or past week. To indicate the supplier's performance, coloured icons are used. This enables the user to quickly see which suppliers are performing good, and which suppliers have KPIs that are below target. Three colours are used to indicate the performance of the suppliers KPIs. The situations that lead to a certain colour are:

- Red light: at least one of the KPIs has performed poorly;
- Red light: no poor KPIs, and more than 50% of the KPIs are OK;
- Yellow light: no poor KPIs, and between 25% and 50% OK KPIs;
- Green light: no poor KPIs, and a maximum of 25% of KPIs is OK.

If the light is yellow or red, you should look further into the supplier. A green light indicates a good performance. If desired, Odin Groep could look into these KPIs as well, but it is not a necessity.

In Appendix L suppliers are selected on the number of order lines, and the filter timeframe is set to "last year". Last year indicates the purchasing value and number of order lines for the period between the current date, and the current date a year before.

Supplier dashboard

The supplier dashboard shows the values of all KPIs for the supplier, or for the combined group of suppliers (the option "select multiple" is also available in the filters). In this case, the supplier credit makes no sense, and its box will thus be empty (N/A). On the left is the important data that are not KPIs, but give context to the user about the supplier(s). Here are also the filters: supplier and timeframe. When the timeframe is set to, for example, month, all data in the PMS will represent the previous month (for example: the number of problems indicates the number of problems of the previous month). Some additional informative is also adopted in the PMS' dashboard. The ISO/NEN certifications are marked with yes (Y) or no (N) and a coloured icon. The other information simply have a value and a coloured icon. The middle (darker green) part of the dashboard shows the KPIs themselves and their values. There are three types of KPIs used to measure supplier performance at Odin Groep: numbers, percentages and times. In the right top corner of the PMS is the overall status of the KPIs, which displays the number of KPIs that are "good", "OK", and "poor".

For the KPIs where a number is given, the current- and previous number, the change and status are displayed and indicated with symbols. Bar charts are used for the percentages. In case of stacked bars, the colour "green" is used to indicate the best situation, and a spectrum of "red" colours is used to indicate the other situations. The lead time table shows the actual lead times, the average and the trend. Additional information about the KPIs (e.g. definition) can be found through hovering over the KPIs name.

5.4 Conclusion

How to implement the PMS with the KPIs as developed in Chapter 4 is answered using the literature on this topic and the goals and requirements from Odin Groep. Section 5.2 answered Sub question 6a and Section 5.3 answered Sub question 6b.

Sub question 6: How to implement a system to measure supplier performance using KPIs?

a. *How should Odin Groep implement the system?*
b. *What should the performance measurement system look like?*

Implementing a PMS can be seen as a change. Therefore change management should be followed. The organisation should firstly unfreeze (plan and prepare for the PMS), then Odin Groep can move (develop the PMS), and lastly Odin Groep should refreeze the new situation (test and implement the PMS). The system should be implemented in multiple steps (Table 9, Section 5.2) , of which at least the working dashboard should be available by the end of 2018 (before the ISO audit). For the timeframe, see Table 10 (Section 5.2).

Firstly, the data needs to be extracted from the systems and prepared to use. Secondly, the dashboard needs to be developed, tested and validated. Then there is the implementation phase, where the system will be used, and feedback will be gathered. Lastly, an evaluation should be planned to improve the system and check the progress towards the goals. In this initial dashboard, KPI 4 will not be used, as this is not measurable. As Odin Groep is moving towards new ERP, CRM and Bookkeeping systems, an addition to the implementation is proposed. KPI 4 is desirable, but currently not measurable, however, with the new systems it is measurable. This KPI needs to be added, data sources should be altered and the data exports need to updated and prepared again. Secondly, an updated dashboard should be developed, tested, validated, implemented, used and evaluated. After the evaluation, the system needs to be maintained (i.e. continually improved) with new KPIs and the deletion of obsolete KPIs. What the full dashboard should look like is shown in Appendix L (Section 5.3). Additionally, an overall dashboard showing all suppliers will be available (Section 5.3). This way, Odin Groep can firstly filter on the type, purchasing value, order lines and performance. This dashboard is developed for the Purchasing and Logistics Department. Other departments have other dashboards, as they do need other (fewer) KPIs.

It will take about fourteen weeks until the PMS is fully functional. After a half year of data gathering, the system can be evaluated. After the implementation of the new systems, the PMS needs to be updated. This is expected to take six weeks. Afterwards, the time needed to maintain the PMS consists of updating KPIs and data sources, and providing feedback to the suppliers.

6. Conclusion and discussion

This chapter concludes this research. In Section 6.1, the research question is answered. In Section 6.2 the recommendations for Odin Groep are given. Lastly, in Section 6.3, the results of this research are discussed. In this section, the limitations and suggestions for further research are addressed as well.

6.1 Conclusion

Currently, supplier performance is measured based on gut feeling. To overcome the problems that are caused by this, the following research question is answered.

> *How can Odin Groep implement a system to continually measure supplier performance in order to ensure Odin Groep is working with the best suppliers, and to further develop these suppliers, using KPIs?*

To answer this research question, firstly, the characteristics of a good PMS and its KPIs have been determined in Section 2.3. These characteristics have been used in the development of the KPIs and the PMS. Secondly, in Section 2.4, research has been done on the KPIs that are currently used. These KPIs have been used as inspiration and to ensure no important KPIs are forgotten at Odin Groep. Thirdly, a Delphi study has been executed with managers of different departments at Odin Groep, in order to find which goals and requirements Odin Groep poses for the PMS and its KPIs (Sections 3.2 and 3.5). Part of these requirements were which categories to focus on, while developing KPIs (Section 3.5). In the next step, the KPIs Odin Groep should use were developed (Section 4.1). Afterwards the KPIs' measures were selected (Section 4.2). Lastly, the implementation plan has been written (Section 5.2) and a prototype of the dashboard of the PMS has been developed (Section 5.3).

The first part to answer the research question is to show the KPIs that Odin Groep should use to measure supplier performance, and how these can be measured. The KPIs are based on the six categories: quality, financial, delivery, communication, safety and sustainability. The KPIs and how to measure these are:

1. Product quality – % of returned products;
2. Invoice errors – % of invoices with an error;
3. (*) Carrier delivery errors – % of deliveries with an error;
4. Rescheduling quota – average number of delivery date changes;
5. On time, in full – % of deliveries that are on time and in full;
6. Lead time – average time between order and delivery;
7. (*) Communication – number of information channels;
8. Problem solving capabilities – % of problems solved and the average time this takes;
9. (*) Information security standards – score from the information security survey;
10. (*) Environmental sustainability – CDP score on environmental sustainability.

Most of these ten KPIs are measurable from the systems, others (indicated with an asterisk (*)) need to be measured manually. A prototype dashboard has been developed, which contains all KPIs, but also some general information about the supplier(s). How Odin Groep can develop and implement this dashboard is shown in the implementation plan (Section 5.2). The main steps to take are: gathering data, developing the dashboard, testing the PMS, implementing the PMS and evaluating the PMS.

If Odin Groep follows this implementation plan, the PMS should be fully functional within fourteen weeks. The initial investment of five weeks for the project team, and six weeks for the development team is worthwhile. Using the new PMS, Odin Groep is able to objectively measure supplier performance, know whether she is working with the best suppliers, and able to meet demands by ISO certifications. Secondly, Odin Groep is able to improve her suppliers, possibly increasing the relation with and commitment of those suppliers, which in turn might decrease costs and/or increase quality.

The yearly costs of using the PMS are about one and a half hour for data gathering and feedback per supplier. Although this seems an extra investment, this time is currently spent "measuring" supplier performance as well.

6.2 Recommendations

There are some recommendations for Odin Groep based on the findings in this research. These recommendations are based on the implementation and usage of the PMS and other parts of this research. This section also gives some general recommendations for Odin Groep.

Implementation and usage of the PMS

The first recommendation is to implement and use the PMS as suggested in Section 5.2. When the implementation plan is followed, all KPIs are visible in the PMS. Section 5.2 also suggests changes to be made to the PMS when the new systems are in place, and how to maintain the system. The implementation plan also includes milestones, it is recommended to celebrate these milestones. Secondly, all departments, except the Purchasing and Logistics Department, have to develop the PIs for the KPIs. This is important, as these PIs give insight in why the KPI has a certain value.

Another recommendation is to determine how many suppliers to evaluate before starting the evaluations. It is suggested to firstly determine how much time is available, and calculate the number of suppliers to evaluate from there. Likewise, the targets need to be improved and agreed on by all stakeholders, and suppliers need to be made aware of these targets. When using the PMS, it is recommended to maintain the system through the deletion and addition of KPIs. To maintain the PMS, it is important to ensure the employees have the skills to do so.

Sustainability

Odin Groep mentioned sustainability as an important topic. However, the interviewees did not think sustainability should be included in the PMS, because at Odin Groep, it is all about money. Therefore, it is recommended to look into the reasons why employees seem to disagree with sustainability policy. If this is known, Odin Groep should make sure that her employees are on the same page concerning policy. The why question has been posed in the discussion in Section 6.3. Secondly, Odin Groep should define "in order" (i.e. the target used for sustainability), as this is too vague to actually use.

Targets of KPIs

It is recommended to firstly use the targets as proposed in Section 4.3. As targets exist to improve performance, the targets should be evaluate regularly. Therefore, when data has been gathered, and the PMS has evaluated the suppliers, the targets should be updated. It should be noted that the target should be challenging, but realistic.

