DATA STRATEGY FOR PROJECT DELIVERY PROCESS

Master's Thesis

Lappeenranta–Lahti University of Technology LUT

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ABSTRACT
Lappeenranta–Lahti University of Technology LUT
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Data strategy for project delivery process

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Rapid development of the business world and technology has shown that learning new things is only way to survive for companies. Technology is one main reason for megatrends and megatrends are the key drivers for companies' development. One of the biggest megatrends is digitalization. A huge amount of data in the companies is a consequence of digitalization. This master's thesis target company is one of the biggest technology companies in Finland. A great part of the company's business is based on projects. These projects are complex with long schedules and global stakeholders. Because of a great number of different applications and reports used during the project execution, the data amount is massive. The company has noticed that there is need for more efficient data usage in the project delivery process. This master's thesis purpose is to make a study how company is handling the data during the process and how it should be developed to make things more efficient.

To achieve proper results with good quality, this master's thesis includes theoretical and empirical parts to support conclusions done in this study. Theory part is based on literature review and its target is to examine previous studies made from the topic. Theory includes mainly books and articles. Empirical part includes interviews, company's material and this writer's own experience. Interviews are done in semi-structured format and its purpose is to find out the challenges in the project delivery process regarding data.

Results from the study reveals that there is a lot of potential to develop data usage regarding project delivery process. Results shows that data architecture is not done from project delivery perspective. That is a reason for poor data quality regarding project monitoring. Some defined indicators are not doable because of missing data. Indicators are divided into many different reports, because of heterogenous data and lack of data architecture. Some of the defined indicators are not doable currently because there is no data to calculate it. Also, one main reason for bad monitoring quality is that some indicators and reports have need for manual updating. Yet, company is going to right direction. Data platform will have needed data with comprehensive attributes in the future. Important thing for project management is to make specifications from the needs that should be done from the data.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT
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Tuotantotalouden koulutusohjelma

Rene Riepponen

Datastrategia projektin toimitusprosessille

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Liike-elämä ja teknologian kehitys on näyttänyt sen, että uusien asioiden omaksuminen on yrityksille elinehto. Teknologian kasvun tuomat megatrendit ovat suuria ajureita, mikä tulee yrityksien kehitykseen. Yksi suurimmista on digitalisaatio ja sen myötä kasvava datan määrä. Tämän diplomityön kohdeyritys on yksi Suomen suurimpia teknologiayrityksiä, jonka liiketoiminnassa korostuu projektiluonteisuus. Suuria ja monimutkaisia projekteja toimitetaan ympäri maailmaa, jolloin dataa kertyy suuria määriä. Tämän diplomityön tarkoituksena on keskittyä ratkaisemaan miten data saadaan käyttöön mahdollisimman tehokkaasti tukemaan kohdeyrityksen projektitoiminnan prosessia.

Laadukaan lopputuksen saavuttamiseksi diplomityö pitää sisällää teoreettisen ja empiriirisen osuuden, jotka muodostavat pohjan työssä tehtäville johtopäätöksille. Ensimmäinen osa käsitelee yrityksen haasteita datan suhteen teoriapohjalta. Teoria perustuu pääosin kirjallisuuteen ja edellisiin tutkimuksiin aiheeseen liittyen. Toinen osa on empiirinen osuus, jossa käytetään hyödyksi yrityksen omaa materiaalia, työn kirjoittajan hankkimaa kokemusta asiasta, sekä haastatteluja. Haastattelut on toteutettu puolistrukturoituna, tavoitteena löytää ongelmakohtia tutkimuksen kohteena olevasta prosessista dataan liittyen.

Tutkimuksen tulokset osoittavat sen, että kohdeyrityksen datan käytössä on paljon parannettavaa. Yrityksen data-arkkitehuuria ja datankäyttöä ei ole rakennettu tukemaan projektin prosessinomaista mittausta ja suorittamista. Projektin suorityskykyä mittaavat mittarit ovat hajautuneet useaan eri raporttiin ja data niihin tulee useista eri lähteistä. Raportit ovat osin manuaalisesti ylläpidettäviä ja siten tietoa on saatavilla vain osalle projekteista. Mittarit ovat myös joiltain osin puutteellisia eikä niitä nykytilanteessa pysty raportoimaan ilman muutoksia käytössä olevissa sovelluksissa. Tulosten perusteella yrityksen toiminta ei ole täysin toteutettavissa pelkän datan avulla, koska data on huonolaatuista. Laadun nostaminen on hidasta, mutta se on yrityksessä jo aloitettu. Tämä tarkoittaa käytännössä sitä, että kaikki oleellinen data tullaan viemään osaksi yrityksen data-alustaa. Data-alusta mahdollistaa oikein rakennettuna tehokkaat ja luotettavat raportit projektin suorituskykyyn ja hallintaan.

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I am glad that I got enough fortitude and willpower to finish this research. One main reason for this achievement is supportive and professional group that I have privilege to be a member. I want to thank whole Operational Development team for giving me this opportunity to develop my understanding from Valmet's project execution. Especially I want to thank Mikko Sillanpää and Tuomo Luhanko for guidance to right direction with this master's thesis. I have raised a lot of my knowledge about the project delivery data and company's activities while doing this research. I'm sure that knowledge from this study will help me to achieve more valuable results regarding project delivery data in upcoming work tasks.

Tampere, 27.7.2022

Rene Riepponen

ABBREVIATIONS

B2B	Business to Business
B2C	Business to Customer
BL	Business Line
BPM	Business process management
BPMN	Business process management notation
BSC	Balanced Score Card
CD	Continuous Deployment/Delivery
CFS	Critical Success Factor
CI	Continuous Integration
COPQ	Cost of Poor Quality
DBMS	Database Management System
ECN	Engineering Change Notification
GUI	Graphical User Interface
HSE	Health and Safety Environment
KPI	Key Performance Indicator
NPS	Net Promoter Score
OS	Operating System
OTD	On-time delivery
PEM	Project Execution Model
PI	Performance Indicator
PM	Performance Measurement
PPI	Process Performance Indicator
R&O	Risks and Opportunities
SaaS	Software as a Service

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1 Introduction

In this chapter is introduced how digitalization and global trade has been a reason for companies' challenges and opportunities to manage processes by data. This master's thesis topic is an assignment from a company that has huge amount of data but no efficient way to use it for controlling processes. Based on this problem are presented this study's scope and object. Writer of this master thesis has done the structure and execution by the way that is estimated to be the best for results. After defining object and scope is also introduced structure and execution of this study.

1.1 Background

Digitalization is one of the world's biggest megatrends. It has been that for a while since internet started to be popular from the beginning of 21st century. Data is a consequence from the digitalization. Nowadays we can collect almost every single detail about the company's activities from software in use, only if we have right systems and knowledge to do so.

Data integration, data mapping and basically everything what is related to modifying data is quite new tasks for companies. That is because of companies' slow transition from old reporting tools and manners to new ones. Data amount is growing exponentially, challenge is to move the data from software to end-user who is making decisions based on the data. The bigger the company is, more complicated data management is. Complex corporation with many business lines and functions is a huge challenge to adapt data efficient and valuable way. Yet it offers multiple possibilities to discover potential efficiency targets between company's tasks. To achieve total efficiency and potential from data to support decisions, company's data management must share responsibility between business lines and functions. (Henderson et al. 2017)

Right and focused plan for data usage will make measurement more efficient and comprehensive. Companies are collecting data from different sources with different techniques and trying to analyze the data to make better solutions and decisions. Companies' each business function measures its own success with defined Key Performance Indicators (KPI). Those

indicators are focusing only for measuring that specific part of the company with no availability to make cause-and-effect relationship analysis. This way to measure causes information lacks between functions and is called silo - based measurement. Silo -name's purpose is to describe theoretical barriers between company's functions and business lines. This measurement technique is against the most important attribute that KPI may have, to be actionable (Kerzner 2013, 125). In this case actionable means that if indicator's numbers are not close to target, company knows what to do to achieve target. Operating inside one function KPI can be actionable, but when situation is viewed from the process perspective it may not be actionable at all.

Barriers between company's functional parts can be noticed when perspective is from the company's management side. Big companies with complex supply chains runs its' businesses based on the process execution. Typical example from the process *order-to-cash* business execution. In that process work starts from customer's order and it ends when ordered product is delivered. Between order and delivery, company is executing its processes. Those processes target is to produce ordered product with the best and the most efficient way that is possible. This can be done by an efficient information transfer between process parts. As said before, silo -based measurement is not supporting efficient execution of process. In the figure 1 is presented the basic lifecycle of process execution.

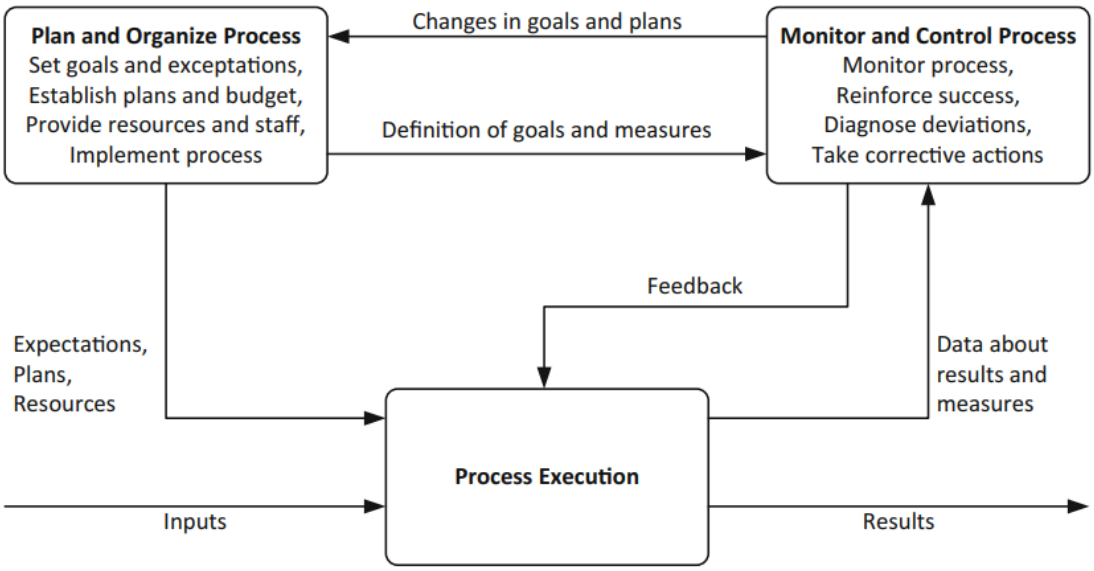

Figure 1 Business process management (Dumas et.al 2018, 16)

Figure 1 is presenting how process is executed during the input and results. Results can be considered also as an output from the process. In an efficient process execution, data between process execution data is transferred automatically between job functions (boxes in the figure 1).

Before success in process execution company needs to know what they should measure during the process execution. Each function in the process knows their own KPI targets, but those targets may not support the success in whole process execution. To achieve efficient process execution, company must consider how they are using their applications. Applications are producing raw data for process management and indicators. To adapt raw data to correspond company's needs, there should be a guidance for data architecture. Data architecture is a result from a data strategy. Data strategy is a guidance to use data more efficiently way to achieve measurement targets. In this case measurement targets means that what data company should have to build measurement indicators that are supporting process execution. Because the amount of the data, it is important to know what data company needs. Many businesses get so caught up in the big data because they are collecting all the available data, without really considering what they want to do and measure with that data (Marr 2017, 56). It is important to define what attributes company should collect from the data sources, because irrelevant data will encumber indicator dashboards and gateways.

Because of the target company's complex hierarchies and functions, defining data strategy should be done by some third party which does not have interests to raise one function from the group. In that way company can have an impartial opinion about the data and how to adapt it more efficiently. In a small company there is no problem to do data strategy by itself, because management has a good knowledge from each functions data and purpose. In the bigger company there is a specific information that only each function's management knows, for example are there problems with some single supplier. This leads to that each function keeps its own information and makes sure it handles data and information by the way that they think is the best (Tupper 2011).

1.2 Objective and scope

Technically every task made in company, target is to make or save money. Combining data from multiple sources can offer a great improvement to obtain a competitive advantage in savings and sales. (Doan et.al. 2012)

Based on the previous paragraph, this study's scope could be increase of savings and sales by making process execution more efficient. It may be in long term, but in short term scope is to define how to get from silo -based measurement to process based measurement. In a practical way it means that company's process parts have good vision how well other process part are performing during the process execution. Yet, scope can be defined more specifically, because during this study cannot be achieved any ready process -based measurements. Main challenge for achieving transparency between business processes is to have proper data architecture. Data architecture's purpose is to support the needs that company could have information connections between applications used in the process execution. Data architecture can be considered to contain three categories that are System Architectures, Enterprise Data Architectures and Enterprise Technology Architectures. System Architecture is focusing on developing applications and provides the mapping of applications and data stores. Enterprise Data Architecture is focusing on that company has only necessary data stores, target is to make development fluent with data. Third category, Enterprise Technology Architectures, is focusing on that company is developing right applications in right platforms. (Tupper 2011, 58)

To control something that has many variables and layers, company should have a proper plan for how to execute and control processes. For success in this plan company should know its target. Based on the target can be defined vision and mission. Vision and mission are parts to support strategy. To achieve for example good data architecture, there must be a strategy first. Perspective has a great impact on what is the target and how it can be achieved. Strategy's purpose is to define priorities, for example in business. Hard part is to define which steps should be done for achieving strategy targets (Treder 2020, 49).

The aim of this study is to define data strategy for this master thesis company's project delivery process. To achieve good strategy, there must be done comprehensive groundwork for research current situation. Data is mainly used to be an informative tool between company's tasks. To support data strategy, this thesis focus is to examine information flow in the company's one main process. Because of company's project -based business, one of the most important processes in the company is project delivery process, which is also this thesis' process to examine. Findings from the information flow is supporting data strategy. Information flow includes many dimensions, to focus on right issues there are listed three main research questions below:

1. *What are the indicators that are the most efficient to measure success in project delivery process?*

2. *What are the main applications for execute project delivery process?*

3. *How needed indicators and applications should be modified to be get from silo - based measurement to process based measurement?*

Project delivery process includes many functions with many indicators and applications. This causes a need for data architecture in all three categories listed before in this chapter. Yet, to fulfil this master's thesis target, focus is on Enterprise Technology Architectures. This architecture category is focusing on developing applications so that company can use its data more efficient way. Target applications and data is delimited to focus on project delivery process execution. Figure 2 is to describe the focus area in the top level.

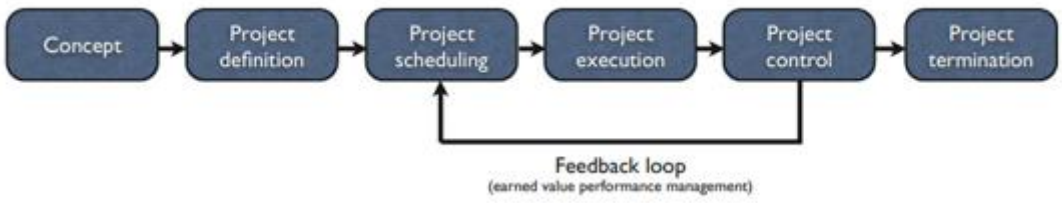

Figure 2 Data loop in project delivery process (Vanhoucke 2012, 5)

Figure 2 can be considered as a one level up from the Figure 1. Feedback loop in the Figure 2 includes loop and process execution presented in the Figure 1. During the project

execution, data from the implemented tasks is produced. From that data is made indicators which are giving information to control the project execution. Adjustments based on the indicators are making the loop starts from the beginning again. Project scheduling is one of the most important phases and it has an impact to almost every variable in the project (Vanhoucke 2012, 11).

To develop process execution, most important thing is to define information that is necessary in each process part. Source for information is usually application that process part is using. The real value for company and its process execution comes when applications and machines can communicate between each other by the data that is produced during the process (Marr 2022, 91). To achieve that, data must have high quality.

1.3 Excecution of the study

To achieve target of this master's thesis, there is a need for theoretical and empirical parts. Theoretical part's focus is to examine how project delivery process' data management and indicators should be done in theory. Empirical part is focusing on how this master's thesis target company is currently executing project delivery process with the data. Comparing theoretical situation to real situation in the company is describing are there some parts in the company's manners that could be better during project delivery process execution. This is done by collecting data from those metrics that are defined to be critical and comparing results by its' correlation and research methods presented in theory section of this master's thesis.

Indicators are big part of the business. This case is not an exception, all the tasks during the process should be supported by indicators. Because of many applications used during the process execution, there are many sources for the data to make indicators. In an empirical part is done research from the main applications used in the project delivery execution. This part of the study does not have reference point from theoretical section. In theoretical section there is no research from applications, because company's process execution has tailored applications with many attributes. Attributes and variables used in the applications is the thing that matters in this study what becomes to theory section.

Theoretical part is mainly based on literature review. Target of the literature review is to ensure knowledge about the topic Also previously done research is a supporting element for this study's conclusions and thinking. Most of the literature is books. Also, some articles from previous research are used to support this study's execution.

Empirical part can be considered to include four sources. One source that has common information from company's procedures is Valmet Handbook. The handbook includes information from project processes and functions included in the process. Handbook's information is entry level for this master's thesis research. Second empirical source is interviews. To have real and up to date information from process execution, interview is a good tool to make research. Interviews were hold with the persons that have responsibility from process' different parts. Type of the interview was semi-structured, and it was hold via Microsoft Teams or face-to-face. Interview topic was complex and answers to the questions could not be yes or no. Because of that, interviews were hold by semi-structured type. Target of the interviews were to gather information from the topic and allowing exploration when new issues or topics emerge regarding process execution and data (Wilson 2013, 24).

Two other empirical research techniques were process data and writer's own experience from the topic. These two sources are connected to each other, because this thesis writer has experience of the company's data analytics and reports. Data and writer's own experience are used mainly for to support conclusions in this study. Data is collected also to analyze importance of applications and defined measurements.

1.4 Structure of the study

This master's thesis structure is divided into seven chapters. The study starts with theoretical section. Theoretical section consists of second and third chapter of this study. Second chapter is for literature review from project delivery process. This chapter is focusing on the process hierarchy and common process management from the data perspective. Second theory chapter is supporting the output from the previous part. Third part is focusing on how information during the process execution should be reported and how to make decisions based on the reports. This can be described as a monitoring process execution. Output from third chapter

is theoretical glance of how process should be handled by the data to be a successfully executed.

Chapter four, five and six are empirical part of this master's thesis. Chapter four is focusing on how this study's target company is measuring its project delivery process. In the same chapter is also analyzed how well indicators that are defined are working to estimate whole process success. Chapter five is focusing on the process from its whole execution perspective. Process control on the information flow between process parts. Main source for information is applications. Chapter five's target is to examine how applications and indicators are working between process parts and employees. Research of working between employees is done by interviews.

Chapter six is the main chapter of this master's thesis target. Based on the previous chapters' information and findings is compiled for data strategy. Data strategy chapter consist of mission, vision and what are the main indicators and applications to support success in project delivery process. Chapter number seven is conclusion from the findings in chapter six and it is also this study's final chapter. Conclusion chapter's main target is to introduce actions based on the findings that makes data usage more efficient in project delivery process. Another target for final chapter is to estimate reality how needed actions could be executed. Reality check is mainly based on the writer's own experience and estimation.

This study's structure is presented in the table one. In the left side is described main input information that is handled in the chapter. In the middle is listed each chapter in logical order with titles. On the left side is output that is results from the chapter's research based on the input.

Table 1 Structure of the master's thesis

INPUT	CHAPTER	OUTPUT
Background to the company's problem.	1. Introduction	Introduction of the thesis target and how to achieve that target.
Literature review from the data in complex project delivery with hierarchies	2. Business process data architecture	Definition for project delivery process and data management during the project execution
Metrics and reporting techniques during the process	3. Project delivery metrics	Definition for theoretical reporting and metric methods in projects
Defined indicators for project delivery process	4. Valmet project delivery process indicators	Report and calculation methods for defined indicators
Usage of application and data quality based on empirical research	5. Project delivery process control	Estimation of the most important application and attributes in the project delivery process
Current situation of data usage in project delivery process	6. Future of data in project delivery process	Data vision, mission and strategy for project delivery process
Implementation, limitation and future of data development regarding project delivery process	7. Conclusions	Estimation for implementing the data strategy and needs to achieve data driven company with no silo -based data usage

All the visualizations in this master thesis are done by using official Valmet theme. Theme defines used colors and shapes in the tables and figures that are based on the Valmet information. Other tables and visualizations are following the format used in the source.

2 Business process data architecture

Operating in global business, processes are usually a complex and has many different functions. Depending on the type of business, number of functions and its purpose has a variation. Some of the organizations needs to handle complex supply chains in their processes. In an extended supply chain, there are many companies involved during the supply, mainly because of the financial efficiency. For example, logistics are usually implemented by other company than customer and supplier. To answer customer's needs, company's supply chain must deliver the appropriate mix of responsiveness and efficiency (Hugos, 2018).

To ensure customer's satisfaction, company needs to have standard high level of process implementation. Success in processes is supported by great number of different applications and indicators. Applications and indicators are a result from digital transformation, that affects and improves organization's processes (Urbach et.al 2019). Process related thinking, among applications and indicators, supports companies to achieve more efficient working in supply chains. Process model -based business aids employees to understand their responsibility area and full picture of the workflow. It is substantial to understand critical points in supply chain, process -based presentation supports that target well (Claes et.al 2015).

In this chapter is presented theory of how to manage with complex business processes. This includes several different topics. Main topic to understand the full picture of business process execution is to know its purpose and value chain. After understanding of business processes, it is easier to control company's execution and top-level strategy. Control is done by applications and indicators. Most of the cases there are employee between application and indicator executing manual labor what is needed to change the direction if process is going wrong direction. Data that process is producing via applications is the key to operate processes successfully. Produced data is depending on defined data architecture. Data architecture is based on strategy for managing processes, because of that focus should be on data enablement and monitoring process (Bandara et.al 2021; Marek et.al 2021).

Purpose of data architecture is to recognize crucial steps in the process and support those by right applications and data. It is a complex system to implement, so for supporting the execution there needs to be plan how to do it by comprehensive way. The aim of the business process management (BPM) is to provide efficient combination of techniques, applications and data to support process execution (Dumas et.al 2018). Supporting BPM's decisions there needs to be a guidance from many levels of the company's processes. This guidance can be called as a data strategy. The aim of BPM and data strategy is to find and manage processes and data that are valuable to their stakeholders. (Badakhshan et.al 2019)

2.1 Business processes

Business processes consists of set of activities which are organized for logical order. Process' purpose is to describe relationships between different parts of the process. Those parts can be agents, applications and human which are performed in defined order. Because of complex processes, enterprises have many different business processes with many purposes. This is also one reason for BPM. One of the BPM's tasks is to define targets and goals for the organization and therefore also for processes. (Crick et.al 2017; Goedertier et.al 2015)

Enterprises have noticed that they should divide their processes into different categories. By that management is easier and controlling is more efficient. To have a better understanding about the company's purpose and actions, main level is a "landscape" of the processes. Landscape describes the most abstract view of the business processes. In the landscape level focus is on company's strategic targets. It is important to recognize which chains of operations can be forming an independent business process and which are connected between each other.
In the Figure 3 is presented landscape from company that delivers products. Task names under three main categories has variation between companies, but each company has management, core and support processes to deal with (Dumas et.al 2018, 42).

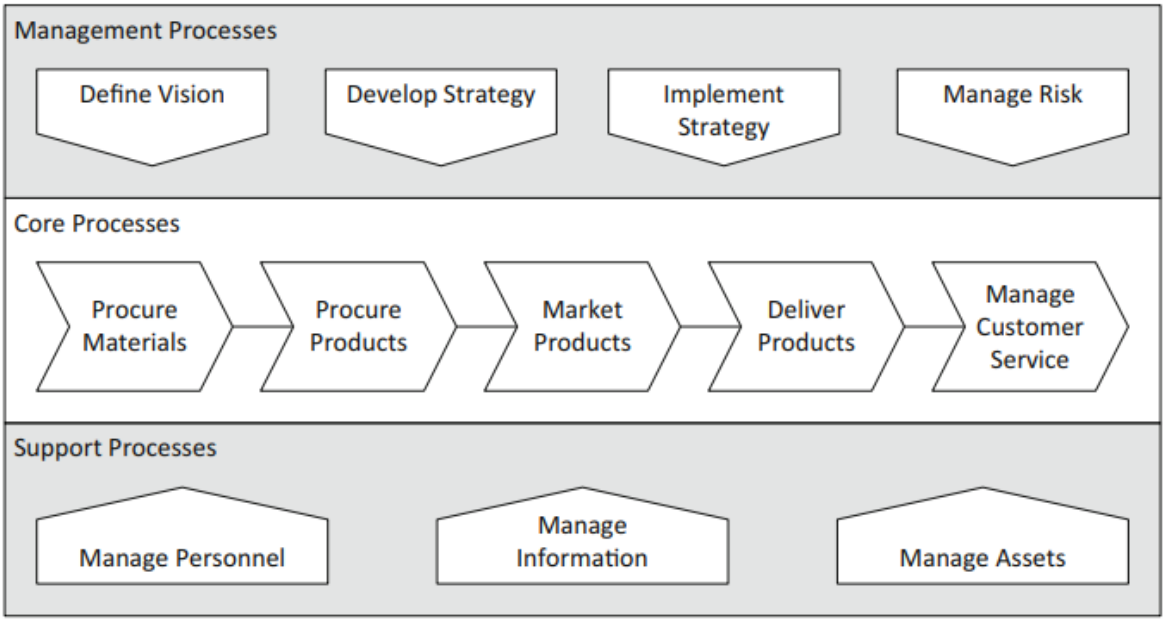

Figure 3 Process landscape (Dumas et.al, 42)

Process landscape figure presents three main categories that companies are focusing on. These categories have different purpose and targets. Yet, they are depending on each other. For example, there cannot be "procure materials" if there are no employees that Human recourses (manage personnel) has been hired to the job. Dumas et.al (2018, 41) have defined categories' purposes in the company's operation. Main distinction of three categories is strategic importance to the company.

As said, landscape model from processes is a top-level view for company's activities. Biggest variation between companies is in core process category. Core processes are focusing on the essentials of value creation. In a short term, value creation demands production of goods and services for which customer pays. Core processes covers all actions what are necessary to implement customers' needs in a short term. For example, procure materials must be a core process, because without that, product to customer cannot be delivered. Yet, each enterprise can define its core processes by own choice. Activities in core processes depends on company's business area. Activities are a collection of related and structured tasks that produces a specific service or product (Krogstie 2016). Support processes enables the execution of these core processes. They are, as the name says, supporting core processes. Previously mentioned human resources (HR) is a common supporting process in every large company. Supporting processes are in the bottom line in the Figure 3 to describe their

responsibility area in the company's business execution. Management processes has a responsibility in long term to guidance and make strategic decisions. Management processes provides directions and rules for core and support processes. For example, making data strategy is a management process that supports other processes in long term. (Dumas et.al. 2018, 41)

Previously presented landscape figure of the company's processes is strategical level model. To have more practical information about the processes, need to go to tactical and operational level in the hierarchy. Dumas et.al (2018, 44) have presented the hierarchy at three - level pyramid. On the top of the pyramid is process landscape, which is the "ground" level to define other levels. Other hierarchy levels' purpose is to present purpose of the process in more practical way. In the Figure 4 is presented pyramid structure from business process hierarchy.

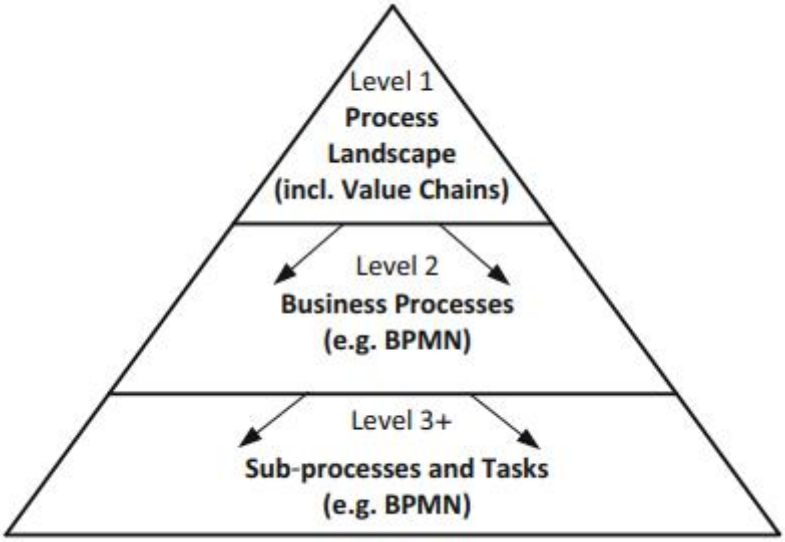

Figure 4 Process architecture levels (Dumas et al. 2018, 44)

After process landscape level, there are business process level. Business processes represent one of the core assets of the organizations for many reasons. One big reason is that it orchestrates company's resources to fulfil customers' demands and therefore is a key factor to determine costs and efficiency (Dumas et.al 2018, 44). Sub-processes and tasks are following business processes in the hierarchy. Sub-processes and tasks level presents the division of business processes into more accurate and operational parts. Level three can be divided into

many different accuracy levels, that is a reason for the plus -sign after the level three. (Krogstie 2016, 41)

BPMN is mentioned in the Figure 4 in the business process level and sub-processes and Tasks level. BPMN stands for Business Process Management and Notation, it means how processes are presented in more practical way. Purpose of BPMN is to visualize critical parts and tasks of the process. BPMN is only for level two and three because landscape level does not have actionable tasks. BPMN is aimed to provide process models that are understandable by both technical and non-technical stakeholders. (Lübke et.al 2021)

2.2 Project delivery business process

One variable that has a big effect for company's business and process execution is the type of the business. Business type can be delivering standard product in standard time. For example, factory producing carton for other company that modified it to shipping boxes. In this case company producing carton is delivering huge amount of one single product. High volume and standard product are good things for process implementation and development. There can be done a lot of analysis from the data, because process without variation can be modified more easily to have a better performance. (Amiri et.al 2017)

Controlling process will be much more challenging if the delivery product is different every time. Even small variation of the product can have a big impact to whole process execution. This means that project delivery process is each time less or more tailored. Tailoring has an affect for project management approach, governance and processes to adapt more suitable way to execute project properly (Anon 2021, 131). Enterprises has a great number of different tasks in processes. Some of those processes are typical for all companies which are operating in global business, for example previously mentioned supply chain process. Supply chain process can be considered as a core process, which can be divided into smaller and more accurate parts of the process (level two and three in the Figure 4). Sub-processes are focusing into smaller parts of the main top-level process. When the delivery product has a variation between each project, supply chain will be a bit different in each case. When acting in global business, procuring materials in supply chain can differ for example by the location where goods should be purchased. Complex process with high variation causes that company

needs many applications with many attributes. It affects challenges for BPM to find suitable indicators to measure process. (Amiri et.al 2017)

Level two in process hierarchy description's purpose is to introduce parts of the upper level consist of. These parts have been defined to be as main tasks in the company's operation. Yet, according to Nickols (2003, p. 1,4) it is extraordinary difficult to achieve progress in improving efficiency by processes. Reasons for difficulties are that names, definitions and examples in the process are not understandable for employees. BPMN's purpose is to prevent misunderstanding, yet it is hard to visualize common level process flows. Challenges are in employee's knowledge of the process and visualizations informativeness. To fulfil the needs in informativeness and employee's knowledge, there has to be big amount of process charts. This may lead to confusing and lack of work efficiency. BPMN should provide a notation for all the employees in the company. That is a reason for developing BPMN more accurate. To have benefit from BPMN to all employees there should be four levels visualized. According to Krogstie (2016, 39) those levels are process, choreography, collaboration and conversation diagrams.