Other recommendations

- Using the data available, Odin Groep should look into other processes that are currently not measured objectively. It is recommended that KPIs are developed for these processes as well, to increase objectivity and to enable Odin Groep to make decisions based on the data;
- Odin Groep is recommended to negotiate SLAs with the suppliers. From the analysis followed that Odin Groep could use the SLAs she has with her customers to do this;
- Odin Groep is recommended to give her suppliers a status (i.e. silver, gold, platinum) based on their performance. How to do this, and when a supplier should reach a certain status, yet needs to be investigated. This is a free method to show extra appreciation to the suppliers;
- Mistakes are frequently made while entering data into the systems. Odin Groep should take measures to reduce these errors, and thus have more reliable data. This can be done through training for all employees who use the systems. This training should focus on procedures, which data to enter where, and the necessity for reliable data;

- The PMS does not focus on all possible categories. Odin Groep is recommended to take into account some other categories (e.g. innovation) in the stage of selecting the suppliers.

6.3 Discussion

This section discusses this research through the description and explanation of the findings. The aim is to increase the understanding of the research problem.

Measuring supplier performance in the IT sector

Odin Groep is an IT company. Trends in the IT sector are fast growth, mergers and acquisitions, and more and more revenue from "as-a-service" products (van Kampen, 2018). Firstly, due to the increase in "as-s-service" products, more and more delivered products are services. As you cannot have inventory of a service, lead time might increase and you cannot measure the "returns" anymore. Secondly, growth brings its own challenges in supplier performance measurement. The suppliers should be able to meet the growing demand and still perform conform the targets communicated by Odin Groep. This will not pose problems to the bigger distributors, however, smaller suppliers might face problems delivering large quantities in time. Odin Groep could look into substitutes to eliminate the risk of no delivery, or increase the partnership with these suppliers. This way, Odin Groep can ensure to get the suppliers' delivery as soon as they have inventory.

Challenges at Odin Groep to measure performance

Although Da Silva & Borsato (2017) mentioned that poor data availability is one of the challenges in measuring performance, it appeared not to be the challenge at Odin Groep. It was found to be more difficult to prepare and use the data such that objective KPIs could be created. Nevertheless, some required data was unavailable in the systems. This does not mean (K)PIs cannot be measured. They still can, just not objectively. The challenges with a subjective measure are trustworthiness and comparability of the KPI. Trustworthiness can be increased through the following process:

- Two or more colleagues individually determine the performance;
- The individual results are discussed;
- A final score for the performance is given based on the discussion.

Using this method, the process becomes objective, and the data source can thus be seen as "similar". Although the (K)PI itself is still subjective, it will be much easier accepted in the organisation.

Number of suppliers to evaluate using the PMS

In order to evoke action from the supplier, the metrics and its scores from the PMS should be shared with suppliers (Maestrini, Maccarrone, Caniato & Luzzini, 2018). Odin Groep is planning to give feedback to the supplier through sharing all metrics and scores (with an explanation) through email. As this takes quite some time per supplier, Odin Groep cannot measure all suppliers' performance. Odin Groep should thus select which suppliers to evaluate. As not much literature is present on this "prequalification step" (Luzzini, Caniato & Spina, 2014), which suppliers to focus on remains a valid question. ISO demands that the "bigger" suppliers' performance is measured. Most buying companies currently use the Kraljic matrix (profit and risk) to determine which suppliers are "key" (Pardo, Missirilian, Portier & Salle, 2011). Odin Groep, however, categorizes suppliers on the number of order lines instead of the profits. This has not been found in literature, but, is expected to be a valuable means to select which suppliers to evaluate. Evaluating the number of order lines does, implicitly, include the product price and delivery time. Because usually, Odin Groep buys at the supplier who is the first to have inventory, with a reasonable price (A1). Therefore this categorization is more valuable for Odin Groep than simply the profits. Additionally, we learned from the Kraljic matrix that one should not blindly focus on financial impact (e.g. profit, number of order lines), but evaluate the risks as well. Suppliers that deliver a crucial product of which no substitutes exists, might be the most important to evaluate, due to the risks of no supply.

Quantitative focus

Odin Groep is focussed on quantity. The choice to determine which suppliers to evaluate from the number of order lines, is one aspect. Another aspect is that price is amongst the most important criteria in the purchasing process at Odin Groep. A shorter lead time and/or better quality influence the acceptable price level. As price is not an independent factor, there is no KPI for it. The price level can be deducted from the number of order lines and the delivery time This focus on quantity and price might not always be preferable. Odin Groep could wait for a better price if the lead time is not critical, however, this usually does not happen. Possibly both price and lead time might not be most important. As the focus on quantity impacts the PMS, it is advised that Odin Groep looks into the qualitative side as well. Because of the filter on the number of order lines, critical suppliers, who supply a limited number of products, might not be evaluated. Similarly, a supplier might score low on the KPI OTIF, as Odin Groep demands immediate delivery of the parts that are available, instead of waiting for the full order, which still may arrive on time.

Categories for KPIs

Odin Groep decided not to use the categories product development and innovation from Chapter 2 because other categories, including self-developed categories such as SLAs, fit with strategy and certifications, have shown to be more important to the interviewees. According to A8, it is nice to have innovative suppliers, but not necessary (A5). Odin Groep is a follower, which means the organisation has to supply the new solutions (i.e. innovations) too (Lechler, 2018). Therefore the suppliers need to be either innovative, or Odin Groep should be able to quickly switch to another supplier. Product development is mostly important for safety updates (A8) and in the development of Odin Groep's own Predia line (A1; A9). The number of suppliers where either reason is applicable is very limited. Therefore, it is evident why this category is seen as less important. Apart from that, these two categories are more selection criteria than criteria to measure performance on. If you need a supplier that has high performance in product development and/or innovation, Odin Groep should use these criteria in the initial selection of the supplier. It would not make sense to wait until performance measurement to look at these categories, as Odin Groep will then probably be too late.

Interdependencies between KPIs

In real-life scenarios, it is found that not all KPIs are completely independent (Kucukaltan et al., 2016). Independence can be assumed if the performance of one KPI can be judged without considering the performance of another KPI (Goodwin & Wright, 2004). At Odin Groep, this resulted in some proposed KPIs that have become PIs for another KPI. In some cases, it is impossible to be fully independent. However, when these KPIs can be judged without looking at the other KPIs, they are still useful. Users of a PMS should keep in mind independence while drawing conclusions from the PMS.

Sustainability

Sustainability is one of the elements that has not received enough attention in PMSs (Balfaqih et al., 2016). At Odin Groep, sustainability has received increasing attention, and is very important to the organisation. However, price and quality still come first. The interviewees, however, seemed to disagree with Odin Groep, as they do not consider sustainability an important category to measure supplier performance. According to Paillé and Raineri (2015), when implementing an environmental policy, it is important to make sure that the right intention is shared with the employees, and that no psychological contract-breach (i.e. the feeling that the organization does not work towards their own policy) is perceived. This might be the case at Odin Groep, where it was frequently mentioned that, although sustainability is important, in reality, it is all about money. The hypothesis of Paillé and Raineri (2015) has not yet been extensively tested, but it would explain why the interviewees disagree with the sustainability policy at Odin Groep.

Benefits of the PMS
The PMS could also lead to the appearance of internal errors at Odin Groep. When a lot of suppliers score low on certain KPIs, it might appear that Odin Groep is the reason for this. Therefore, the PMS does not only increase supplier performance, it might also increase Odin Groep's performance. Secondly, the results from the PMS can be used in the negotiation of new contracts with suppliers. If the supplier scored poorly, Odin Groep might have better bargaining power when negotiating new contracts, possibly resulting in lower costs or better quality.

6.3.1 Limitations
This research has its limitations. Because of the importance of strategic alignment on KPIs, this research, and the KPIs suggested, are not directly applicable to another company, whether similar or not. Other limitations are:

- The new ERP, CRM and bookkeeping systems are not fully developed yet. Therefore, it is not 100 percent certain which options will be available in the new systems, and which will not;
- Following the maintenance part in the implementation plan, a PMS is never perfect, and always needs to be improved. Therefore, part of this research might not be valid in the future;
- This research does not focus on KRIs, as due to time limitations, a choice has been made to focus on KPIs and their corresponding PIs. To solve the problems at Odin Groep, it is more important to know how to increase performance (KPIs) than to know how you have performed in the past (KRIs). The few KRIs that have been found are further explained in Appendix J.

6.3.2 Additions to literature and suggestions for further research
Interesting findings that have not been found in the existing literature are:

- The application of the number of order lines as a selection criteria for the evaluation of suppliers;
- In the literature is no distinction made between categories that are relevant for the selection of suppliers (sourcing) and categories relevant for the performance of the suppliers. I found that, for example, innovation and product development are sourcing categories, but not performance measurement categories;
- As safety is highly regulated, less KPIs are developed for this category. This differs from the view that regulations are a motivation for KPIs (Chaim, Muschard, Cazarini & Rozenfeld, 2018).

Following the discussion, some parts of this research require further attention. Topics suggested are:

- Which methods are available for the selection of suppliers to evaluate performance? Odin Groep is planning to use the number of order lines, whereas the limited research that is available focusses on the Kraljic matrix. If more options have been found, it should be studied which method is most effective in which situation. This research could be done starting with qualitative questionnaires on the current methods used. Afterwards, using case studies, the effectiveness of the methods can be determined;
- Are there good KPIs for the "People" and "Profit" parts of "Sustainability" for supplier performance measurement? The goal is that the supplier can improve her performance, and the KPIs can be measured objectively?;
- Is it possible to meet all characteristics of a good KPI, when the measure cannot be measured objectively? And if so, how? To answer this question, you should look into the characteristics trustworthiness and comparability, and see how they are influenced by subjective measures. This can be done through for example a case study.

Concluding remarks
With this report, Odin Groep can implement a PMS to continually measure supplier performance. Odin Groep is professionalizing this process through the use of the most valuable KPIs in a simple PMS. It is recommended to follow the implementation plan of Section 5.2 to reach the PMS' full potential.

References

Badawy, M., El-Aziz, A.A.A., Idress, A.M., Hefny, H. and Hossam, S. (2016). A survey on exploring key performance indicators. *Future Computing and Informatics Journal, 1*(1-2), pp. 47-52, https://doi.org/10.1016/j.fcij.2016.04.001.

Bai, C. and Sarkis, J. (2014). Determining and applying sustainable supplier key performance indicators. *Supply Chain Management: An International Journal, 19*(3), pp.275-291

Balfaqih, H., Nopiah, Z.M., Saibani, N and Al-Nory, M.T. (2017). Review of supply chain performance measurement systems: 1998 – 2015. *Computers in Industry, 82*, pp. 135-150, https://doi.org/10.1016/j.compind.2016.07.002.

Barr, S. (2018). *How Many KPI Data Points Do You Need To Use And Interpret Them?.* Retrieved from https://www.staceybarr.com

Bauer, K. (2005). The Search for a Holy Grail: Best Practices for Defining KPIs. *Data Warehousing & BI Conference, September 2005*, Orlando, Florida.

Bhatti, M., Awan, H. and Razaq, Z. (2014). The key performance indicators (KPIs) and their impact on overall organizational performance. *Quality & Quantity, 48*, doi: 10.1007/s11135-013-9945-y.

Bhushan, N. and Rai, K. (2004). The Analytic Hierarchy Process. In *Strategic Decision Making – Applying the Analytic Hierarchy Process* (pp. 11-21). London, UK: Springer, ISBN: 978-1-85233-756-8

Bourne, M., Neely, A., Mills, J. and Platts, K. (2003a). Implementing performance measurement systems: a literature review. *International Journal of Business Performance Management, 5*(1), pp.1-24.

Bourne, M., Neely, A., Mills, J. and Platts, K. (2003b). Why some performance measurement initiatives fail: lessons from the change management literature. *International Journal of Business Performance Management, 5*(2-3), pp.245-269.

Business Dictionary (n.d.). *Purchase price variance.* Retrieved from: http://www.businessdictionary.com/definition/purchase-price-variance.html

Cambridge Dictionary (n.d.). *Escalate*. Retrieved from: https://dictionary.cambridge.org/dictionary/english/escalate

Centraal Bureau voor de Statistiek (CBS) (2018). *Nine percent recycled materials in the economy*. Retrieved from https://www.cbs.nl

Chae, B. (2009). Developing KPIs for supply chain: an industry perspective. *Supply Chain Management: An International Journal, 14*(6), pp. 422-428.

Chaim, O., Muschard, B., Cazarini, E. and Rozenfeld, H. (2018). Insertion of sustainability performance indicators in an industry 4.0 virtual learning environment, *Procedia Manufacturing, 21,* pp. 446-453, https://doi.org/10.1016/j.promfg.2018.02.143.

Choy, K., Bun Lee, W. and Lo, V. (2004). Development of a case based intelligent supplier relationship management system – linking supplier rating system and product coding system. *Supply Chain Management: An International Journal, 9*(1), pp. 86-101.

Computable (2017). *Computable 100 financieel onderzoek 2017*. Retrieved from: https://www2.computable.nl/apps/cp100.php

Cousins, P., Lamming, R., Lawson, B. and Squire, B. (2008). *Strategic supply management: Principles, theories and practice (first edition)*. Essex, UK: Pearson Education Limited.

Da Silva, F.A. and Borsato, M. (2017). Organizational Performance and Indicators: Trends and Opportunities. *Procedia Manufacturing, 11*, pp. 1925-1932.

Dalkey, N. C. and Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science, 9*(3), pp. 458-467.

Dey, P.S., Bhattacharya, A., Ho, W. and Clegg, B. (2015). Strategic supplier performance evaluation: A case-based action research of a UK manufacturing organisation. *International Journal of Production Economics, 166*, pp. 192-214, https://doi.org/10.1016/j.ijpe.2014.09.021.

Eckerson, W. W. (2009). *Performance management strategies: How to Create and Deploy Effective Metrics*. TDWI Best Practices Report, Quarter 1, 2009.

Fitzgerald, L., Johnston, R., Brignall, S., Silvestro, R. and Voss, C. (1991). *Performance Measurement in Service Business*. London, UK: CIMA.

Fortuin, L. (1988). Performance indicators- why, where and how? *European Journal of operational research*, *34*, pp. 1-9.

Galar, D., Stenström, C., Parida, A., Kumar, R. and Berges, L. (2011). Human Factor in Maintenance Performance Measurement. *Proceedings of the 2011 IEEE IEEM*, pp. 1569 – 1576.

Gonçalves, C.D.F., Dias, J.A.M. and Machado, V.A.C. (2014). Multi-criteria decision methodology for selecting maintenance key performance indicators. *International Journal of Management Science and Engineering Management, 10*(3), pp. 215-223, doi: 10.1080/17509653.2014.954280.

Goodwin, P. and Wright, G. (2004). *Decision Analysis for Management Judgment* (third edition). Hoboken, NJ: John Wiley & Sons Inc. ISBN: 0-407-86108-8.

Gordon, S. (2010). *When measuring supplier performance, it's how well, not how many*. Retrieved from https://valuechaingroup.com/

Ha, M-H. and Yang, Z. (2017). Comparative analysis of port performance indicators: Independency and interdependency. *Transportation Research Part A, 103*, pp. 264-278, https://doi.org/10.1016/j.tra.2017.06.013.

Hagspiel, S. (2018). Reliability with interdependent suppliers, *European Journal of Operational Research*, *Volume 268* (1), pp. 161-173, https://doi.org/10.1016/j.ejor.2018.01.014.

Hanafi, M. and Abdel-Raouf, A. (2014) Software Maintenance from the Change Theory Perspective. *Proceedings of the 2014 International CSSCC*, pp. 66-71, Venice, It. ISBN: 978-1-61804-228-6

Hausfather, Z. (2017*). Analysis: Global CO2 emissions set to rise 2% in 2017 after three-year 'plateau'.* Retrieved from: https://www.carbonbrief.org

Hey, R.B. (2017). Performance Focus. In *Performance Management for the Oil, Gas, and Process Industries* (pp. 227-241). Cambridge, MA: Gulf Professional Publishing, https://doi.org/10.1016/B978-0-12-810446-0.00015-3.

Ho, W., Xu, X. and Dey, P.K. (2010). Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. *European Journal of Operational Research, Volume 202*(1)*,* pp. 16-24, https://doi.org/10.1016/j.ejor.2009.05.009.

Kampen, van M. (2018). *ICT-update maart 2018.* Retrieved from: https://www.rabobank.nl/

Kaplan, R. S. (1984). Yesterday's accounting undermines production. *Harvard Business Review, 62*(4), pp. 95-101.

Kaplan, R.S. and Norton, D.P. (1992). The Balanced Scorecard: measures that drive performance. *Harvard Business Review, 70*(1), pp. 71-79.

Kaplan, R. S. and Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review, 74*(1), pp. 75-85.

Keegan, D.P., Eiler, R.G. and Jones, C.R. (1989). Are your performance measures obsolete?. *Management Accounting, 70*(12), pp. 45-50.

Khan, K. and Shah, A. (2011). Understanding Performance Measurement Through the Literature. *African journal of business management, 5*, doi:10.5897/AJBMX11.020.

Kucukaltan, B., Irani, Z. and Aktas, E. (2016). A decision support model for identification and prioritization of key performance indicators in the logistics industry. *Computers in Human Behavior, 65,* pp. 346-358.

Kumar, A., Sah, B., Singh, A.R., Deng, Y., He, X., Kumar, P. and Bansal, R.C. (2017). A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews, 69*, pp. 596-609, https://doi.org/10.1016/j.rser.2016.11.191.

Lechler, A. (2018). *Business Innovation: Pros and cons of the fast follower approach*. Retrieved from: https://www.bie-executive.com/

Lewin, K. (1947). Frontiers in Group Dynamics: Concept, Method and Reality in Social Science; Social Equilibria and Social Change. *Human Relations, 1*(5), pp. 5-41.

Liebetruth, T. (2017). Sustainability in Performance Measurement and Management Systems for Supply Chains. *Procedia Engineering, 192*, pp. 539-544, https://doi.org/10.1016/j.proeng.2017.06.093.

Ljunglöf, J. and Nisser, H. (2017). KPIs in a service organization - a case study of Axfood IT. *Uppsla University*, Department of Business Studies.