In a company that has several different business lines and functions, it is even more difficult to understand the variables in the process. Business lines has many functions, and they are focusing on their own parts in the process. Because of function's own targets, their decisions may be detrimental to whole process outcome in some cases. One reason for establishing BPMN is that there is a need for view processes from company level. Main target of BPMN is to oversee how work has been performed in an organization. Purpose of BPMN is to manage entire chains of events, activities and decisions, not to focus on individual activities (Dumas et.al 2018, 23). One example from BPMN work is to define functions that are operating during the project process execution. It is important to solve theoretical order for functions' execution. In the Figure 5 is presented process hierarchy from project delivery core process to business process. Yet, Figure 5 gives information only from control-flow perspective and not from data perspective. One major challenge for BPMN is to make models based on many functions with many heterogenous software used is process. (Kossak et.al 2016)

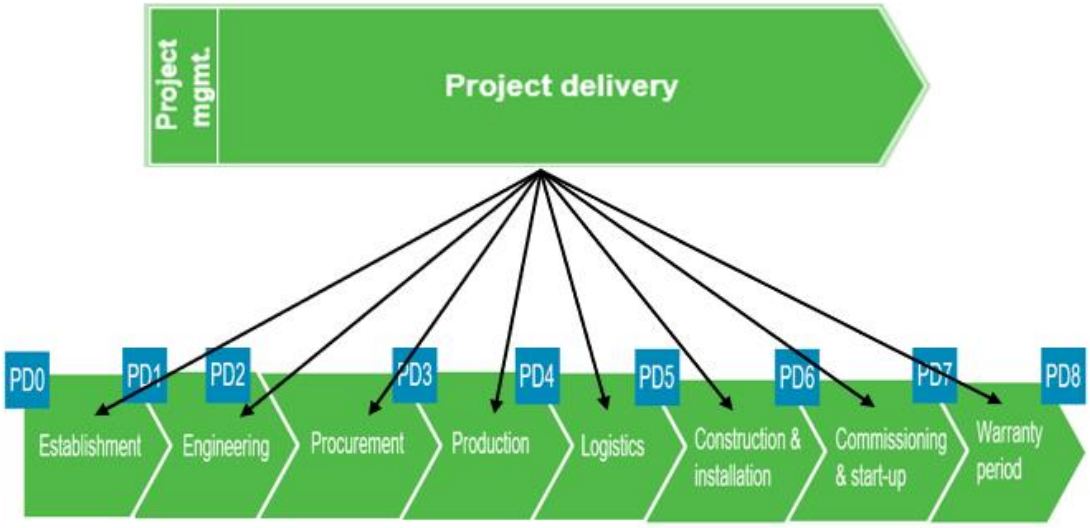

Figure 5 Project delivery process & gates (Valmet handbook)

Project delivery process covers all the practical tasks what are necessary to deliver the customer order. Figure 5 shows how the work should be done in theoretical order in the top level. In practice, this is not so realistic, because of delays and work tasks are overlapping. In the process there are many moving parts, if one thing causes delay, it can be very harmful for the rest of the process tasks. Delay may happen also from external reasons, for example supplier problems. According to previous theory and real-world correlation, it is a big challenge for BPMN to present processes by how they are implemented in real-world (Weske 2019).

As said before, bigger ensembles should be divided into smaller parts. In the Figure 5 there are numbers from zero to eight in the process. ”PD” stands for project delivery. Common way to monitor execution in processes is follow milestones. In the Figure 5 there are nine milestones to achieve during project delivery process. Milestones are widely used to indicate progress in the process (Münch et.al 2012, 214).

2.3 Project delivery sub-processes

In the process architecture, level three answers the question that what should be done in one particular process part to deliver its responsibilities during the process. A sub-process presents self-contained activities that can be broke down into smaller units of work in each particular section of the process (Dumas et.al. 2018, 102). Sub-processes notation introduces

the main tasks of that particular process part. In the Figure 6 is shown main one example from the sub-process notation from the project deliver core process.

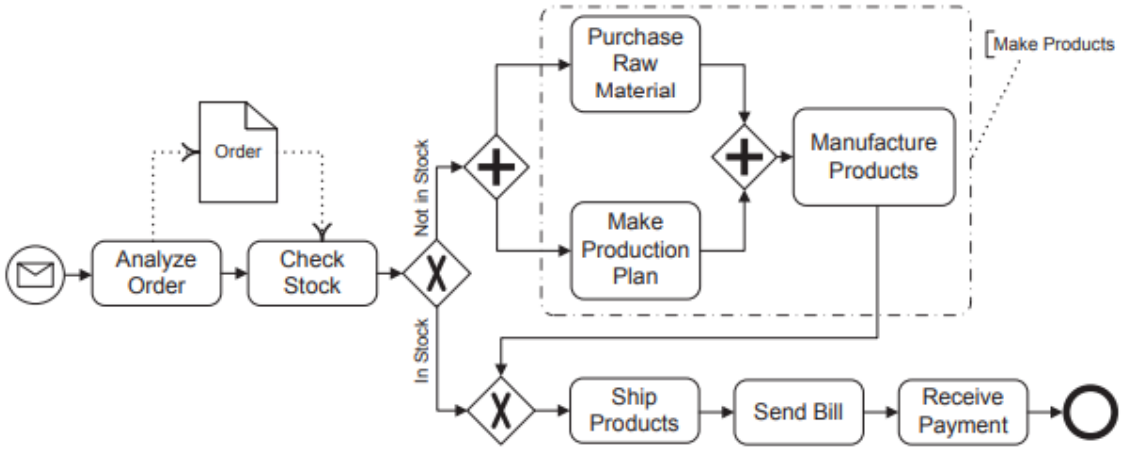

Figure 6 Sub-process diagram (Weske 2019, 208)

Figure 6 can be considered for example as s sub-process from the procurement part in the Figure 5. Company's one team can order item from company's other team. Figure 6 is presenting the workflow from the order to delivery. There are two possible routes to execute this task. Depends on the stock situation, which route will be executed. Figure 6 offers more information from the data than Figure 5. From Figure 6 can be defined needed variables that are important for this part of the sub-process. For example, Figure 6 tells that item inside the order plays a key role in this sub-process. (Kossak et.al 2016, 93)

Figure 6 notation is not considering situations if there are some problems during the execution. For example, delays in raw material shipment may cause problems to whole process. Also, information is incomplete to execute tasks without previous experience from the process. For example, Figure 6 notation is not giving information of applications used in each part. It is not also telling how interactions with other process parts is done. It is typical for business processes that they interact with other organization in and out from the company (Weske 2019, 206)

2.4 Control complex projects

From the previous information about the company's processes, assumptions can be made that whole project delivery is quite complex. One main thing that has great variation between projects is time duration. Duration of project execution can be anything from days to years. Because of tailored products, assumptions about the project's specification may be changed because of long time duration. These two dimensions are general for complex and nontraditional projects (Kerzner 2013, 5). In general level projects can be considered to consist of five dimensions. These dimensions are work, organization, cost, time and resources. All the dimensions are connected between each other, like in process landscape figure presents (Figure 3). (Lock 2013, 174)

Because of long time duration, many things can change during the project's execution. There are things that company itself cannot have affect on, for example price fluctuations of raw materials. High raw material cost increasing during the project execution may be fatal for projects success financially. Company can try to avoid increased cost situations by purchasing products when raw material prices are low. That would be great for projects budget calculations. Yet, there are several obstacles for buying needed products when project has been launched. One issue from tailored product perspective is doing engineering just-on-time style. Engineering is done when it is needed. From the internal and external perspective project has key people to execute project properly. More complex the project is, more people are involved to the process. Many people involved to the project and time duration is years, some people will leave the project during execution. That causes problems to project handling and software usage (Kerzner 2013, 6). Depending on the project, it may cause delays and other major issues regarding project's execution. That is because tasks in the process demands experience and knowledge. Long project duration with delays may cause big number of changes in the project. Changes can arise from a customer's request, company's own needs or outside from the project. Just like previously mentioned employee leave, changes have usually negative impact for the project. Hard thing to solve is that who is going to fund the cost of changes and how. (Lock 2013, 414)

To avoid lack of information and support project's execution regarding all the challenges like mentioned in previous paragraph and others, it is important that project's information

flow is transparent. Transparent information flow prevents negative surprises. which supports success in the process. To achieve transparent information flow, there are lot of work to be done. One key target is to have proactive working habits during the process. To achieve that automated real-time reporting is needed. Real-time reporting is common habit in non-traditional complex projects, but automated reporting with many unique KPIs is a real challenge to have (Kerzner 2013, 8).

2.4.1 Efficient project control

In the Figure 3 (process landscape) developing strategy is defined to be as one cornerstone of management processes. Purpose of that is to define and ensure company's targets and success in the future. Major thing what becomes to the strategy is clear object. Most effective, efficient and profitable companies are those that focused to set clear targets for company and persons (Tracy 2015, 12). Results from Tracy's research can be implemented also for smaller groups in the company, for example project management and project managers.

Target setting will be much easier when company is aware of its critical values. Also monitoring successful in strategy implementation will much more profitable when there are right KPIs available. In a common level, data strategy's purpose is to make company's strategy monitoring more reliable and efficient. To achieve that point, there needs to be done comprehensive groundwork. Depends on the starting level, but in today's business world global companies has defined already the limitations and direction data strategy. Before rapidly increased amount of data and applications, companies recognize possibilities of using data poorly. Same time executing processes came more complex and full perspective to organize data and applications was inefficient. To simplify situation that is happened from these actions is presented in the Figure 7. Siloed applications and data usage are reasons for lack of transparency and inefficiency in the business process. In the Figure 7 is presented three applications, but big global companies have huge number of siloed applications. Before dedicated subsystems were invited for the data, each application program was responsible for storing the data (Weske 2019, 25).

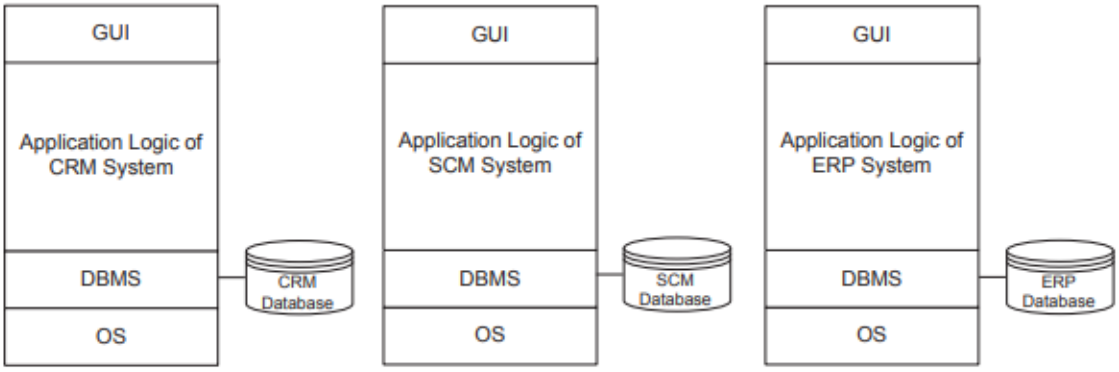

Figure 7 Siloed enterprise applications (Weske 2019, 25)

Graphical user interface (GUI) is a most familiar aspect from the application parts presented in Figure 7. This type of data management is reason for inefficient information flow between applications. For example, if some information is needed in ERP that SCM is producing, employee must open GUI in SCM and find the information there. Then transfer it to ERP application. This type of data transfer takes a lot of time, and it has great possibility for human mistakes (Weske 2019, 25). Different and separate databases cause problems for indicators as well. Some indicators need two or more variables that it can be calculated. These variables can be in different databases. Same situation than what it is in task execution, employee must open all necessary databases and find the correct variable. After that employee needs to import data into one place and then calculate indicator. Companies are often using heterogenous mix of different applications that are producing data for same manner. This causes obstacles for providing indicators that could be needed. (Han et.al 2011, 67)

To get rid of siloed execution, there needs to be done a lot of changes. Depends on the company's size and perspective, data strategy is a suitable guidance for success when planning to move off from silo -based execution. Just like business strategy, data strategy needs a vision and a mission to support its targets and implementation. According to Treder (2020, 49) data related vision, mission and strategy should be answer for following questions:

- Vision: How managing data should look like in near future in this company?
- Mission: Which targets are we planning to meet to achieve our vision?
- Strategy: What are business priorities and how to get there?

Needed actions are related to data and process architecture. Depends on the perspective how data vision, mission and strategy should be implemented. In this study perspective is on project execution.

2.4.2 Enterprise data architecture

Enterprise data architecture's purpose is to fulfil the needs what company has from the data. These needs are related to application integration and reporting techniques. Organizations with the most accurate and readily accessible data can make faster decisions with better quality (Tupper 2011, 57). To have accurate and ready data for decision making, there must a comprehensive data architecture. Data architecture plays a key role in efficient control of business processes.