Luzzini, D., Caniato F. and Spina, G. (2014). Designing vendor evaluation systems: An empirical analysis, *Journal of Purchasing & Supply Management, 20*, pp. 113–129

Lynch, R.L. and Cross, K.F. (1991). *Measure Up - the Essential Guide to Measuring Business Performance*, London, UK: Mandarin.

Maestrini, V., Maccarrone, P., Caniato, F. and Luzzini, D. (2018). Supplier performance measurement systems: Communication and reaction modes*, Industrial Marketing Management*, ISSN 0019-8501, https://doi.org/10.1016/j.indmarman.2018.07.002.

Mbugua, L., Harris, P., Holt, G. and Olomolaiye, P. (1999). A framework for determining critical success factors influencing construction business performance. *Proceedings of the Association of Researchers in Construction Management 15th Annual Conference.*

Meier, H., Lagemann, H., Morlock, F. and Rathmann, C. (2013). Key performance indicators for assessing the planning and delivery of industrial services. *Procedia CIRP, 11,* pp. 99-104.

Moullin, M. (2007). Performance measurement definitions: Linking performance measurement and organisational excellence. *International journal of health care quality assurance, 20*, pp. 181-183, doi: 10.1108/09526860710743327.

Nederlands Normalisatie-instituut (2015a). Kwaliteitsmanagementsystemen – Eisen (ISO 9001:2015). NEN, Normcommissie 400 176 “Kwaliteitsmanagement", Delft, NL.

Nederlands Normalisatie-instituut (2015b). Milieumanagementsystemen - Eisen met richtlijnen voor gebruik (ISO 14001:2015). NEN, Normcommissie 390 012 “Milieumanagement", Delft, NL.

Nederlands Normalisatie-instituut (2017). Medische informatica – Informatiebeveiliging in de zorg (NEN 7510-1). Normcommissie 303 006 “Informatievoorziening in de zorg", Delft, NL.

Neely, A. (2005). The evolution of performance measurement research: Developments in the last decade and a research agenda for the next. *International Journal of Operations & Production Management, 25*(12), pp. 1264 – 1277.

Neely, A., Mills, J., Platts, K., Gregory, M. and Richards, H. (1996). Performance measurement system design: Should process based approaches be adopted?. *International Journal of Production Economics, 46-47*, pp. 423-431, https://doi.org/10.1016/S0925-5273(96)00080-1.

Neely, A., Richards, H., Mills, J., Platts, K. and Bourne, M. (1997). Designing performance measures: a structured approach. *International journal of operations & production management, 17*(11), pp. 1131- 1152.

Neely, A., Mills, J., Platts, K., Richards, H., Gregory, M., Bourne, M. and Kennerley, M. (2000). Performance measurement system design: Developing and testing a process-based approach, *International Journal of Operations & Production Management, Vol. 20*(10), pp. 1119-1145, DOI: 10.1108/01443570010343708

Odin Groep (2017). *Duurzaam ondernemen* – Jaarverslag 2017.

Odin Groep (2018). *Visie Missie Strategie ILM*. Internal document.

Odin-groep.nl (2018). Corporate website. Retrieved from: https://www.odin-groep.nl/

Paillé, P. and Raineri, N. (2015). Linking perceived corporate environmental policies and employees eco-initiatives: The influence of perceived organizational support and psychological contract breach. *Journal of Business Research, 68*(11), pp. 2404–2411, https://doi.org/10.1016/j.jbusres.2015.02.021

Pardo, C., Missirilian,O., Portier, P. and Salle, R. (2011). Barriers to the “key supplierization” of the firm, *Industrial Marketing Management, 40*(6), pp. 853-861, ISSN 0019-8501, https://doi.org/10.1016/j.indmarman.2011.06.029

Parmenter, D. (2007). *Key Performance Indicators – Developing, implementing and using winning KPIs*. Hoboken, NJ: John Wiley & Sons Inc.

Pérez, I.J., Cabrerizo, F.J., Alonso, S., Dong, Y.C., Chiclana, F. and Herrera-Viedma, E. (2018). On dynamic consensus processes in group decision making problems. *Information Sciences, 459,* pp. 20-35, https://doi.org/10.1016/j.ins.2018.05.017.

Pernot, E. and Roodhooft, F. (2014). The impact of inter-organizational management control systems on performance: A retrospective case study of an automotive supplier relationship. *International Journal of Production Economics, 158*, pp. 156–170.

Pikousová, K. and Průša, P. (2013). Supplier evaluation: The first step in effective sourcing. *Journal of Transport and Supply Chain Management 7*(1), Art. 87, 4 pages, https://doi.org/10.4102/jtscm.v7i1.87

Podgórski, D. (2015). Measuring operational performance of OSH management system – A demonstration of AHP-based selection of leading key performance indicators. *Safety Science, 73*, pp. 146-166, https://doi.org/10.1016/j.ssci.2014.11.018.

Prahinski, C. and Benton, W.C. (2004). Supplier evaluations: communication strategies to improve supplier performance. *Journal of Operations Management, 22*(1), pp. 39-62, doi:10.1016/j.jom.2003.12.005

Rockart, J.F. (1979). Chief executives define their own data needs. *Harvard Business Review, 57*(2), pp. 238-241.

Sako, M. (1992). *Prices, Quality and Trust: Inter-firm Relationships in Britain and Japan.* Cambridge, UK: Cambridge University Press.

Sayers, A. (2007). Tips and tricks in performing a systematic review. *The British Journal of General Practice, 57*(542), 759.

Selviaridis, K and Spring, M. (2018). Supply chain alignment as process: contracting, learning and pay-for-performance. *International Journal of Operations & Production Management, 38*(3), pp. 732-755.

ServiceNow (2018). *KPI Library.* Retrieved from: http://kpilibrary.com

Slack, N., Chambers, S. and Johnston, R. (2010). *Operations Management (sixth edition)*. Essex, UK: Pearson Education Limited.

Supply Chain Council (2012). Supply Chain Operations Reference Model: Revision 11.0. *SCOR: The Supply Chain Reference*. USA, October 2012, ISBN 0-615-20259-4.

Taticchi, P., Tonelli, F. and Cagnazzo, L. (2010). Performance measurement and management: a literature review and a research agenda. *Measuring business excellence, 14*(1), pp. 4-18, doi: 10.1108/13683041011027418.

Vallurupalli, V. and Bose, I. (2018). Business intelligence for performance measurement: A case based analysis. *Decision Support Systems, 111,* pp. 72-85, https://doi.org/10.1016/j.dss.2018.05.002

Wolf, R. (2016, June 1). Dashboard design. Strategic Finance. Retrieved from: http://sfmagazine.com/

Yadav, N. and Sagar, M. (2013). Performance measurement and management frameworks: Research trends of the last two decades. *Business Process Management Journal, 19*(6), pp. 947-971, doi: 10.1108/BPMJ-01-2013-0003.

Yigitbasioglu, O.A. and Velcu, O. (2012). A review of dashboards in performance management: Implications for design and research. International journal of Accounting Information Systems, 13, pp. 41-59, doi:10.1016/j.accinf.2011.08.002

Zeydan, M., Çolpan, C. and Çobanoğlu, C. (2011). A combined methodology for supplier selection and performance evaluation. *Expert Systems with Applications, 38*(3), pp. 2741-2751, doi: 10.1016/j.eswa.2010.08.064.

Zhou, H., Benton, Jr. W.C., Schilling, D.A. and Milligan, G.W. (2011). Supply Chain Integration and the SCOR Model. *Journal of Business Logistics, 32*(4), pp. 332–344.

Appendices

Appendix A – Odin Groep

The 470 employees work for either one of the companies or for one of the supporting departments at Odin Groep. Odin Groep offers a home for IT-companies and IT-specialists, and last year's 30th place in the Computable 100 shows it is financially healthy (Computable, 2017).

The main companies

- Previder is an IT solution provider, advising, building and managing from workspace to the cloud. Previder delivers all relevant IT technologies and services, and owns twin-datacentres;
- Heutink ICT is an IT specialist, focussed on education. As the need for 'anytime, anywhere learning' grows, Heutink ICT is focusing more and more on developing online platforms;
- Web2Work is a software company developing web-based platforms and applications, both standardized and custom made;
- Winvision is an IT service provider focussed on advising, developing, implementing and managing Microsoft based solutions.

Department Purchasing and Logistics

The Purchasing and Logistics Department is one of Odin Groep's supporting departments. This department is responsible for:

- Purchasing: ordering the right goods, quoting, supplier selection and support with tenders;
- Networking: building and maintaining contacts with suppliers, vendors and distributors;
- Warehousing: ordered goods are received in the warehouse, where the items are checked and stored until they are distributed;
- Network preparation and RMA: technical preparation of customer specific demands, testing hardware, repair and RMA handling towards suppliers and customer;
- AV-installations: the installation of audio and visual goods at the customer;
- Shared Service Centre: repair of hardware.

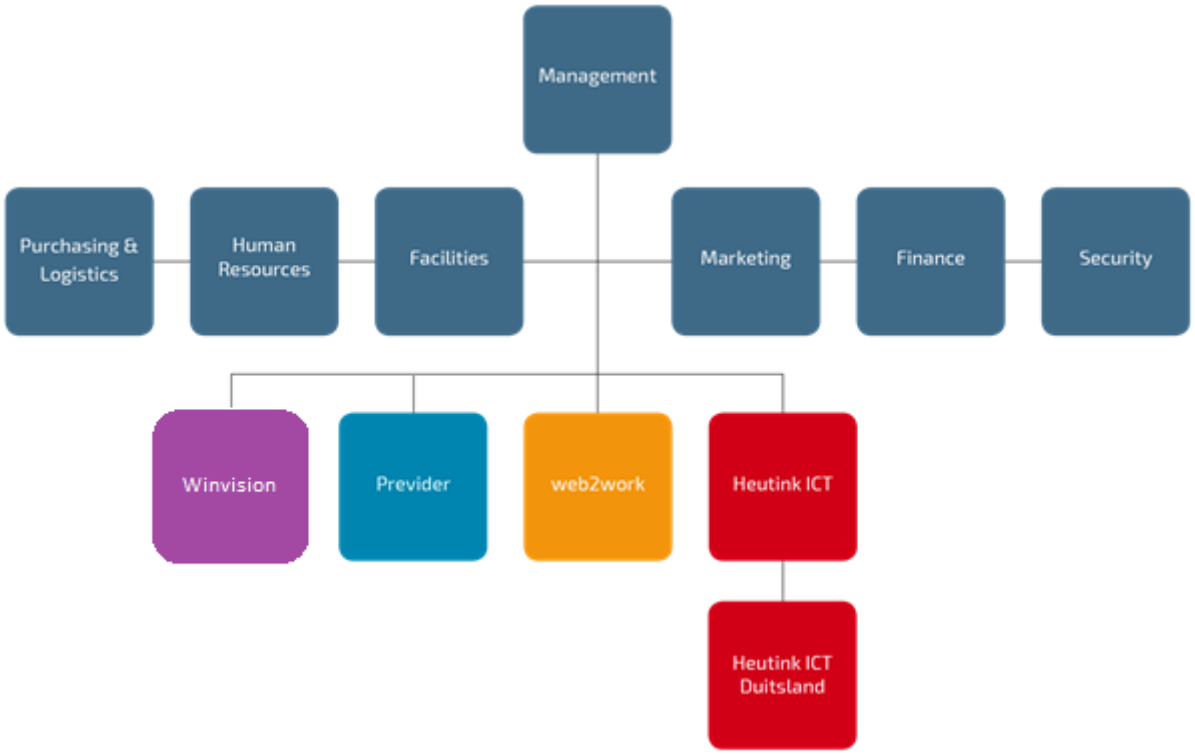


Figure 3: organization Chart Odin Groep

Appendix B – Current format performance measurement

Leveranciersbeoordeling

Datum beoordeling	
Leverancier	
Periode van beoordeling	

	UITSTEKEND	GOED	VOLDOENDE	ONVOLDOENDE
Prijs	☐	☐	☐	☐
Raamcontracten	☐	☐	☐	☐
RMA procedure	☐	☐	☐	☐
Levertijd	☐	☐	☐	☐
Algehele service	☐	☐	☐	☐
Communicatie	☐	☐	☐	☐
Flexibiliteit	☐	☐	☐	☐
Voldoen aan logistieke afspraken	☐	☐	☐	☐
Manco's / surplussen	☐	☐	☐	☐
Kennisniveau	☐	☐	☐	☐
Kwaliteit	☐	☐	☐	☐
Maatschappelijk Verantwoord Onderneen	☐	☐	☐	☐
Milieu	☐	☐	☐	☐
Specifiek voor merken				
Onsite garantievoorwaarden	☐	☐	☐	☐
Kengetallen (Solvabiliteit, liquiditeit)	☐	☐	☐	☐

Voorgestelde verbeteringsactiviteiten en/of opmerkingen

Eindoordeel

Handtekening hoofd inkoop
_____ Harm Scheper Manager Inkoop & Logistiek

Appendix C – Characteristics of good KPIs

#	Recommendation
1	Performance measures should be derived from strategy
2	Performance measures should be simple to understand
3	Performance measures should provide timely and accurate feedback
4	Performance measures should be based on quantities that can be influenced, or controlled, by the user alone or in co-operation with others
5	Performance measures should reflect the "business process" – i.e. both the supplier and customer should be involved in the definition of the measure
6	Performance measures should relate to specific goals (targets)
7	Performance measures should be relevant
8	Performance measures should be part of a closed management loop
9	Performance measures should be clearly defined
10	Performance measures should have visual impact
11	Performance measures should focus on improvement
12	Performance measures should be consistent (in that they maintain their significance as time goes by)
13	Performance measures should provide fast feedback
14	Performance measures should have an explicit purpose
15	Performance measures should be based on an explicitly defined formula and source of data
16	Performance measures should employ ratios rather than absolute numbers
17	Performance measures should use data which are automatically collected as part of a process whenever possible
18	Performance measures should be reported in a simple consistent format
19	Performance measures should be based on trends rather than snapshots
20	Performance measures should provide information
21	Performance measures should be precise – be exact about what is being measured
22	Performance measures should be objective – not based on opinion

Table 11: list of recommendations for a good KPI (Neely et al., 1997)

#	Characteristic	Explanation
1	Sparse	The fewer KPIs, the better
2	Drillable	Users can drill into detail
3	Simple	Users understand the KPIs
4	Actionable	Users know how to affect outcomes
5	Owned	KPIs have an owner
6	Referenced	Users can view origins and context
7	Correlated	KPIs drive desired outcomes
8	Balanced	KPIs consist of both financial and non-financial metrics
9	Aligned	KPIs don't undermine each other
10	Validated	Workers can't circumvent the KPIs

Table 12: characteristics of a good KPI (Eckerson, 2009)

#	Characteristic	Explanation
1	Nonfinancial measures	not expressed in dollars, yen, pounds, euros, etc.
2	Measured frequently	e.g., daily or 24/7
3	Acted on by the CEO and senior management team	-
4	Understanding of the measure and the corrective action required by all staff	-
5	Ties responsibility to the individual or team	-
6	Significant impact	e.g., affects most of the core CSFs and more than one BSC perspective
7	Positive impact	e.g., affects all other performance measures in a positive way

Table 13: characteristics of a good KPI (Parmenter, 2007)

Appendix D – List of KPIs used in literature

KPI	Reference
The frequency of delivery delay	Choy et al., 2004
Quotation price of each transaction	Choy et al., 2004
The frequency of defective rework	Choy et al., 2004
Number of customer compliant	Choy et al., 2004
First time fix rate (FTF) % - Proportion of service delivery processes that could be completed at the first attempt.	Meier et al., 2013
Operating time [hours] – The operating time needed for the completion of the service task on site, excluding preparatory activities.	Meier et al., 2013
Process stability [%] – The operating time for all delivery processes of the same type minus the average standard deviation of the operating time in relation to the operating time.	Meier et al., 2013
On time delivery (OTD) [%] – Proportion of delivery processes, which could be completed within the time window promised to the customer.	Meier et al., 2013
Mean time to problem solution (MTPS) [hours] – Only relevant for time critical repair activities: average time from the moment of arrival of the fault report until the moment of function checkout. (According to [19], function check-out describes an "action taken after maintenance actions to verify that the item is able to perform as required", which is usually carried out after down state.)	Meier et al., 2013
Costs [€] – Incurred overall costs for service delivery.	Meier et al., 2013
Revenue [€] – Revenue achieved by service delivery (depending on business and revenue model [21]).	Meier et al., 2013
Mean time between failure (MTBF) [days] – Average time between failures.	Meier et al., 2013
Mean down time (MDT) [days] – Average breakdown time of the equipment within a specific time period, e.g. a year.	Meier et al., 2013
Travel time proportion [%] – The average travel time of service technicians in relation to the total working time (including operating and travel time).	Meier et al., 2013
Resource utilization [%] - Resource working time (including operating and travel time) in relation to the overall availability time of the resource.	Meier et al., 2013
Rescheduling quota [%] – Number of delivery processes that were rescheduled after the customer has been notified or after required resources have been booked in relation to the total number of delivery processes.	Meier et al., 2013
Reactivity [hours] – Only relevant for time critical repair activities: average time from the moment of fault notification until the scheduled begin of repair activities.	Meier et al., 2013
Acceptance rate [%] –	Meier et al., 2013