In the process execution it is even more important that data is available and accurate, because one mistake can have domino effect in the process. Process architecture on the data level is focusing to provide necessary and fluent information flow between each process part. Architecture is taking responsibility that data is available in all the parts of the process when it is needed. In practice, it means that architecture is trying to find the best solution how to transfer data during the process execution. Enterprise data architecture is focusing to minimize disintegration of needed data. By other words, purpose is to manage data to achieve situation that working is fluent what becomes to data usage. According to Tupper (2011, 58) that developing new activities can be sustainable only when data architecture can provide needed information to previous situation. Especially in big companies this is an issue, because integration between various applications can be vulnerable and complex. To avoid inefficiency, it is important to explore business processes and enterprise (data) architecture hand on hand while developing new data related activities. (Gong et.al 2021)

Because of heterogenous tasks in company's processes, there are many different applications needed with many variables. One main key for successfully implemented enterprise data architecture is to define how to integrate applications by the way that it supports company's targets by providing needed data for the indicators (Gong et.al 2021). There are a few possibilities to build the architecture between applications. One nowadays popular solution is to build centralized application all the other needed applications connect. This solution is called

hub-and-spoke architecture. This solution is decreasing direct connections between applications. As Figure 8 is presenting, spokes (applications) are not connected between each other. This makes data maintenance more efficient and information flow is easier to control. (Weske 2019, 35)

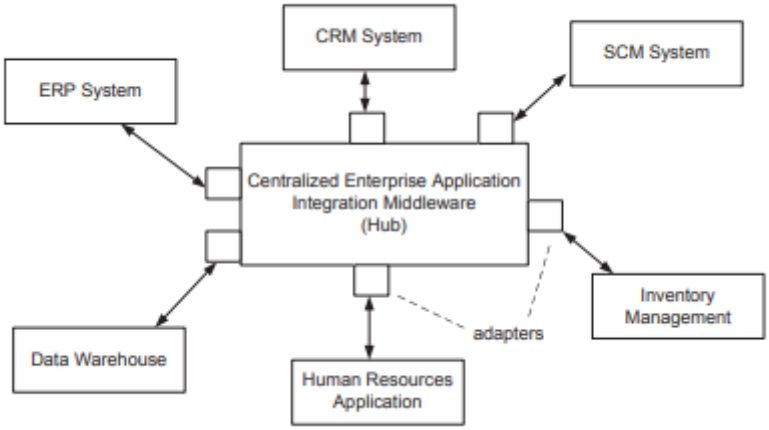

Figure 8 Hub-to-spoke architecture (Weske 2019, 34)

Problems that are in the siloed applications can be solved by hub-spoken architecture. Yet, it takes a lot of research to get in that point. It is necessary that each application has needed attributes that connection to hub is working properly. Adapters on the hub provides that heterogenous between applications is not making problems to the connection. Each application still needs dedicated adapter to attach to the hub. In the project delivery process this adapter should be some unique variable that is used during the process. (Weske 2019, 36)

3 Project delivery metrics

Purpose of metrics is to give information how company is executing its business and processes. Indicators are built from several different variables that company is using to control its business. These variables can be for example working hours, raw material costs or on time delivery. Indicators need to modify to each level of the business, because organizations are usually hierarchically structured (Schuetz 2015, 1). Indicators are categorized by its purpose and importance. Both, purpose and importance, can differ. Depends on the perspective is the indicators Key performance indicator (KPI) just a performance indicator. KPI should have information from the most critical aspects, that changing them increases performance dramatically (Parmenter 2007, 1). This chapter's is investigating how business processes should be measured from project delivery perspective.

3.1 Metrics hierarchy

"Metrics keep stakeholders informed as to the status of the project." (Kerzner 2013, 82) Project has many different stakeholders with different needs from the project's information. To fulfil each stakeholder's needs, metrics are divided into three main hierarchy categories. Metrics hierarchy consist of strategic, tactical and operational levels. Figure 9 is showing the hierarchy. Comparing to process hierarchy (Figure 4 Process architecture levels) in Figure 9 direction is opposite. Arrows are turned because of the information flow regarding the metrics. For example, in level three company is measuring supplier on-time delivery. Value of supplier on-time delivery has an impact for project execution milestones, there may be delays because of low supplier on-time delivery. Project execution measurement is a level two indicator which can have a great impact for example customer satisfaction. Customer satisfaction is level one indicator. In the Figure 9, wheel sizes are presenting the number of metrics in each level. Just like number of business processes level three has the greatest number of metrics. Wheels rotating each other is presenting the relationship between indicators in different levels of the company's process execution. Relationships between hierarchy levels and metrics are hard to notice and understand in some cases. (Krause et.al 2019)

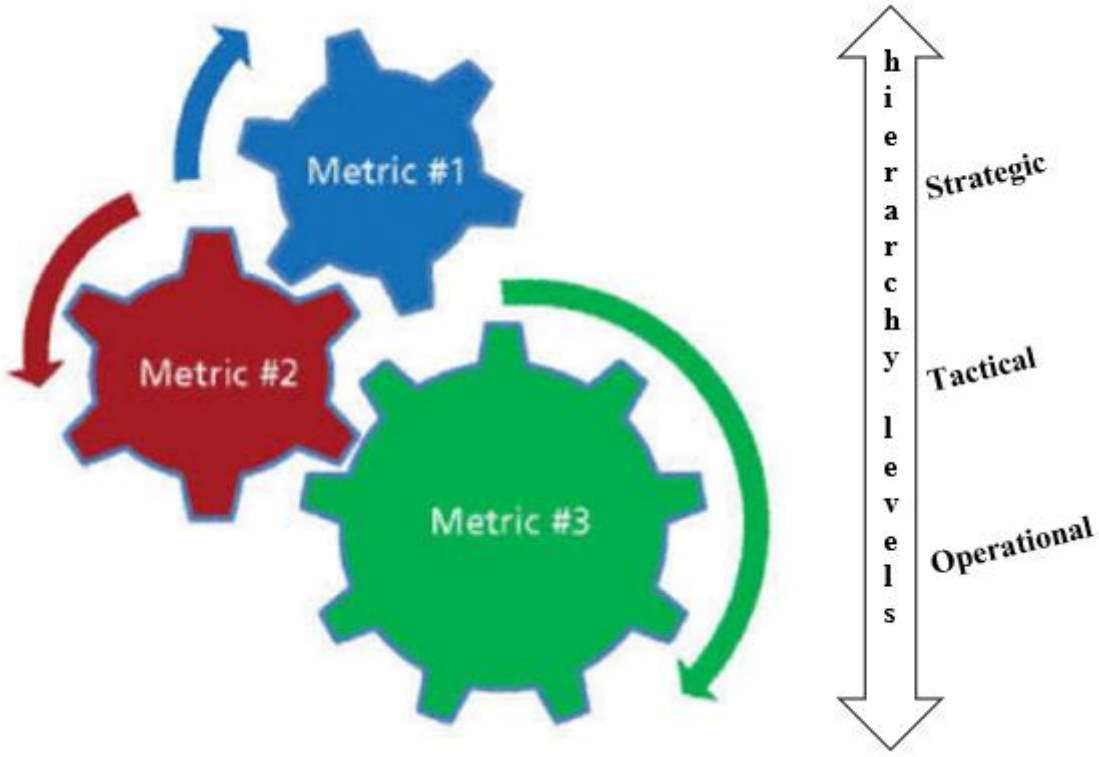

Figure 9 Metrics hierarchy (Kerzner 2013, 141)

Like Kerzner (2013, 82) says, metrics should keep stakeholders informed from the situation of the project. That is also a reason for hierarchy and number of metrics in each hierarchy level. Number of metrics has also correlation between amount of people working in these hierarchies. Hierarchies with different indicators are also supporting focus areas for each employee. Like Krause (2019, 2) says that each stakeholder should be aware of the targets of their indicator(s). Because of that, it is efficient that each stakeholder has only few indicators to follow. From the business management perspective, metric hierarchy levels can be defined as a strategic (1), tactical (2) and operational (3) level.

Strategic level metrics (number one in Figure 9) are focusing on the most critical factors in company's success in top level. This level indicators can be called as "critical success factors" (CSF). CSF indicators have been defined according to company's strategic targets. That is why stakeholders for CSFs are company's top management (Manville et.al 2012). CSF indicators are focusing on long time targets in corporate level and not mentioned to be

daily used. CSF indicators are answering to the questions “what have been accomplished”. Previously mentioned customer satisfaction can be considered as a CSF. (Kerzner 2013, 102)

Tactical level metrics (number two in the Figure 9) are called key performance indicators (KPI). Key performance indicators are usually focusing on smaller parts than CSFs. Yet, tactical level KPI can be defined CSF as well, but in a different scale. In this context different scale means focusing area of the KPI and CSF. KPI can focus only in one business line values or one project’s values, CSF is corporate level measurement. For example, one project’s on-time delivery can be considered as a KPI, but when perspective is on all the company’s projects, indicator is considered as a CSF. This also helps to understand the relationship between strategic and tactical levels (Manville et.al 2012). Tactical level KPIs are defined by a project manager, client and stakeholders. (Kerzner 2013, 118)

Operational level metrics (number three in Figure 9) are called performance indicators (PI). Performance indicator is a generic term that can be almost every measurable information what company has collected from its actions. Performance indicators can be formed a great amount and that is a reason there are more PIs than KPIs. Just like relationship between CSF and KPI, there are similar situation between PI and KPI. One example from PI can be indicator from resource usage, it depends on the company which indicators it defined to be as a PI, KPI and CSF. Main difference between PI and KPI is that KPI has a specific definitions and information (Kerzner 2013, 117).

There are also fourth group for indicators. Indicators in the fourth group are called process performance indicators (PPI). PPIs allows quantitative evaluation of business processes and provides information for stakeholders (del-Rio-Ortega et.al 2017). As the name tells, PPIs can be used in all three hierarchy levels. Difference between PPIs and other indicators is that PPIs can be defined for one exact process. One process provides data for indicator and by that it is a good tool for process owner. Yet, one indicator is not enough, because processes are usually complex. Defining PPIs is hard, and it requires know-how to find the right indicators and right data. (Diaz et.al 2021, 73)

Yet, it is not enough to just measure company’s success. Metrics should provide information that benefits stakeholders and make their work more efficient. Defining hierarchy is a key

requirement to manage and maintain company's assets more efficiently, and by that also makes work more efficient (Mohammadi et.al 2022, 25). Nevertheless, hierarchy and right asset management is not all key requirements for company's success and managing complex projects. There must be possibility to act based on used indicators. It is hard to handle complex projects with many stakeholders and functions. Successfully working in projects needs four critical components to achieve:

- Effective communications
- Effective cooperating
- Effective teamwork
- Trust

Maturity of these components has a variation between companies and projects. (Kerzner 2014, 283). Three of these four needs can be implemented partially with right metrics and reporting techniques in the project delivery. Trust issues can be also improved by right metrics and reporting tools. Degree of maturity must be high in metrics handling and usage to achieve critical components. It is not enough to have good reporting tools and scheduled updates for metrics. Reports should be trustworthy and metrics informative enough to make right decisions based on the project's successful execution. Maturity of process execution is related to expected performance, so indicator for maturity is a comprehensive tool to analyze how well company can perform its processes. (Looy 2014, 4)

Regarding metrics hierarchy, tactical and operational level metrics are important to achieve four critical components listed above. Most important and clear information is communicated with measurable actions during the projects. Yet, it only counts if metrics are understandable, and stakeholders can implement actions according to the values metrics (Kerzner 2014, 79). Maturity is a key tool to achieve understandable and efficient process controlling. Maturity is a combination from company's process management, and it can be measured for example by survey of process owners. Complex processes and large-scale company's maturity of processes is hard to examine properly. (Looy 2014, 80)

3.2 Metric groups and indicators

In addition, company must divide indicators into more specific subject groups than hierarchies. Hierarchy is giving information for how metrics should be reported and handled by

stakeholders. To manage and control actions efficiently regarding information from indicators, subject groups should be clearly defined. Different levels of measurements have a different need from the indicators. Low-level indicator needs to be more practical than strategic level indicators. Kerzner (2013, 133) has divided indicators into groups based on what they are intended to indicate. What indicator is intended to indicate affects on how the indicator results have been presented. For example, it is much more informative for the end users that company is reporting on-time delivery in a percent than in number of late deliveries. Some of the indicators are difficult to group into under specific process task, that is second reason for grouping indicators by the indicators intend. Indicators ca be categorized into five different groups according to indicators reporting purpose.

1. **Quantitative:** Numerical values
2. **Practical:** Interfacing with company processes
3. **Directional:** Getting better or worse
4. **Actionable:** Effect change
5. **Financial:** Performance measurements

These five categories are made because of the complexity of the information. Process produces a lot of information from different tasks. These tasks have a great variation and cannot be measured by the same principals. Number of possible metrics from each category is varying between process hierarchies. Grouping indicators into different categories also helps to identify relationships between them (Kang et.al 2016). Operational level metrics are usually quantitative, practical and actionable. That is also a target because actions based on the indicator may change project's direction of success fast. Tactical and strategical level categories are mainly financial and directional. Financial category is giving answers to the company's strategic targets, for example EBIT percent (Earnings Before Interests and Taxes). Directional category can be used in many indicators. Directional category is informative way to visualize results from some repetitive metric. Directional category is popular when there is no big variation between numbers and stakeholders are focusing on the top-level of the project. (Kerzner 2013, 134)

Categories are also defined by the quality of the available data. Usually there is a need for another attribute than just the target number. For example, company can measure quality costs in many ways. Company can estimate quality costs before the project starts and during the execution of the project comparing estimation to realized costs. This measure can be visualized by a percent number for example. Anyhow, there is a possibility that estimation cannot be done to the project because of several reasons. In that case company needs to change the indicator category and visualization of the quality costs. It depends on the needs of stakeholder that which visualization category is the most informative. Yet, it is the most important that stakeholder itself understand the nature of the indicator and visualization category. (Morgenshtern et.al 2022)

Company's financial numbers have an impact to the indicator's values by many ways as well. If the company's turnover grows, it has an effect for many indicators. These indicators have a connection for company's internal actions and number of tasks. When number of tasks is bigger, indicator's value would be changed. Changes in company's turnover affects mainly to the quantitative and practical category indicators. Indicators should be informative and easy to interpret even when operational environment changes (Franceschini et al. 2019, 7). That is a real challenge to the company to have independent indicators that are not depending on internal or external transformation. External transformation can be for example rapid price growth of raw materials. Price change of raw materials has an affect on many indicators directly, indirectly to almost all of company's indicators. Tailored products and changing measurement environment cause lack of trust for indicators, especially in strategic level. That is because those indicators are usually measuring past performance in long-term. (Kerzner 2013, 138)

Also available data amount is limiting possibilities of indicators. Because of the data, companies need to categorize indicators by the way that data can deliver. For example, if previously mentioned quality costs are reported by a directional category, it does not give information to the stakeholders what to make better that company could have lower quality costs. In that situation, conclusions from the realized numbers are depending on the stakeholder's experience and opinion. Because of the internal and external transformation, it is very challenging to collect right data to make right indicators. Usually cost performance is reported in past numbers, so it makes it even more challenging. This is a reason for need to present

indicators in many levels and categories. It causes a need for more comprehensive data collection and application usage with needed attributes. (Brüggemann et.al 2011)