Number of times that the customer's desired date for the delivery process could be accepted, related to the total number of delivery processes.	
Supplier cost-saving initiatives	Bai & Sarkis, 2014
Labour efficiency	Bai & Sarkis, 2014
Cost variance from expected costs	Bai & Sarkis, 2014
Environmental costs savings	Bai & Sarkis, 2014
Energy efficiency systems	Bai & Sarkis, 2014
Environmental cost performance variance	Bai & Sarkis, 2014
Number of environmental penalties	Bai & Sarkis, 2014
Supplier lead time against industry norm	Bai & Sarkis, 2014
Supplier's booking-in procedures	Bai & Sarkis, 2014
Purchase order cycle time	Bai & Sarkis, 2014
Percentage of late deliveries	Bai & Sarkis, 2014
Information timeliness	Bai & Sarkis, 2014
Efficiency of purchase order cycle time	Bai & Sarkis, 2014
Length to time to implement environmental programs	Bai & Sarkis, 2014
Meeting environmental program implementation period	Bai & Sarkis, 2014
Speed of acquiring environmental information	Bai & Sarkis, 2014
Communication speed on environmental issues to supplier's suppliers	Bai & Sarkis, 2014
Byer-supplier partnership level	Bai & Sarkis, 2014
Level of supplier's defect-free deliveries	Bai & Sarkis, 2014
Supplier rejection rate	Bai & Sarkis, 2014
Delivery reliability	Bai & Sarkis, 2014
Percentage of wrong supplier delivery	Bai & Sarkis, 2014
Mutual trust	Bai & Sarkis, 2014
Satisfaction with knowledge transfer	Bai & Sarkis, 2014
Satisfaction with supplier relationship	Bai & Sarkis, 2014
Supplier assistance in solving technical problems	Bai & Sarkis, 2014
Extent of mutual planning cooperation leading to improved quality	Bai & Sarkis, 2014
Extent of mutual assistance leading in problem-solving efforts	Bai & Sarkis, 2014
Distribution of decision competences between supplier and customer	Bai & Sarkis, 2014
Quality and frequency of exchange of logistics information between supplier and customer	Bai & Sarkis, 2014
Quality and perspective taking in supply networks	Bai & Sarkis, 2014
Information accuracy	Bai & Sarkis, 2014
Information availability	Bai & Sarkis, 2014
Environmental relationship and cooperation level	Bai & Sarkis, 2014
Waste generated from products and materials	Bai & Sarkis, 2014
Percentage recycled material	Bai & Sarkis, 2014
Supplier ability to respond to quality problems	Bai & Sarkis, 2014
Response to product changes	Bai & Sarkis, 2014
Materials variety (number of materials available)	Bai & Sarkis, 2014
Product and service variety	Bai & Sarkis, 2014
Product volume variability capabilities	Bai & Sarkis, 2014
Product development time	Bai & Sarkis, 2014
Number of environmentally safe alternatives	Bai & Sarkis, 2014
Response to environmental programs for suppliers	Bai & Sarkis, 2014
Response to environmental product requests	Bai & Sarkis, 2014
Satisfaction with knowledge transfer	Bai & Sarkis, 2014

Technological capability levels	Bai & Sarkis, 2014
Involvement in new product design	Bai & Sarkis, 2014
Introduction of new processes	Bai & Sarkis, 2014
Environmental technology levels	Bai & Sarkis, 2014
New environmentally sound processes introduced	Bai & Sarkis, 2014
New environmentally sound product development	Bai & Sarkis, 2014
Vendor lead times	Chae, 2009
Vendor fill rate	Chae, 2009
Materials Quality	Chae, 2009
On-Time shipment	Chae, 2009
On-time delivery	Chae, 2009
Perfect order fulfilment	Chae, 2009
In-stock availability	Chae, 2009
Transport delivery accuracy %	Selviaridis & Spring, 2018
Picking accuracy %	Selviaridis & Spring, 2018
Product damages %	Selviaridis & Spring, 2018
Perfect orders % (OTIF)	Selviaridis & Spring, 2018
Product availability % (store and central warehouse)	Selviaridis & Spring, 2018
Supply chain cost per annum (transport, warehousing, export/import, customs, duties, labelling)	Selviaridis & Spring, 2018
Reduction of supply chain costs (% per annum)	Selviaridis & Spring, 2018
Freight cost reduction %	Selviaridis & Spring, 2018
Accuracy of sailing list when using multiple carriers %	Selviaridis & Spring, 2018
Carbon emissions reduction %	Selviaridis & Spring, 2018
Logistics cost reduction % (resulting from supplier innovations)	Selviaridis & Spring, 2018
Agreed lead time (agreed time of the delivery of goods)	Pikousová & Průša, 2013
Average lead time (actual time of the delivery of goods)	Pikousová & Průša, 2013
Cancellation ratio (measure of the number of originally ordered (confirmed) goods that are not delivered)	Pikousová & Průša, 2013
Delivery security (indication of the supplier's ability to deliver originally confirmed order)	Pikousová & Průša, 2013
% of orders delivered with damaged products/items	ServiceNow, 2018
Total transport cost as % of delivered sales	ServiceNow, 2018
Damages as % of throughput	ServiceNow, 2018
Total logistics costs as a percentage of sales	ServiceNow, 2018
On time In full (# of orders of which not all items are delivered in the requested quantity)	ServiceNow, 2018
Order fulfilment lead time (time between order and receipt)	ServiceNow, 2018
% orders requiring rework	ServiceNow, 2018
% orders delivered by committed date	ServiceNow, 2018
Order fill rate	ServiceNow, 2018
Order cycle time (time between order release and shipment)	ServiceNow, 2018
% delivery errors (unacceptable products)	ServiceNow, 2018
% invoice errors	ServiceNow, 2018
% of overdue orders	ServiceNow, 2018
Backlog of orders (older than x days)	ServiceNow, 2018
Average days late per late order	ServiceNow, 2018
% of orders with correct documentation (shipping / invoice etc)	ServiceNow, 2018
% of orders processed without damage	ServiceNow, 2018
% of neglected orders	ServiceNow, 2018

% of incorrectly assigned orders	ServiceNow, 2018
% of escalated orders	ServiceNow, 2018
% of re-opened orders	ServiceNow, 2018
Mean duration to fulfil service	ServiceNow, 2018
% of orders with “Delay” status	ServiceNow, 2018
Rate of returns or billing disputes due to products shipped but not ordered	ServiceNow, 2018
% of orders delivered with damaged products / items	ServiceNow, 2018
% of backorders	ServiceNow, 2018
Cash to cash cycle time (days between paying and getting paid)	ServiceNow, 2018
On time ship rate (% of orders delivered before requested time)	ServiceNow, 2018
% variability in lead time	ServiceNow, 2018
% of uninterrupted orders	ServiceNow, 2018
Purchasing price variance	ServiceNow, 2018
Average age of product backlog	ServiceNow, 2018
On time delivery	ServiceNow, 2018
Number of formal disputes with suppliers	ServiceNow, 2018
Ratio of price paid to price quoted	ServiceNow, 2018
Average number of requests for information to suppliers for orders	ServiceNow, 2018
Perfect order fulfilment (no errors)	ServiceNow, 2018
% of schedules changed within supplier’s lead time	ServiceNow, 2018
Perfect order fulfilment	SCC, 2012*
Order fulfilment cycle time	SCC, 2012*
Upside Supply Chain Flexibility	SCC, 2012*
Upside Supply Chain Adaptability	SCC, 2012*
Downside Supply Chain Adaptability	SCC, 2012*
Overall Value at Risk	SCC, 2012*
Total Cost to Serve	SCC, 2012*
Cash-to-Cash Cycle Time	SCC, 2012*
Return on Supply Chain Fixed Assets	SCC, 2012*
Return on Working Capital	SCC, 2012*

* SCC = Supply Chain Council

Table 14: list of possible KPIs

Appendix E – Explanation for removal of possible KPI list

Not all KPIs in Appendix D are in fact KPIs. This appendix shows the reasons. In order to readably display Table 15, abbreviations are used.

Abbreviations

Ref. = reference	Rel. = Relevant	Explain = Explanation
Abs = Absolute number	Rel = relative number	NaN = Not a Number
Y/N = yes / no question	Def. = definition unknown	

RI =Absolute numbers only gain significance when compared to other indicators (Meier et al., 2013).
PROD = The production at a supplier is not interesting for supplier performance.
INTERNAL = This KPI measures internal processes (Supply Chain Council, 2012).
INFORMAL = This is an informal control instrument and thus implicit (Pernot & Roodhooft, 2014).
CHAR = This does not meet the most important characteristics of a good KPI (e.g. measurable).

The references are numbered. The numbers correspond with the following references:

1. Choy et al. (2004)	2. Meier et al. (2013)	3. Bai & Sarkis (2014)
4. Chae (2009)	5. Selviaridis & Spring (2018)	6. Pikousová & Průša (2013)
7. ServiceNow (2018)	8. Supply Chain Council (2012)	

Category	**KPI**	**Ref.**	**KPI**	**#**	**Rel.**	**Explain**
Delivery	# of Backlog orders (older than x days) / Average age of backlog orders	7	N	Abs	Y	RI
Delivery	Average days late per late order	7	N	Abs	Y	RI
Development	Product development time	3	N	Abs	Y	RI
Environment	Environmental cost performance variance	3	N	Abs	N	RI / INTERNAL
Environment	Number of environmental penalties	3	N	Abs	Y	RI
Environment	Number of environmentally safe alternatives	3	N	Abs	Y	RI
Environment	Environmental relationship and cooperation level	3	N	NaN	Y	CHAR / INFORMAL
Environment	Response to environmental programs for suppliers	3	N	NaN	Y	CHAR / INFORMAL
Environment	Response to environmental product requests	3	N	NaN	Y	CHAR / INFORMAL
Environment	Energy efficiency systems	3	N	NaN	Y	CHAR / INFORMAL
Environment	Environmental technology levels	3	N	Abs	Y	RI
Environment	New environmentally sound processes introduced	3	N	Abs	Y	RI
Environment	New environmentally sound product development	3	N	Abs	Y	RI
Environment	Length to time to implement environmental programs	3	N	Abs	Y	RI
Environment	Meeting environmental program implementation period	3	N	NaN	Y	Y/N / INFORMAL
Environment	Speed of acquiring environmental information	3	N	Abs	Y	RI
Environment	Communication speed on environmental issues to supplier's suppliers	3	N	Abs	Y	RI
Flexibility	Upside Supply Chain Flexibility - minimum time required to achieve unplanned increase	8	N	Abs	Y	RI

Flexibility	Overall Value at Risk - sum of VaR (Probability of Risk Event * monetized impact)	8	N	Abs	Y	RI
flexibility	Response to product changes	3	N	NaN	Y	CHAR / INFORMAL
flexibility	Supplier ability to respond to quality problems	3	N	NaN	Y	Y/N / RI
flexibility	Materials variety (number of materials available)	3	N	Abs	Y	RI
flexibility	Product and service variety	3	N	Abs	Y	RI
flexibility	Product volume variability capabilities	3	N	Abs	Y	RI
Innovation	Satisfaction with knowledge transfer	3	N	NaN	Y	Y/N / RI
Innovation	Technological capability levels	3	N	Abs	Y	RI
Innovation	Involvement in new product design	3	N	NaN	N	CHAR / PROD
Innovation	Introduction of new processes	3	N	Abs	N	RI / PROD
Financial	Return on Supply Chain Fixed Assets - return on investment on the supply chain	8	Y	Rel	N	INTERNAL
Financial	Return on Working Capital	8	Y	Rel	N	INTERNAL
Financial	Total Cost to Serve - total costs of the supply chain (source, make, deliver)	8	N	Abs	N	RI / PROD
Financial	Costs [€] – Incurred overall costs for service delivery.	2	N	Abs	Y	RI
Financial	Supply chain cost per annum (transport, warehousing, export/import, customs, duties, labelling)	5	N	Abs	Y	RI
Financial	Labour efficiency	3	Y	Rel	N	INTERNAL
Financial	Quotation price of each transaction	1	N	Abs	Y	RI
Financial	Revenue [€] – Revenue achieved by service delivery (depending on business and revenue model [21]).	2	N	Abs	Y	RI
Financial	Supplier cost-saving initiatives	3	N	NaN	N	CHAR / INTERNAL
Quality	Quality and perspective taking in supply networks	3	N	NaN	Y	CHAR / INFORMAL
Quality	Number of customer compliant	1	N	Abs	Y	RI
Quality	The frequency of defective rework	1	N	Abs	N	RI / INTERNAL
Quality	# billing disputes due to products shipped but not ordered	7	N	Abs	Y	RI
Quality	Number of formal disputes with suppliers	7	N	Abs	Y	RI
Quality	% of neglected orders	7	N	Rel	N	CHAR / DEF.
Quality	Average number of requests for information to suppliers for orders / information availability	3, 7	N	Abs	Y	RI
Quality	Quality and frequency of exchange of logistics information between supplier and customer	3	N	Abs	Y	RI
Quality	Information accuracy (%)	3	N	Rel	Y	CHAR / RI
Quality	Materials Quality	4	N	NaN	Y	CHAR / RI
Quality	Supplier's booking-in procedures	3	N	NaN	N	CHAR / INTERNAL
Quality	% orders requiring rework	7	Y	Rel	N	INTERNAL
Quality	Satisfaction with knowledge transfer	3	N	NaN	Y	Y/N / RI
Quality	Supplier assistance in solving technical problems	3	N	NaN	Y	Y/N / RI

Quality	Mutual trust	3	N	NaN	Y	CHAR / INFORMAL
Quality	Satisfaction with supplier relationship	3	N	NaN	Y	Y/N / RI
Quality	Extent of mutual planning cooperation leading to improved quality	3	N	NaN	Y	CHAR / INFORMAL
Quality	Extent of mutual assistance leading in problem-solving efforts	3	N	NaN	Y	CHAR / INFORMAL
Quality	Distribution of decision competences between supplier and customer	3	N	NaN	Y	CHAR / INFORMAL
Time	Operating time [hours] – The operating time needed for the completion of the service task on site, excluding preparatory activities.	2	N	Abs	N	RI / PROD
time	Cash to cash cycle time (days between paying and getting paid)	7, 8	N	Abs	N	RI / INTERNAL
Time	Purchase order cycle time	3	N	Abs	Y	RI
Time	Efficiency of purchase order cycle time	3	Y	Rel	Y	-
Time	Mean time to problem solution (MTPS) [hours] – Only relevant for time critical repair activities: average time from the moment of arrival of the fault report until the moment of function checkout.	2	N	Abs	N	RI / PROD
Time	Mean time between failure (MTBF) [days] – Average time between failures.	2	N	Abs	N	RI / PROD
Time	Mean down time (MDT) [days] – Average breakdown time of the equipment within a specific time period, e.g. a year.	2	N	Abs	N	RI / PROD
Time	Travel time proportion [%] – The average travel time of service technicians in relation to the total working time (including operating and travel time).	2	Y	Rel	N	PROD
Time	Reactivity [hours] – Only relevant for time critical repair activities: average time from the moment of fault notification until the scheduled begin of repair activities.	2	N	Abs	N	RI / PROD
Time	Agreed lead time (agreed time of the delivery of goods)	6	N	Abs	Y	RI
Time	Average lead time (actual time of the delivery of goods) / mean duration to fulfil service	6, 7	N	Abs	Y	RI
time	Order fulfilment lead time (time between order and receipt) | vendor lead time	4, 7	N	Abs	Y	RI
Time	Order (fulfilment) cycle time (time between order release and shipment) (average cycle time /order)	7, 8	N	Abs	Y	RI
Time	Resource utilization [%] - Resource working time (including operating and travel time) in relation to the overall availability time of the resource.	2	Y	Rel	N	PROD

Table 15: explanation of removal of “KPIs” of the possible KPI list

Appendix F – Interviews

Reference	Department
A1	Purchasing & Logistics
A2	Marketing
A3	Sales
A4	Purchasing & Logistics
A5	Management
A6	Finance
A7	Sales
A8	Quality officer
A9	Product manager
A10*	Security officer

Table 16: reference codes of the interviews to answer Sub question 3

Appendix G – ISO / NEN certifications

ISO 9001 (Nederlands Normalisatie-instituut, 2015a):

- Section 7.1.1: the organisation has to think about what is needed from suppliers in order to implement, maintain and improve quality management systems;
- Section 8.4.1: the organisation has to determine criteria to evaluate, select and monitor the performance of suppliers. This information needs to be documented and supplemented with activities based on the evaluations;
- Section 8.4.2: the organisation has to make sure suppliers do not negatively influence the companies quality;
- Section 8.4.3: the organisation has to share the requirements to her suppliers for: delivery, approval, competences, interaction with the organisation, performance measurement monitoring and possible verification- and validation activities;
- Section 9.1.3: the organisation has to evaluate her own performance and use this to evaluate the performance of suppliers.

ISO 14001 (Nederlands Normalisatie-instituut, 2015b):

- Section 8.1: the organisation has to communicate her environmental requirements with suppliers;
- Section A.1: in case of a change from a supplier, the organisation has to check if this does not influence the results for the environmental management system;
- Section A.6.1.2: the organisation has to check for the environmental performance and practice of suppliers;
- Section A.8.1: the organisation has to measure the competence of a supplier in relation to meeting the environmental requirements from the organisation.

NEN 7510 (Nederlands Normalisatie-instituut, 2017), which is based on **ISO 27001**:

- Section A.15.1.1: information security demands with the intention of risk reduction, which have a connection with suppliers, need to be agreed on and documented;
- Section A.15.1.2: every supplier with access to the IT infrastructure has to agree on all relevant information security demands;
- Section A.15.1.3: supplier agreements have to contain demands about information security risks and the supply of ICT products and services;
- Section A.15.2.1: organisations have to monitor, measure and audit the services from the supplier regularly;
- Section A.15.2.2: in case of a change from a supplier, the organisation has to re-evaluate risks in information security.

Appendix H – Developing KPIs from Table 2

The KPIs from Table 2 (Section 2.4) are displayed here, with in the third column that it is either a useful KPI for Odin Groep ("Yes") or the reason why it is not a useful KPI for Odin Groep. The rows with the KPIs that are not useful for Odin Groep are coloured red.