Before collecting data, company needs to know what data it should collect. In matrix -based organization, it is very slow and hard to find out what is the most efficient data to whole project success. Indicators should be informatively competent in many forms, one of the most difficult activities is making indicators tangible (Franceschini et al. 2019. 8). Because of the many levels of metrics hierarchies and stakeholders, there are different needs that indicators should fulfil. This leads for need to have many reports with many indicators. Too many reports cause a lack of information, because stakeholders are not aware of reports where they should find information to their needs. Another barrier to have efficient report usage is that stakeholders have their own ways to follow realized numbers and they are usually reluctant to study using new reports. To manage and use data in an efficient manner, data and reports should be organized centrally. Centrally organized data also affect for efficient monitoring and transparency, in a long-term of data development. (Treder 2019, 77)

3.3 Performance measurement system

"You get what you measure, and you cannot manage a system unless you measure it." (Franceschini et al. 2019, 133). Conclusion from the previous sentence is that companies should measure everything what can be measured. In some level, companies do that. Yet, in the previous chapter came up that too many metrics can cause a lack of capability to make decisions based on the metrics results. That is a reason for data behind metrics should be considered as an asset that company treats with same diligence as any other asset, for example raw materials. (Treder 2019, 76)

Target of performance measurement (PM) system is to provide a structured approach for focusing on a strategic plan (Francheschini et al. 2019, 134). Performance measurement system should include metrics with defined targets and current performance results to support strategic plan implementation. These metrics are usually previously mentioned CSF or KPI metrics. CSF metrics are highly related to the company's strategic targets, KPIs are usually focusing more into tactical level. Results from the CSF metrics is giving information what

went well and where should be paid more attention. Another target for performance measurement system is to be an informative tool for communication between internal employees and external stakeholders. In the performance measurement system, there are indicators that are measuring internal implementation and external results. Combine from these two categories will help to communicate results. Typical example from PM system is supply chain process. PM system's purpose in supply chain is to give information on how to resources are used during the process. Main purpose is to utilize PM systems for better resource orchestration. (Koufteros et.al 2014)

Diagnostic performance measurement system report can be considered as a set of dashboards, reports and indicators for steering company's decisions based on the metric's results. Just like supply chain, can PM system be implemented to other ensembles. For example, there can be PM system for project delivery process, yet data quality needs to be on correct level to have benefit from diagnostic PM systems (Treder 2019, 11). Managers are trying to make right decisions based on the results from performance measurement system. It can be compared to the usage of car. If there is a need for speed up, you need to accelerate and to achieve that you need to press pedal. Yet, connection between performance metrics and operational tasks are very hard to recognize. For example, if there is a need to get quality costs down, ground reasons to solve can be numerous. Manager cannot be sure did his or her decisions help to get numbers down or was it just luck. Main difficulties in implementing measurement systems are related to the data. Quality of the data is preventing transparency between metrics' numbers and operational tasks. Measures cannot be linked between each other and to the organization's targets (Franceschini et al. 2019, 135). It is important to solve what are the critical factors for each metrics that are affecting to the number. This method is called "balancing" which purpose is to recognize critical indicators. Example case for balancing could be recognizing critical indicators that are affecting customer satisfaction. It will help managers to focus recourses on right subjects. Balancing scorecard -method is one of the most popular methods to recognize metrics that should be involved to PM system. (Koufteros et.al 2014)

3.4 Balancing performance indicators

To achieve efficient measurements to support decisions, company needs to know what subjects are relevant to measure. Amount of data and attributes may be massive, so defining right indicators is very important. Concept "balanced scorecard" was introduced in 1992 by Robert Kaplan and David Norton. They presented an idea that is focusing on how to translate the business objectives of an organization into a critical set of indicators. This method includes four major dimensions that should be in balance. These four dimensions are 1. Financial 2. Customer 3. Internal Business Process 4. Learning and Growth. (Franceschini et al. 2019, 145). Dimensions with relationships are presented in the Figure 10.

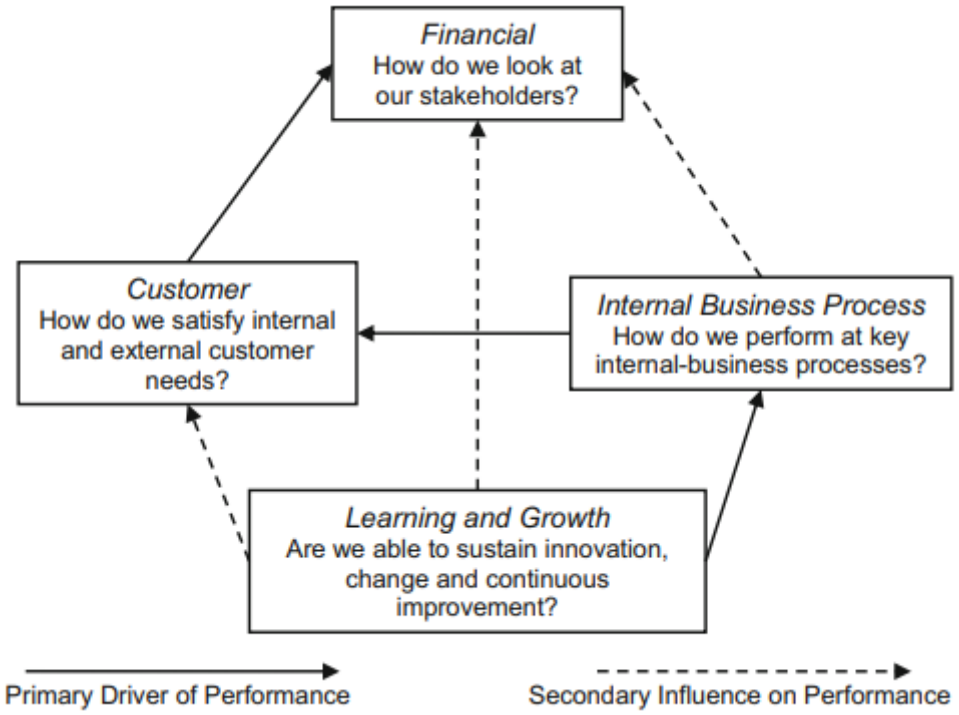

Figure 10 Dimensions in Balanced Scorecard (Kaplan et al. 1996. 9)

Balance scorecard (BSC) is a common way for systematic approach of organizations performance measures. Balanced scorecard's purpose is to find the way how each indicator can be done with minimizing negative competition between individuals and functions. It means that methodology avoids indicators that make one dimension look good while deflating other dimensions needs to be avoided. (Kaplan et al. 1996, 10).

To cover all four dimensions, there are a lot of possible indicators available. Yet, in this study is previously mentioned that less is more. Drawbacks for having too many indicators are:

1. Losing sight of indicators impact
2. Distracting managers focus from critical subjects
3. Neglecting possible correlations between indicators

Part of the performance measurement process is to cut a large number of indicators into smaller group. This method is called “Critical few”. Critical few -method’s purpose is to find the most critical indicators from a big group of company’s indicators (Franceschini et al. 2019. 147).

To achieve good results from balanced scorecard analysis and critical few research, goal needs to be defined. Like driving a car, goal is to move from place A to place B. Car has a dashboard that tells the driver is everything well. The outside world tells the targets to the Driver. Driver does adjustments to achieve targets. Driver knows what to do by experience and information from dashboard. In theory, driving a company can be considered as a driving a car. Company has an informative from its previous action as dashboard to make adjustments. Targets have been mainly defined by company itself. In this case goal for driving a company could be a value from strategic level measurement (CSF). Regarding success in business, one cornerstone is customer satisfaction. Customer satisfaction counterpart on how well company has implemented it’s processes and promises about the products. In addition, customer satisfaction can also describe how relationship with customer will continue. It is a significant determinant of upcoming orders and opportunities (Austen et.al 2012, 973). Driving a company versus driving a car has a different response time. Pushing a gas pedal accelerates car immediately. Results from pushing a theoretical gas pedal in the company may be seen in the dashboard after years. This makes hard to collect critical indicators for company’s dashboard. If the response time is short, explore right indicators is fast. Correlation between goal and variance in indicators is key thing to research to achieve critical indicators for performance measurement system. Yet, balanced scorecard is focusing on information on wide perspective, which is a good and popular approach to define indicators. Even so results may be usable in long term. (Krause et.al 2019, 1)

4 Valmet's project delivery process indicators

Previously mentioned challenges in reporting are limiting what company can measure during the project execution. There are many different reporting techniques in many different metrics. Reporting and calculating metrics are depending on the available data. There may be a need to collect data manually and then there is a risk for human mistakes. Another downside of manual reporting is slowness. Slowness affects to metrics that it is hard to have forecasting metrics for short range actions, for example workshop production schedule. At this moment this master's thesis target company has mixed group of different metrics defined to be as a measuring project delivery execution.

Regarding project delivery, there are many indicators in each process task to measure success. In this study we are focusing on success in project delivery. Success in project delivery can be measured in many ways. Yet, there is a lack of measures that has an affect to this study. Project delivery process' main target is to fulfil customer's needs. In that case we can say that the best indicator to measure success in process is Customer Satisfaction. From the top level of business perspective, customer satisfaction indicator is a good to measure, because it drives financial success in many ways. Financial success is a key driver for company's success, and in that case also for project delivery. Yet, customer satisfaction is not a comprehensive indicator for company's internal processes. Customer satisfaction value does not depend on company's internal failures or success that don't have an effect to delivery product. For example, delays between procurement and engineering causes problems in scheduling and manufacturing. Also, when products are needed within shorter delivery time from the suppliers, price is higher. In the Figure 7 are presented metrics structure in strategic, tactical and operational level of Valmet's project delivery.

Figure 11 Valmet project delivery metrics structure

All the metrics from tactical and operational levels are focusing to provide better results from customer satisfaction. Tactical level indicators are combined results from all the operational level tasks. For example, Cost of Poor Quality (COPQ) can be measured in many parts of the process, it is more fruitful for project management to examine this number in tactical level. In this chapter is presented indicator from each level and topic. This study's empirical research is also focusing how defined indicator is reported. Study is focusing more into tactical level indicators, because those are more critical measures for project management.

Reason for studying project delivery process indicators is that those are one factor that affects construction of data strategy. Ground target in this chapter is to find out are there any one single data platform where data is collected. Reporting tools are also presented, because information from reporting tools are implying how current data architecture is implemented. If there are several different reporting tools, conclusion can be made that data architecture is not properly done what becomes to the project delivery reporting. It is also studied how defined indicators are reported from the project delivery perspective.

4.1 Strategic level indicator(s)

In strategic level there is only one indicator in this study to examine. Needless to mention that company has several strategic level indicators, but in this study, focus is on customer satisfaction. Regarding to increase turnover, company needs to have new orders. Because of specific industry segment, there are not so many customers. That is a major reason to focus on customer satisfaction, because usually same customers make new orders at random intervals. For measuring customer satisfaction, Company is using Net Promoter Score (NPS). NPS measure typically takes the form of single survey questions. Questions are focusing on how satisfied customer is from company's delivery and would they order it again from the company. Typical questions are asking respondent to rate the likelihood that would they recommend the company, product, or a service to a colleague.

There are two to four surveys done in each project, depending on the project category. Surveys are done in gates number one, five, seven and eight (Figure 11). Surveys are done in these gates because of the work with customer. Between gates one to five, success in the process is not affecting to the customer satisfaction. Actions between gates one to five are mainly done between company's internal functions. That is a reason for survey gates. Net promoter score -indicator has been categorized to the company's customer excellence group, which is one of six Must-Win categories. Categories are divided into more specific parts, NPS' specific category is growth in business lines (Valmet Handbook 2022).

Results from surveys are collected to the excels manually. Surveys are done via word file. Because of long and complex projects, data amount from surveys is not big. Number of projects that has NPS measured is low. From the excel files are done two main reports that are followed. One report is company's high level must-win report, which is excel file. Another report is available from power bi, mainly targeted to the business' lines managers and salespersons. High level number in must-win report are shown as financial percentage number. Company has defined target to the NPS and in must-win report realized numbers are compared to the target number. Report from power bi is trying to be more informative. Power bi report should give answers to the sales team that how to handle the customer in the next project and how this delivered type project should be handled with other customers in the

future. To the project execution team report's information should give guidance for the general corrective actions to make process better in the project delivery.

Valmet has defined NPS indicator scale from -100 to 100. There are four categories between these numbers. Category "needs improvement" from -100 to 0. "Good" from 0 to 30. "Great" from 30 to 70 and "excellent" from 70 to 100. Target is in the excellent category. Power bi report should be capable to analyze results that it can answer the needs. In the Figure 12 is shown how the NPS score is reported in more practical level.

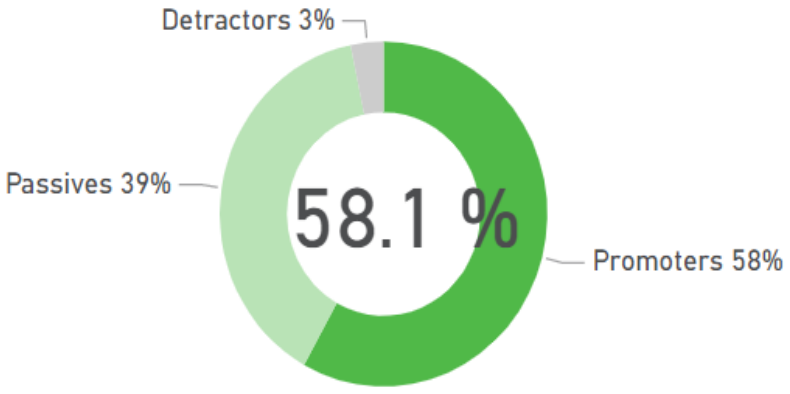

Figure 12 NPS indicator (Valmet NPS customer survey report)

There are many filters in the report that affects to the number of NPS. Result in Figure 12 is "great" when comparing to the defined categories. Anyhow, it is under the Valmet's target. Main thing from the reports available should be information on how to make the numbers to reach the targets.

It is noted that NPS data is manually updated and has no integration between any other application or database. That causes a problem for to do reason-effect relationship investigation between other indicators. Investigation can be done manually, but it demands data structure that can be connected to other indicators.

4.2 Tactical level metrics

As Figure 11 presents, there are six topics to focus on in tactical level. Tactical level topics are combined numbers from the practical level and those are mainly followed in project delivery level. This is also the reason for focusing more into tactical level indicators in this study. This master's thesis target company is defining the success of each project by these tactical level subjects. Tactical level measurements are focusing mainly on company's internal project delivery execution.

4.2.1 Health and safety environment

HSE category is one of the main focusing areas. That is because of employer's injuries cannot be measured in money practically but has a great impact for example to company's image. HSE stands for Health, Safety and Environment (HSE) and has many tactical level indicators. In this study focus is on LTIF and TRIF indicators regarding health, safety and environment. LTIF stands for Lost Time Injury Frequency. LTIF is counting those incidents that have caused at least one day sick leave from work. TRIF stands for Total Recordable Incident Frequency. TRIF includes also numbers that belongs to LTIF. TRIF covers all the incident that needs more healthcare than band-aid, including numbers from LTIF. Company is calculating also those band-aid situations. That is because of preventive actions to avoid LTIF and TRIF numbers in the future.