Category	**KPI**	**Useful for Odin Groep (Yes or reason why not)**
Delivery	Variability in lead time [%]	Yes
Delivery	Supplier lead time against industry norm	Yes
Communication	Information timeliness [%] Is the information present before it is needed?	Yes
Environment	Recycled material (% of total used materials)	Yes (from a sustainability perspective this is helpful)
Environment	Carbon emissions reduction [%] (compared to previous year)	Yes (from a sustainability perspective this is helpful
Delivery	Rescheduling quota [%] – Number of delivery processes that were rescheduled after the customer has been notified or after required resources have been booked in relation to the total number of delivery processes.	Yes
Delivery	Cancellation ratio (measure of the number of originally ordered (confirmed) goods that are not delivered)	Yes
Delivery	On time delivery (in full) [%] (proportion of items/complete orders delivered on time)	Yes
Delivery	On-Time shipment [%]	Yes
Delivery	Orders without damage [%]	Yes
Delivery	Delivery errors [%]	Yes
Delivery	Delivery reliability [%]	Yes
Quality	Buyer-supplier partnership level	Yes
Flexibility	Product availability [%] (are items available at supplier?)	Yes (but part of Delivery)
Financial	Invoice errors [% of invoices with errors from total number of invoices]	Yes
Delivery	Accuracy of sailing list when using multiple carriers [%]	Too vague
Financial	Purchasing price variance (difference between amount paid and amount budgeted (Business Dictionary, n.d.))	No (price variance can be explained by different factors, which are more significant themselves)
Financial	Total logistics costs as % of sales	N/a (costs are incorporated in purchasing price)
Financial	Reduction of supply chain costs [%] per time	N/a (costs are incorporated in purchasing price)
Financial	Total transport cost as % of delivered sales	N/a (costs are incorporated in purchasing price)
Environment	Waste generated from products and materials [%]	N/a (Regulated by law - WEEE certification)
Communication	Uninterrupted orders [%] (automated orders that are not returned by the supplier)	N/a (no automated orders yet)

Flexibility	Upside Supply Chain Adaptability - maximum sustainable % increase in quantity delivered	N/a (no standard quantities)
Flexibility	Downside Supply Chain Adaptability - % reduction of quantities ordered without inventory or cost penalties	N/a (no purchase obligation)
Financial	Cost variance from expected costs	N/a (costs are incorporated in the purchasing price)
Quality	First time fix rate (FTF) % - Proportion of service delivery processes that could be completed at the first attempt.	N/a (always FTF due to own ability to repair and to return / exchange broken items)
Communication	Escalated orders [%] (involving someone more important or higher in rank in a situation or problem (Cambridge dictionary, n.d.))	N/a (does not happen and costs too much time to document)
Quality	Orders with correct documentation [% of total)	Too vague
Quality	Incorrectly assigned orders [%]	N/a (supplier cannot prevent this)
Delivery	Supplier rejection rate [%]	Too vague
Delivery	Process stability [%] – The operating time for all delivery processes of the same type minus the average standard deviation of the operating time in relation to the operating time.	N/a (this is about internal performance)

Table 17: reasons why KPIs from Table 2 are used in Table 7 (or not)

Appendix I – Explanation KPI measurement

This appendix explains which values are given to certain factors of KPIs 9 and 10. The values are based on logic, guide lines and previous experience at Odin Groep. Some KPIs are also given values that might not be representative for all types of suppliers.

9. Information security standards

- The factor "Odin Groep standards" is given a value 10 if the survey information security (Appendix K) scores more than 90%, a value 8 if the survey score is more than 80% and a value 1 if the survey score is less than 80%. If the mandatory part of the survey is less than 100%, the value is 0.

10. How polluting is the supplier?

In the CDP tool, companies are scored in a range of A-F. Where the scores indicate:

- A – Leadership
- B – Management
- C – Awareness
- D – Disclosure
- F – Failure to disclose

In case the supplier is not in the CDP database, factors for recycling and CO2 need to be gathered manually, using the following values:

- F: if nothing on Recycle[5] or CO2[6] is disclosed;
- D: if either CO2 or Recycle is disclosed, but nothing more;
- C: if something is recycled, and CO2 is slightly reduced;
- B: if more than 50% of materials are recycled and CO2 is reduced with more than 1%;
- A: if more than 75% of materials are recycled and CO2 is reduced with more than 5%.

[5] Around 80% of all waste is reused in Europe (CBS, 2018).

[6] Carbon emissions in the European Union reduced by 0,02 GT of CO2 in 2017, which is a 0,0005% reduction (Hausfather, 2017).

Appendix J – Key Result Indicators

The Key Result Indicators (KRIs) from Table 7 (Section 4.1) are further explained below.

R1: Is the supplier ISO 9001 certified?
The factor "ISO" is given a value 10 if the supplier is ISO9001 certified, and 0 otherwise.

R2: Safety certificates
The factor "Safety" is give a value 10 if there are more additional safety certificates than average, 5 if the number of safety certificates is average, and 0 if there are less than average.

R3: (*) Partnership level
Partnership level = a * Goodwill + b * Proactivity

- Goodwill = Is the supplier willing to do more than expected compared to others?;
- Proactivity = How proactive is the supplier?.

These numbers could be given by the Purchasing Department yearly without much effort (A1).

- The factor "Goodwill" is given a value 10 if the supplier is willing to do more than expected compared to others, a value 7 if the supplier is average, a value 4 if the supplier does less than average and a value 1 if the supplier does nothing extra at all;
- The factor "Proactivity" is rated subjectively by representatives of the Purchasing and Logistics Department on a scale of 1 to 10.

R4: Creditworthiness
There are different methods to calculate the creditworthiness, for example: solvency, liquidity and profitability. There are also online tools that calculate the creditworthiness, based on the financial statement, demographics and industry. Currently, two tools are used to find the creditworthiness information of suppliers: Creditsafe[7] and Company.Info[8]. These tools both generate reports and combine the data into a single creditworthiness number between 0 and 100. These tools are thus much easier to use than to calculate the creditworthiness of each supplier manually. Which tool to use poses the next question. There are three options. Use "Creditsafe"(a=1, b=0), use "Company.info" (a=0, b=1), or use a combination of both tools.

Creditworthiness = a* Creditsafe + b*Company.info

- Creditsafe = value for creditworthiness in report of Creditsafe;
- Company.info = value for creditworthiness in the report of Company.info.

R5: Accessibility of inventory information
Accessibility of inventory info = How easy is it to access inventory information on a scale of 1 to 10?
This number could be given by the Purchasing Department without much effort each time it changes (A1).

R6: Is the supplier NEN 7510 / ISO27001 certified?
The factor "ISO/NEN" is given a value 10 if the supplier is NEN 7510 AND / OR ISO 27001 certified and 0 otherwise.

R7: Is the supplier ISO 14001 certified?
The factor "ISO" is given a value 10 if the supplier is ISO 14001 certified and 0 otherwise.

[7] www.creditsafe.nl
[8] https://companyinfo.nl/

Appendix K – Survey: "Supplier performance measurement for information security"

This survey is used to measure the supplier's performance on information security yearly by the security officer at Odin Groep. The survey is categorized in five mandatory requirements and ten desirable requirements. Odin Groep asks for 100% on mandatory requirements and 80% on the desirable requirements to pass.

Instructies:

- Vul a.u.b. de volgende vragenlijst in.
- Voor vragen of voor extra informatie kan dit in de kolom toelichting ingevuld worden of voeg een bijlage toe met vragen of extra informatie.
- Vermeld niet van toepassing wanneer een vraag niet relevant is met de onderbouwing waarom.
- Selecteer ja of nee d.m.v. een X.

Opmerking: leverancier moet tenminste 80% scoren op de aanvullende vragen om te slagen voor het evaluatie proces.

Vragenlijst risico analyse leveranciers			
Risico analyse categorieën	**Compliant**		**Toelichting**
	Ja	**Nee**	
Verplichte vereisten			
1. Heeft de organisatie een informatie beveiliging (IB) beleid dat is goedgekeurd door het management, gepubliceerd is en bekend is bij alle medewerkers? Wordt het IB beleid regelmatig gecontroleerd op correctheid?	☐	☐	
2. Ondertekenen medewerkers of medewerkers van derde partijen een geheimhoudingsverklaring of non-disclosure overeenkomst op het moment dat zij werkzaamheden voor het bedrijf verrichten?	☐	☐	
3. Worden er achtergrond screenings en security awareness checks uitgevoerd bij medewerkers (van derde partijen)?	☐	☐	
4. Zijn de beveiligingsfuncties en de verantwoordelijkheden gedocumenteerd en gecommuniceerd naar alle medewerkers en derde partijen en wordt dit regelmatig opnieuw gecommuniceerd?	☐	☐	

5. Zijn de verantwoordelijkheden voor beveiliging van klantgegevens en organisatie gegevens en/of assets duidelijk gedefinieerd?	☐	☐	
Gewenste vereisten			
1. Voldoet de organisatie aan de eisen gesteld in ISO27001:2013 en is de organisatie hiervoor gecertificeerd?	☐	☐	
2. Is er een informatie classificatie schema in gebruik die assisteert in het vaststellen hoe informatie behandeld en beveiligd moet worden? En zijn medewerkers en derde partijen bekent gemaakt met dit schema?	☐	☐	
3. Is er een uit dienst procedure opgesteld en worden medewerkers ook op de hoogte gesteld van vertrekkende personen?	☐	☐	
4. Zijn er identificatiebadges verstrekt aan alle werknemers en derde partijen die aan het werk zijn op het terrein van de organisatie of bij klanten?	☐	☐	
5. Wordt er een change management procedure gebruikt voor het implementeren van wijzigingen aan de IT omgeving of aan diensten geleverd aan klanten?	☐	☐	
6. Is er een procedure voor audit logs welke gebruikers acties, uitzonderingen en security events bevatten?	☐	☐	
7. Is er een procedure voor het registreren en verwijderen van toegang tot informatiesystemen en services?	☐	☐	
8. Zijn er bepaalde wachtwoordvereisten gedefinieerd en worden deze ook actief geforceerd?	☐	☐	
9. Is er een beveiligingsincident rapportage proces in gebruik? Zijn medewerkers op de hoogte van dit proces en rapporteren zij security incidenten via vastgestelde kanalen zo snel als mogelijk?	☐	☐	
10. Is business continuity management geregeld? En dekt dit BCM ook de zekerheid richting klanten en aandeelhouders dat diensten door gaan?	☐	☐	

Handtekening: _____

Appendix L – Prototype dashboard

- Figure 4: Overview of suppliers
- Figure 5: Supplier dashboard