To have a better understanding from company's health and safety indicators, numbers should be scaled somehow. Because of different tasks during the project delivery, company is reporting working hours to each project. Working hours is the scale to measure LTIF and TRIF numbers. That is because of variation between years and projects in working hours. More working hours causes more health and safety issues. TRIF indicator is calculated by the formula:

$$TRIF = \frac{(RW+MT+LT1+LT4)}{(\frac{working\ hours}{1000000})} \quad (1)$$

Company has defined *RW* (restricted work), *MT* (medical treatment), *LT1* (lost time over one day) and *LT4* (lost time over four days) as a HSE incidents that are counting in *TRIF* calculation. *LTIF* is based on the same formula, but only with *LT1* and *LT4*. (Valmet handbook 2022)

TRIF and *LTIF* indicators are quite complex what comes to the data architecture. There are two dimensions that needs to be connected, HSE incidents and working hours. Company is reporting *LTIF* and *TRIF* in a reporting tool called QlikView. *LTIF* and *TRIF* values are reported by all company's working hours. It means that working hours for each project is not calculated, so working hour dimensions is missing. HSE information for projects are available in the values of *RW, MT, LT1* and *LT4*. From the project management perspective HSE reporting is not valid indicator without changes in reporting technique.

4.2.2 Quality

Quality is reported as a cost of poor quality (COPQ) in euros and in percent of net sales. Cost of poor quality is mainly focusing on the costs that occurs due to defects and deviations in the products.

Cost of poor quality -indicator is defined as of process indicator in the company. It is reasoned, because company is focusing on tailored product deliveries. Quality costs are quite easy to measure when cost source is physical product. Physical product's price is easy to define, so company can target the costs to specific group and team. Yet, poor quality may not be discovered in that part of the process where the product has been installed or manufactured. To make quality measurement more informative, company has divided the COPQ measurement to two categories. These categories are focusing on process execution for defining cost source and cost impact for quality costs. Cost impact is focusing on in which part of the process cost is realized. Cost source defines which part of the process caused the problem. To explain the quality cost categories by process perspective, Figure 13 is presenting the categories and its' connection in the process.

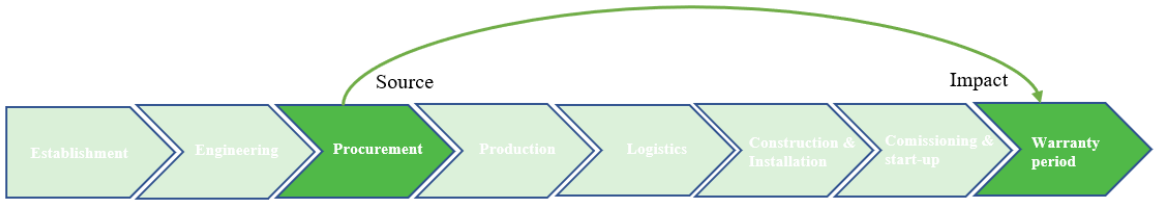

Figure 13 COPQ source and impact in the process

In this example, source is procurement and impact is detected in warranty period. This case could be that procurement has ordered wrong product. The product will not be in heavy use until the implementation in customer's factory. That is a reason that warranty period is the biggest impact part of the process.

Physical product's price is easy to define. In addition, there are many more sources for cost of poor quality than product's price. Depending on the situation, there could be seven different sources for COPQ. Company has defined sources cost sources; 1. Additional hours, 2. Additional purchases, 3. Additional traveling expenses, 4. Obsolete inventory scrap, 5. Interests of overdue receivables, 6. Contractual penalties and special agreements, 7. Other sources of additional costs. Because of complex projects, bad quality can cause a long and expensive chain reaction. All the costs from bad quality product are hard to point on one specific source. That is because of different applications and reporting techniques during the process. Accuracy of the reported variables allows only prognosis of the costs of poor quality.

Current technique for reporting cost of poor quality is a report in QlikView. Quality costs have only one dimensions (euros), so it is simply to report. In this case perspective is also from the corporate level, so report is not done based on the project execution. Yet, quality costs for each project can be discovered by minor adjustments. Because of different applications used as a source for collecting quality costs, report is showing only part of the quality costs. Amount of quality costs that are reported with all the needed information covers circa 95 percent of all estimated quality costs. Reason for the gap is poor application usage and manual labor to transfer information. All the quality costs are available from another QlikView report, but without any project information.

4.2.3 Project execution model

PEM stands for Project Execution Model. PEM measurement is a main tool to track project execution in corporate level. PEM is based on the project gates (from PD0 to PD8 in Figure 11). Each gate has several different tasks to perform during the project. These tasks are defined in the establishment part of the process. In the same part of the process is defined schedule for each gate to be implemented. Gates are standardized, but tasks have variance between projects. That is because of the type of variation between projects. In the Table 2 are presented example from project's milestones and tasks. In this example is presented first and second milestone from the project. Other milestones and tasks from this particular project are presented in Appendix 1. Milestones are bolded in the table and the appendix.

Table 2 Milestones and tasks in project delivery (Valmet Radar)

Milestone/Task	Baseline Finish	Finish	Finish Variance
PD0 Decision to set up project	3/12/2018	3/12/2018	0
PD1 Decision to start delivery project	9/12/2018	9/12/2018	0
- MS1A Identification of Long Lead Items (LLI)	9/12/2018	9/12/2018	0
- MS1B Product splits are confirmed	9/12/2018	9/12/2018	0
- MS1C Project schedule has been issued	9/12/2018	9/12/2018	0
- MS1D As-Sold pricing issued	9/12/2018	9/12/2018	0
- MS2A Machine Section Layouts are certified	10/10/2018	10/10/2018	0
- MS2B Internal orders to other delivering units sent	10/10/2018	10/10/2018	0

When every task under the milestone is completed, gate can be marked as a completed. Because of reporting lacks in the software, every task under the milestones is not visible. Only most critical tasks to execute project are presented in the PEM reporting. These tasks are focusing on the project schedule and common planning about execution of the project. Project planning gives guidelines for milestones and tasks for the rest of the project. Based on

the project planning, another critical variable in PEM reporting is when project will be delivered to the customer.

Project execution model reporting has several different variables and visualizations. Company is measuring completion of gates and milestones based on the schedule that has been defined in the establishment part of the process. PEM measurement is based on the gate meetings done on time. This calculation has several different variations, but the formula is simple.

$$Gate\ execution\ on\ time = \frac{Gates\ done}{Planned\ gates} \quad (2)$$

To have more information about the situation, gate execution on time -calculation needs to be filtered by many ways. For example, timeline should be able to filter for three dimensions, past, present and to the future. Timeline is based on variables “Baseline finish date” and “Finish date”. Baseline finish date is a date that has been defined target date to complete tasks and milestones, finish date is actual complete date. Gate completed on time will be accepted if finish date is +-14 days from the baseline finish date. That is because of long and complex projects. Target for gate execution on time is 80%, gate execution on time is designed to be a practical KPI for project management to track company’s delivery process success.

PEM reporting is used only for project controlling, so it is project based. There is a Power Bi report available from the PEM execution that has many available filters and variations. PEM report covers all the projects with automated data transfer from source application. Filtering for three dimensions (past, present and future) is also available. For example, project management would like to know what gates are not yet done and how gates are executed in common level, this is possible in current report.

4.2.4 Risks and opportunities

R&O (Risks and Opportunities) measurement purpose is to identify and manage risks and opportunities in harmonized way in each project. Target for successful risk and opportunity measurement is to improve company’s project execution in many different measurement areas. Top level target is to improve customer satisfaction, like every measured task’s

purpose is in tactical level of project delivery. Risks and opportunities measurement is focusing on to manage sustainability, quality and HSE in the project.

Because of project based business, risks and opportunities may have a great part in project. For example, selling projects to new market or customer, it is important to pay attention on risks and opportunities. Sales budget must be defined before starting project, so it is important to success that company is aware of the project risks. Risk and opportunity definitions inputs are basic project information, for example projects scope, schedule, budget and resource availability. Risk and opportunity management's outputs can be seal into three main parts. These parts are 1. Updated risk and opportunity register for the project, 2. Estimated financial impact, 3. Concrete risk response actions.

Challenging part is to produce results and numbers from inputs to outputs. Company's risk and opportunity analysis is mainly based on expert assessment. Two other techniques to identify R&Os are brainstorming and checklists. One defined input is also "lessons learned from previous projects". The most efficient way to track previous decisions and project execution is by data and measures. Company is measuring for example how well they have recognized risks and opportunities and how recognized variables have realized. One of the main metrics is *Realized risk percent*. Realized risk percent describes how well company's recognized risks has come true. Formula for the realized risks percent:

$$Realized\ risks\ \% = \frac{Number\ of\ closed\ risks\ with\ final\ cost}{Number\ of\ closed\ risks} \quad (3)$$

Company is reporting realized risk as a recognized risk with materialized costs. With these two variables that have been used in realized risks percent calculation, can be also calculated realized cost versus estimated cost.

Opportunities have been calculated with same principals than risks. For example, company can define cost savings as an opportunity and on the other hand as a risk if costs are bigger than expected. In the Figure 14 is visualized opportunity total value from one project. It is important to track risk and opportunity development by time.

Figure 14 Opportunity Total Value

In chapter 4.2.3 mentioned gates (PD0 to PD8) are also considered as intervals when company is calculating risks and opportunities. Because of different tasks in gate implementation, company is focusing on different risks and opportunities in each gate. Risks and opportunities are reported in Power Bi. Format is same than PEM reporting, it is based on project perspective. Risks and opportunities are handled in the same application than PEM, so data transfer from the source is also working automatically.

4.2.5 Chance and Claim management

Change and Claim Management (C&CM) is focusing on projects intentional or unintentional changes. Change management is focusing on changes in project delivery scope. This can mean changes in schedule or in project specification (technical or contract). Purpose of change management is to ensure that changes in the projects are managed in advance for minimizing negative impacts. Success in change management is highly connected to claim management. If changes have been recognized and reported to stakeholders by advance, there are less claims in the future of the project implementation.

Even with good change management, there are claims in projects. Projects has a many variables and long schedule, so there is always something that need to be changed or redone. In project management, claims can be done by customer or company itself. Claims can be reported to customer, company or supplier. Typical situation for claims is poor quality in supplier deliveries or work delays on customer's site. Suppliers are also able to make claims,

but regarding project delivery, it is different topic to manage. Claims made by supplier has been left out from this study, because of the project delivery perspective.

Claims cannot be done by advance, so claim management is focusing on how to solve situation with best practices. Impact from claims can have affect to many process parts in project delivery. In the figure 15 is presented process how customer complaints are handled in the company. relationships regarding claim reporting in project delivery from customer to this study's company. Change and claim management are different units in project delivery process. Is important for the process development that lessons have been learned from previous mistakes. Company can implement learning better from lessons to have an independent change and claim managements.

Input	Activities	Output
Customer complaints (received by phone, during customer visits, letter, email, etc.)	• Create CI event in Spotlight and/or other systems • Describe • Immediate actions • Investigation • Negotiation • Corrective actions • Approvals for actions	• Solved issue • Closed Claim • Formal response to customer

Figure 15 C&C reporting process (Valmet handbook 2022)

Company is measuring changes during the projects by measuring *additional sales*. Additional sales will be reported if original project needs more activities, or there is a need for parallel project regarding the original. Indicators for claims are focusing on number of claims and amount of money. Both indicators are followed from both perspectives, customer and company. Claims from customer are mainly done because of bad quality. From the project delivery perspective, can be assumed that customer claims have the biggest impact to customer satisfaction. In this case information flow from customer to company's claim management is important. Figure 15 is presenting information flow how claims and changes are done.

Customer claims are handled inefficient way from the data perspective. A lot of manual and unstructured work is done when customer make claims to company. In the Figure 15 is mentioned that Valmet's employee makes event to Spotlight according to customer's complaints. This is one thing that could be more efficient. Customer itself could have capability to do claim for Spotlight. Currently there are no report available from customer claims nor changes.

4.2.6 On-time delivery in tactical level

On-time delivery is measuring how defined project schedule has been implemented. Project schedule is defined in the beginning of the project, it is estimation when project will be delivered. In tactical level there is only one major date to reach, it is whole projects delivery date. Yet, because of long and complex projects, a certain date for project delivery is very hard to estimate. It is not so important to define a single date for delivery, for example because company is using two weeks flexible delivery time for project execution gates.
To have on-time delivery information from project delivery, management has defined indicator called *successful project closing.* Purpose of this indicator is to define how well company has delivered its product. Indicator is not based on the one exact date in the calendar. In tactical level it is more informative to measure how company's internal process parts have been implemented during the project. Project schedule can be also changed by customer or subcontractor, so traditional on-time delivery measurement won't be informative tool to estimate success in schedule.

Successful project closing is based on the PEM gates that are introduced in the chapter 4.2.3. Calculation for the indicator is simple, is the timeline between tasks "MS7C" and "MS8A" under 12 months. In the Table 3 is presented needed tasks and dates from the PEM tasks to implement successful project closing calculation. Combination from two possible results are reported as a percent of successful project closing. This quantitative indicator is quite easy to calculate but is has a great informative value from company's success in projects.

Table 3 successful project closing tasks (Valmet Radar)

Milestone/Task	Baseline Finish	Finish	Finish Variance
PD6 Decision to start commissioning and start-up	6/16/2020	6/16/2020	0
- MS7A Installation completion	7/31/2020	7/31/2020	0
- MS7B Start-up	1/17/2021	1/17/2021	0
- MS7C Take-over	2/8/2021	2/8/2021	0
PD7 Decision to start performance testing	4/5/2021	4/5/2021	0
- MS8A Final acceptance	12/31/2021	12/31/2021	0
PD8 Decision to close project	10/11/2022	10/11/2022	0

Each gate and task in PEM have different requirements that it can be marked as finished. For example, in the Table 3 are presented tasks and gates from the end of project execution. Before completing these gates there must have done several other gates. MS7C gate means that basically all the necessary work has been done from the company's side. If everything has done as planned, final acceptance (MS8A) will be reached in 12 months. That is a reason for successful project closing to be as on-time indicator for tactical level. On-time delivery indicator is currently calculated in excel and reported via email.

4.3 Operational level metrics

Operational level metrics has the fastest and the most exact impact from everyday work. That is why operative those metrics must be simply and easy to make conclusions from it. It means that data behind should be as unprocessed as possible that interpret from metric's results is reliable and efficient. Operative level metrics are supporting management in the operative level. Update interval in operational level indicators should be as short as possible. That has an affect to the nature of the indicators implemented in operative level. There are a few main hallmarks that can be recognized from a good operative level indicator used in the company:

- No complex calculations to achieve needed indicator
- Raw data widely achievable in every level of the company
- Purpose and target of the indicator easily to place

- Actions based on the indicator's results can be efficiently targeted to the right process part or function in the process

Root cause for all the specifications listed above is efficiency to act based on the indicator results. Complex calculations should be avoided because indicator has to be easily understandable, it means that attributes used in the calculation should be standard and reliable. Common thing for all low-level indicators are that goal and target is easily placed. That is because of the nature of the measured subject. Low-level indicators usually belong to practical, quantitative or actionable groups. This is possible to implement when measured thing is commonly known, repeatable and possible to predict.

4.3.1 Process performance indicators

Company has a big amount of different operational level indicators. That is because each business line and business unit want to track their own success in real time. That leads variance between indicators, calculations and lack of efficiency what becomes business line's cooperating. Operational level metrics from the project delivery process perspective are listed in the Table 4.

Table 4 Operational level indicators (Valmet handbook)

Process Part	Indicator	Type of indicator
1. Establishment	Contract & project structure	Practical
2. Engineering	Number of engineering change notifications	Quantitative
3. Procurement	Claims from external stakeholders (delays & poor quality)	Actionable
4. Production	Number and completion rate of event feedbacks	Practical
5. Logistics	Number of short shipments	Quantitative
6. Construction & Installation	On-time delivery	Practical
7. Comissioning & Start-up	On-time delivery	Practical
8. Warranty period	Efficient project closing	Quantitative

Indicators in Table 4 are estimated to be the most critical for projects execution in operational level. That is because these indicators are reflecting on how main parts of the process have been handled. For example, number of engineering change notifications (ECN) are telling how well engineering has been implemented in the whole process. If there are a lot of ECNs in a project, it has an impact for other operational level indicators that are measured in the process parts after engineering. ECNs may cause delays in project delivery, for example because procurement needs to order new products afterwards. This will also lead to increasing quality costs, because some goods need to be ordered twice.

4.3.2 On-time delivery in operational level

On-time delivery indicator can be measured in every part of the process. Process parts are measuring OTD, but in project delivery level it is not the most critical indicator in all parts. That is because of the perspective. To fulfil customer's needs, company needs to deliver goods for target location on time. This means that goods need to be there when work starts in construction & installation and commissioning & start-up process parts.

On-time delivery in other process parts are not so important because it has impact mainly for company's internal implementation. Customer is not aware of company's internal challenges, so from project delivery perspective minor delays in other process parts than C&I and C&S are not critical for project delivery. Another reason for focusing less on OTD measurement in other process parts than in six and seven is complexity. From the project delivery perspective, it is hard to define exact and measurable schedule for process parts number two, three, four, five and eight. One main reason for that is work has been done parallelly. There are many reasons for parallel work. One reason is financial, needed goods should be delivered just-on-time to production. If goods are delivered earlier than needed in production, capital is unnecessary out of other actions. Another reason for parallel work between process parts is projects are long and contains many parts that can be done in different business lines. Because of matrix based structure, it is hard to define common OTD specification for whole project's parts than numbers six and seven.

4.4 Metrics monitoring

Previously in this chapter introduced what are the indicators that are defined to be the most important for controlling project execution. Each function and process manager knows the numbers from him or her responsibility area. Function and process heads are usually monitoring numbers from the business line perspective, so he or she does not know numbers for one exact project. Project managers that have responsibility from one project knows the numbers in a common level from his or her project. When monitoring whole success in project delivery process there should be capability for many projects at the same time. Monitoring many projects at the same time allows project management and manager for better

"lessons learned" implementation. In the Figure 16 is presented the loop of executing project managers responsibility areas while process execution.

Figure 16 Project management balance triangle (Valmet handbook)

In the middle of the figure is the target that is presented as a strategic level indicator in the beginning of this chapter. Target is supported by three main dimensions which are resources, schedule and scope. Success in these dimensions is controlled by those seven topics which are in the circle. Some of those seven topics are measurable and by that easier to control.

For the company's project management perspective, it is important to see values from the indicators in strategic and tactical level. Operational level indicators are more important during project execution. Strategic and tactical level indicators are more relevant for project development and "lessons learned" implementation, because for example customer satisfaction can be measured properly only after finishing the project. In the next chapter is done empirical research for how well strategic and tactical indicators are reported to the project management.

This chapter's study is shown that Valmet is not focused to measure its business executions by project perspective. Each from the six subjects that are defined to be important for project are not constructed by project delivery process. Two from the six subjects has no report available to view how project is executed. HSE and C&C management would be reported if data and architecture allows it. Conclusion from the reporting situation is that there is no

common platform for the data. Reports available are scattered into three different locations, excel, QlikView and Power Bi. Situation is not sustainable for making better decisions and analytics based on the project delivery data available. Project management has no view for how projects are executed in common level.

5 Project delivery process control

Previously in this study driving company's business have been compared for driving a car. Because of several business lines and over 17 000 employees, driving this study's company could be better compared as a controlling a spacecraft than a car. Spacecraft's dashboard is more complex than a car, for example because spacecraft is moving in three dimensions with higher speed and weight. This study's company has also many different dimensions to take care in controlling project delivery, for example delivery location, schedule and employees.

In the previous chapter this study went through indicators that company is using for measure project delivery. It is important to know how project is going during the project implementation. Estimating success in project delivery requires setting targets for the indicators. Based on the realized numbers and targets, stakeholders can only make adjustments for tasks and actions in the process.

In this chapter are presented main parts for the project delivery control. Project delivery control includes eight operational level process parts that has direct effect for project controlling. Investigation of the process execution and controlling is done by interviews and research of company's project delivery documentation. This chapter is focusing to examine four main subjects of project execution:

- Primary and secondary software used in the project delivery
- Most important input and output information in the process
- Reporting techniques in and between process parts
- Quality of the data

These subjects are focusing to investigate main parts of the project controlling. In the Figure 17 (Circulation of project delivery management) is presented common execution of project delivery cycle in simplicity. There are no start and finish task marked in the Figure 17. That is because of the nature of the project execution. Parts in the Figure 17 are went through

many times during project execution. Each of the five parts have its own mission how to support project management and process execution.

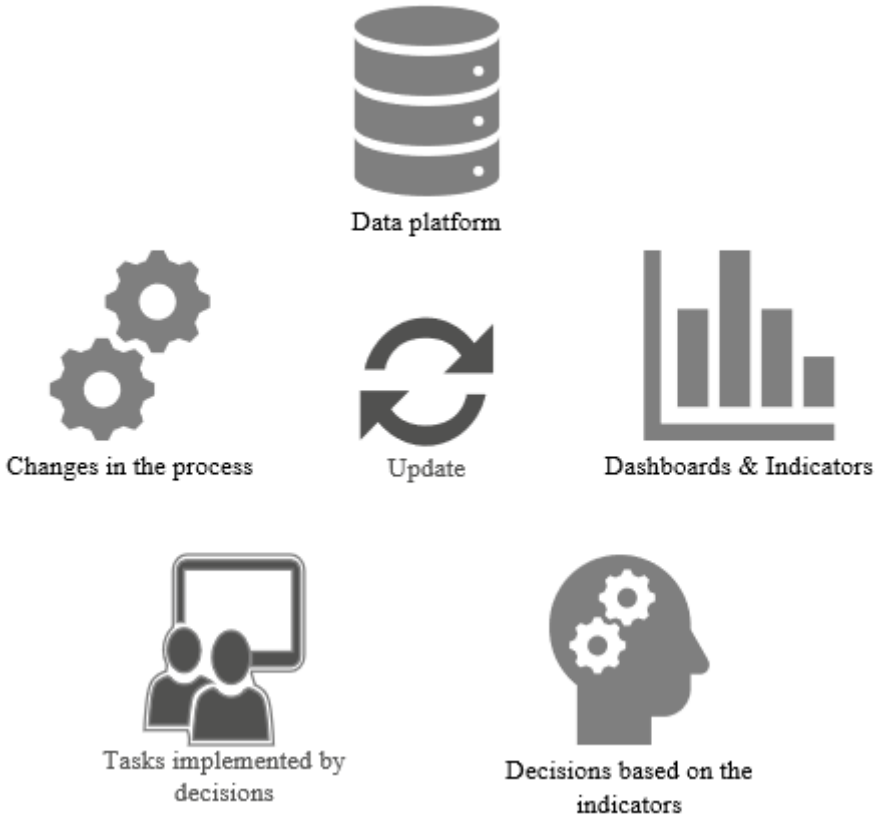

Figure 17 Circulation of project delivery control

Company's project delivery includes eight process parts from Establishment to Warranty period (Figure 11). Cycle presented in the Figure 17 is done separately in each process part and in tactical level, many times during the project. In chapter four presented indicators and dashboards are guiding the decisions. Tasks are done based on the employee decisions. Tasks are done using the company's applications and it produces data from the implemented task. This data will have an affect for the indicators and the loop will start again.

Data platform's mission is to be the place for make the data more valuable. In practical level it means that there could be transparency between implementing cycles in the process parts. This master's thesis target company has started to collect data to the data platform. In the future, company wants to collect all the data necessary for the data platform, not only project delivery data. Data platform usage is quite new in the target company, so data is not widely available from the platform yet. In the future it will give opportunities to make better and

more informative reports and dashboards. Currently there are data in the data platform from many applications, but only a minor part of the company's reports are done based on the data platform data.

Research made in this chapter, and in whole study, target is also to support data platform development. Interviews, procedure handbook and writer's own experience target is to sort out main sources for data in project delivery execution. It requires knowledge from used software and critical attributes. These two are the main variables what becomes to data specification for data platform development.

5.1 Project control information in operational level

Project control in operational level is focusing on daily tasks during the process. Daily tasks are, for example, drawing a machine part in the software. Drawing a part needs a specific input information. Engineering who is drawing the part should know what to do next when drawing is done. Depends on the situation, for example it can be sent to the procurement or added to the Bill of materials (BOM). At all events, information should be transferred via software. Only by that there is a possibility to track information during tasks automatically and reliably.

Research of controlling project delivery in the operational level is done by interviews and from company's documentation. Because of the subject's nature, one person or team can't have exact enough knowledge from the whole process. Of course, there is project management team that operates in corporate level, but it is focusing mainly to the tactical and strategic level management. Project management team has collected documentation from how each process part is handling its own tasks during the project execution. These documents have good information from main subjects that needs to be done in the process part. For example, there is a list from needed software to implement tasks in the process part. For this this study's scope, perspective is too common level in the company's documents. Because of that, interviews have been held with each process part.

Company's documentation from project execution is giving the ground information from the topics that is needed in each process part. Yet, documentation is not taking a stand on for example what is the most important software for implementing tasks. Documentation is giving information, but the perspective is from the management side. That is an inefficient approach for reporting and data development, because one software may be used 90 percent of time when executing project delivery in process. Most likely that software is the most important for implementing tasks in that process part, but not necessarily. This chapter is focusing on to recognize most critical success factors in each process part. This will be done by research of company's documentation and delimiting it by interviews.

5.2 Process part interviews

Each process part has several management layers with many workers. That causes a challenge to find the right person to answer questions that needed to be solve. Person should have knowledge from the operational level, but also have full awareness of what is the target and scope of the process part. Conclusion was that the best answers would get from top managers from each process part. They should have right perspective for thinking challenges in tasks during the project execution. The interview included three categories:

1. Software usage
2. Information flow
3. Data-driven company

Each category's purpose is to explore the situation in the process part. Combination from the interviews gives information from the situation in whole project delivery process. Main purpose from the first question category is to find out the most critical application that is used in that part of the process. In the second category target is to examine input and output from each process part and how information movement is managed. By this research the most important data attributes can be defined. Third category is for explore usage of data, reports and dashboards in common level. Interview template can be found from Appendix number 3.

Because of the nature of the topic, interview template was sent to interviewees in advance. By that was ensured that assumed interviewee can 1. Make sure that he or she is the right person to answer questions, 2. He or she can estimate that right questions were asked, 3. Can think answers and comments for the interview in advance. Reason number one is the critical for other reasons success. That is because it is important that the interviewee has a good motivation and by that he or she will focus on the questions better. To listen interviewees comments from the topic in common level, there was a "additional comments" part in the end of template. Additional comments indicate what are the main things that causes challenges in that particular process part, if it is not asked before in the interview template. Questions in the interview were complex and there cannot be "yes" or "no" answers. Because of that, interviews were hold face-to-face or via Microsoft Teams. Interview had three topics and 14 questions in total.

Eight interviews were hold, one with each process part. One time interviewee sent the interview request forward to some other person, so information of right persons was in good level. Meeting time with each person was 30 minutes. Short meeting time was also one reason to send the interview template in advance. Reason for short meetings was tight schedule, this study's writer's and interviewees. In the Table 5 is presented each Interviewee's responsibility area and title.

Table 5 Interviewees

Part of the process	Title
Establish	Vice precident, Operational development
Engineering	Director, Engineering
Procurement	Vice precident, Operational development
Production	Director, Production
Logistics	Senior Manager, Logistics
Construction & Installation	Director, Site Management
Comissioning & Start-up	Director, Automation
Warranty period	Vice precident, Operational development

First and last part of the process is handled by the same person, so there were actually seven persons to interview. Persons in the list have defined by project management team, so they were already aware of the topics.

Persons responsible from procurement, establishment and warranty period are from the same team than this thesis' writer, so they were aware of the target and scope of this study and interview. Person who is responsible from establishment and warranty period is also subscriber for this master's thesis, so answers to the questions from him were diverse and fruitful. It was glad to notice that other interviewees focused to the topics and meeting as well. All the interviewees were noticed that the topics are important and transparency between process parts will help to implement their tasks in the project delivery. Most of the focusing questions from the interviewees came from the "data-driven company" topic. This was expected, because this part of the interview can have multiple perspectives. One notice from the meetings was that term "data-driven company" is not profoundly understood among people in the process. Increasing awareness of data-driven company concept and how to do that is also increasing commitment and ideas for data usage. Interview was a useful for both directions, interviewee and interviewer, because it increased awareness of how to improve project delivery process.

5.2.1 Applications in the process

Application usage questions were simple and should be easy to answer. Question number one was to find out the main software that is used to implement tasks in each process part. Target for the answer was to define primary application for the process part. Question number two was to find out the number of applications used in the process part to execute all tasks that is required. In the Figure 18 is presented results from the first two questions. Figure is presenting primary application and number of secondary applications used to implement tasks in each process part.

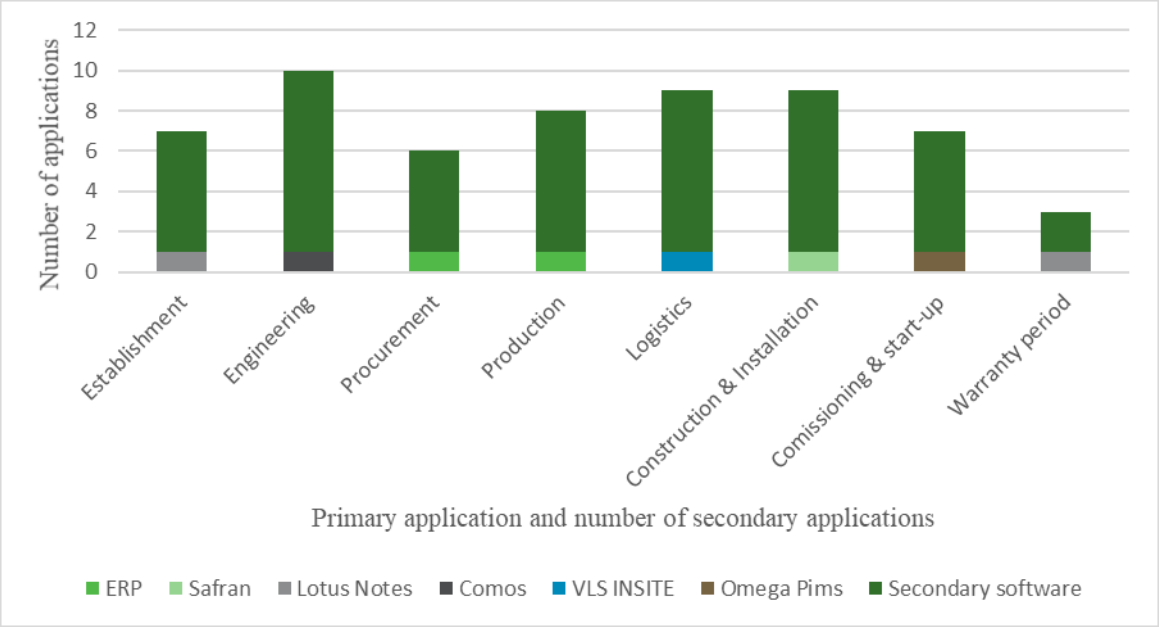

Figure 18 Primary applications and number of secondary applications in project delivery process

Yet, answers to the application usage questions were not simple to give. Answer may be different if perspective is only focusing on process part's internal tasks. In this case perspective is from project delivery, which makes answers more complicated. Because of many Applications in each part of the process, everything unnecessary must be cut out when choosing the primary application. This means that only crucial tasks can be done to deliver the needs for next part of the process. Crucial tasks means that without any errors, changes or modifications project can be delivered with primary application presented in the Figure 18. In theory this can be possible, but in real life situation results won't be good without secondary applications.

Result from question one shows that there are six primary applications in project delivery process. With eight process parts, it can be noticed that some applications are primary in more than one process part. Establishment and warranty period share same primary application, which is Lotus Notes. Lotus notes can be described as an information archive. Common information from each project is gathered to the lotus notes archive. From the project delivery perspective, establishment and warranty period can be considered as a supporting process parts.

Because of tailored products that project delivery process is producing, engineering has a major influence for project success. Main tool for engineering is Component Object Server

(Comos), which is application for comprehensive engineering work. Comos has an integration to and from other software already, for example to ERP system. Enterprise resource planning (ERP) is a primary application for procurement and production. ERP is a common name for application that integrates functions' tasks in the company. This thesis company's ERP is Infor LN. VLS Insite belongs to the same group than Comos and LN Infor, because it is an appurtenance for LN Infor. VLS Insite is a primary tool for logistics handling in the project delivery.

Construction and installation -part is using a tool called Safran. Safran's purpose is so monitor the progress of building machine in customer's site. It can be compared to building a house, it is necessary to know when one task is ready that other can be started. Comissioning and start-up is depending on previous process part's schedule. Machine can be started after the construction part allows it, not a bit before. Comissioning and start-up is using application called Omega Pims. Omega Pims' purpose is also to be a monitoring tool for progress in the customer's site. Both tools, Safran and Omega Pims, are also dividing project to manageable parts. Then project's progress is easier to follow.

Average number of applications used in each process part is 7,4. It is obvious that one software cannot handle all the actions during the process execution in each part. Yet, from the project management and data perspective it is important to know, are there integrations between applications. If there are integrations between all applications, one software can produce all the data that is needed to manage whole process. Next part of the interview is focusing into this issue.

5.2.2 Information flow

Purpose of this part of the interview was to examine what are the applications for main input and output information between process parts. Input and output variables are also giving information about the application importance. Source application for input information to one process part is often other than previous process part considered as a primary application. To implement the work in the process part, secondary software is needed. Enrich data handled in primary application can be considered as a main task in each process part. Variable information needed to enrich data in primary application is also important to examine.

Because by that information can be ranked importance for secondary application. Purpose for this is also figure out how well theorical linear model is realizing in data flow. In theory, previous process part's output information application should be next part's input application. This part of the interview is also focusing on what is the main output and input information for and from the process part. Appendix 2 is presenting whole process with input and output application and main information. In the Table 6 is presented how well the linear model is realized according to the interview results from application usage.

Table 6 input - primary - output application

Process part	Establishment	Engineering	Procurement	Production	Logistics	Construction & Installation	Comissioning & start-up	Warranty period
Input source	Compass	Lotus Notes	Infor LN	Infor LN	Infor LN	Comos, LN infor	Site worker	Lotus Notes
Primary software	Lotus Notes 1.	Comos 2.	Infor LN 3.	Infor LN 4.	VLS Insite 5.	Safran 6.	Omega pims 7.	Lotus Notes
Output source	Lotus Notes	Infor LN	Infor LN	Infor LN	Infor LN	Safran	Lotus Notes	Lotus Notes

Results from the interviews are good what comes to the theoretical data flow between process parts. In the beginning of the process main tools are Lotus Notes an Infor LN, which are used in all three categories (input, primary and output). Amount of data grows explosively when process moves from establishment to engineering. Process parts between engineering and logistics is managed most of the data. For example, most of the item data is produced in engineering and handled especially in procurement and production. Item data is one of the most important input and output during the process. From the item data can be estimated for example project budgets. This study's company has more than 750 000 purchase order lines in rolling 12 months. Each line has one item, so data amount and information related to items is huge. Arrows in Table 6 have been numbered, because for better understanding what are the main variables that needs to be transferred between process parts. In the interview questions three and six are focused to examine main input and output information in each process part. Combining interview results from sequentially process parts can be construct main information to each arrow in the Table 6. The most critical information to execute project delivery process in each arrow is:

1. Project schedule, structure and contract documents
2. Item information (drawings, number of needed pieces) and delivery schedule
3. Project schedule and item delivery schedule

4. Project schedule and materials ready for delivery with item data
5. Shipping plan and information from items that are delivered and undelivered
6. Information from the progress in customer's site and project schedule
7. Information from the progress of customer's site and customer's feedback

When moving to the end of the process, data flow is not so fluent. In construction & installation part there cannot be defined one main input source. Combination of Infor LN and Comos affects an inconsistency for previous research, because Comos and Infor LN should have integration. In a simple, integration means automated data transfer between two or more applications. From this result can be made conclusion that integration between Comos and Infor LN is deficient.

Red arrow in the Table 6 pointing to commissioning and start-up part indicates that dataflow won't work properly. According to interview answers from question seven (how information is reported to next steps/process part in the process), there were a break in data flow. All the critical information from project delivery perspective is produced manually by site workers in commissioning and start-up. Workers may have some benefit from previous Safran application, but mainly for producing critical information, the work is done manually. Latest part, warranty period, is using Lotus notes in all the categories. If everything had went well in the process, one and main information for warranty period is a start-up or take over certificate. In theory it means that this company's work has been done executing project delivery process. Like in warranty period, success in every part is connected to the schedule. Schedule is other main dimensions with item data that interviewees said that is important. Reasons that schedule is important are for example customer satisfactions and workforce resource management. Workforce resources are limited and hard to handle if there are changes in the schedule during project execution. Because of executing multiple projects at the same time, changes in project's schedule may cause a domino effect and delays many projects.

5.2.3 Data-driven process

Last part of the interview was focusing on how well project execution can be done based on the data available from the input and output software. First sight of the challenges in data-driven execution came up in the interview question eight: What is the target process part for output information? Answers for the question eight should be the next process part in each case like Table 6 is presenting. In all cases next part was one of the output targets. Yet, all the interviewees said at least two targets, most said two, some said whole process. This means that basically all the data should be available in every part of the process. In theory this can be done. Company's solution to this issue is that all the information from project is collected to the Lotus Notes. Because of that Lotus notes is important tool for all the process parts. Yet, Lotus notes is archive for information without any proper integration between other applications.

One main issue regarding data-driven process execution was that enrichment must be done manually. Information to enrich input data during the task execution must be collected from many sources. Like in the Figure 18 presented in this chapter, there can be 10 software to be an information source in one process part. This causes also feeling to the employees that data is not reliable. In the interview question number *11. Do you feel that information is reliable?* Almost all the answers included worries about the schedule information. Because schedule is one of the main dimensions during project execution, it is used as a key variable in almost every application. Projects are long and schedule changes many times in especially operational level. Because there is no integration between all software, changes in schedule could be updated for only one application. When employee is using several applications, he or she will notice many different dates for one task. It may take long to be sure which date is the correct one. Also, this date should be updated for all applications, so fixing data quality takes a lot of time away from productive work.

Research made in chapter four is supporting findings from the interviews and application usage. Similarity can be found in many parts. One main thing of findings in chapters four and five is that data is scattered into several different sources. Because of that can conclusion is that there are no comprehensive integrations between applications, information must be transferred manually. "Data-driven" part of the interview highlighted that process is not

working by a straightforward manner. In practice, information from the used applications during project delivery process in needed level to execute tasks in the process is not working in needed level. Even so most of the arrows are “green” in the Figure 18.

5.3 Application ranking

In this chapter is made research for the applications that are used in the project delivery process. Some of the applications are more relevant than others. Application ranking is an estimation from project management perspective. Supporting estimation is done research from input, output and primary software. One of interviews’ purpose was also to find out what is the most important application during process execution.

As a combination from previous findings and information from Company’s handbook has done scoring to applications ranking. Scoring has done by following rules:

- If application is mentioned to be as a tool for process part in handbook, 1 point
- Application estimated to be as a primary tool in interviews, 2 points
- Application is input and/or output source in the process, 0,5 points

Research is based on the knowledge what is the most critical application for process execution. Research is not giving exact information from the data quantity in different parts and application. Yet, it can be assumed that most of the data is running through those applications that are named to be as a primary. Ensuring that focus is on right applications is one of the main targets of enterprise level architecture. In this case focus is on enterprise level, but area is narrower than whole enterprise. In the Figure 19 is presented application ranking based on the scoring system defined above.

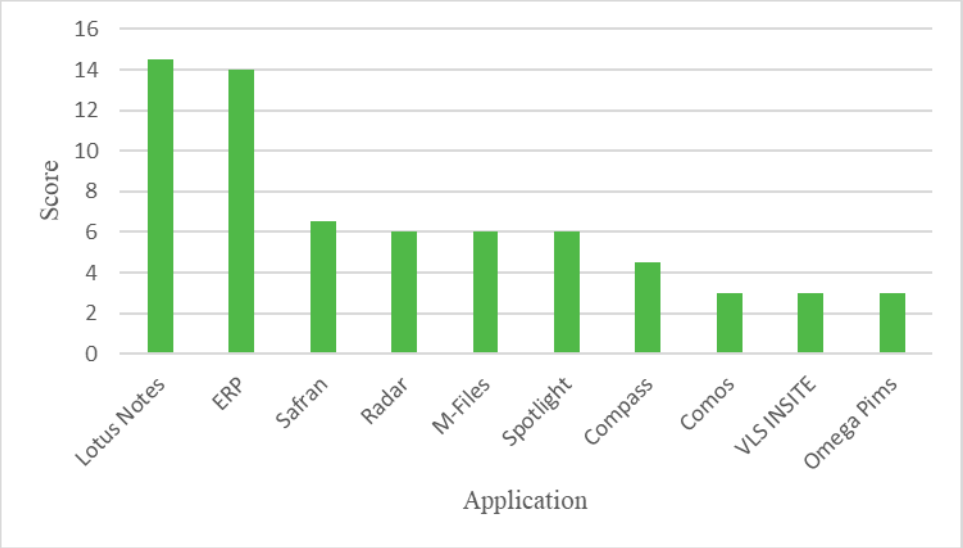

Figure 19 Weighted application score based on information flow

Hypothesis based on the interviews was that ERP will be the most critical application for process execution. Yet, Lotus notes is the most important software according this study's findings based on the interviews. Reason for that one is manual labor that needs to be done during the process. Lotus notes is mentioned to be an information source for all the process parts. After ERP and Lotus notes there is a big gap after next application. Safran is a tool for controlling installation in customers site, that is a critical step for the process. In that part is usually needed some short shipments and purchase orders to have missing parts for customer's site. That may explain that Safran is third on the list. Next three applications are not input, primary or output sources in any part of the process. Radar, M-files and spotlight are supporting applications for project execution. Radar is common tool for monitor PEM -gates (Appendix 1). These gates were presented before, and all the process parts are using these gates. That is a reason for radar importance. Spotlight is a tool for reporting HSE and quality numbers. HSE numbers are sensitive for all the stakeholders during the project execution, so that is a reason for its importance. M-files is another archive tool, just like Lotus notes. M-files includes for example project procedures that are used to support this master's thesis research. Compass is a first input source in whole process, its purpose is to support creating sales documentation. This documentation is used during the process in many parts. Last three tools came up during the interview. Each tool is primary tool for one process part.

Company's procedures include 22 applications that are used during the process execution. Figure 19 is presenting only top 10 applications based on the weighted score. Last 12

applications had score two or less. Estimation based on this study is that those 12 applications are not relevant what comes to the process execution and especially data architecture. 10 applications presented in the Figure 19 are covering more than 80 percent from the points from the total weighted score.

5.4 Data quality

According to results from the interviews, data quality could be better. Interviews gives information on how fluent data flow is between process parts. From the data quality perspective this gives information from the integrations and enterprise system architecture. Based on the system architecture research in this study company knows what are the main sources that are producing data and what applications has the biggest impact on process execution.

5.4.1 Data source

Research of system architecture is important for focusing resources to develop right parts of the process. Yet, it is not giving information from how data in the applications should be managed from the whole process perspective. To do that there is a need to examine attributes that are used in the applications. Attributes are data items, for example supplier, item, date and location. Attributes from needed information that is used to execute process. Because project execution is using many applications, most efficient way is to examine applications that are also sources for indicator data. In this study is already presented indicators that are defined to be the most important for project delivery. Indicators and source for data are:

- HSE (Spotlight)
- Quality (Infor LN)
- On-time delivery (Radar)
- Risks & Opportunities (Radar)
- Change & Claim management (Spotlight)
- Project Execution Model (Radar)
- Customer Satisfaction (Excel)

These four applications (Infor LN, Spotlight, Radar and Excel) are main sources for the indicators. Yet, it is important to notice that sources are defined from the company's common level. It means that source by itself is has not necessarily all the needed attributes to calculate indicators from project delivery perspective. For example, this has already come up when analyzing HSE indicators LTIF and TRIF in chapter four, these cannot be calculated without project execution hours. Hours are not available from the Spotlight currently.

To examine attributes needed in the applications, research is also supporting the theory of hub-to-spoke system. This system was about centralized system that integrates applications by the way that they work between each other. Hub-to-spoke system needs a connection element that is necessary from every application. This can be also considered as key element for performance measurement system that is presented in the chapter three. To make comprehensive and efficient performance measurement system, attributes must be connected between each other. In the Figure 20 is presented the issue regarding data connections in attribute level.

Variables in the Figure 20 can be divided into four categories: sources, data tables, connections and centralized application or data table. From the enterprise data architecture perspective, centralized application is considered to be as a "Project" in Figure 20. When focus is on data visualization and indicator implementation, "Project" is considered as a data table. Yet, in theory both perspectives are following hub-to-spoke operation.

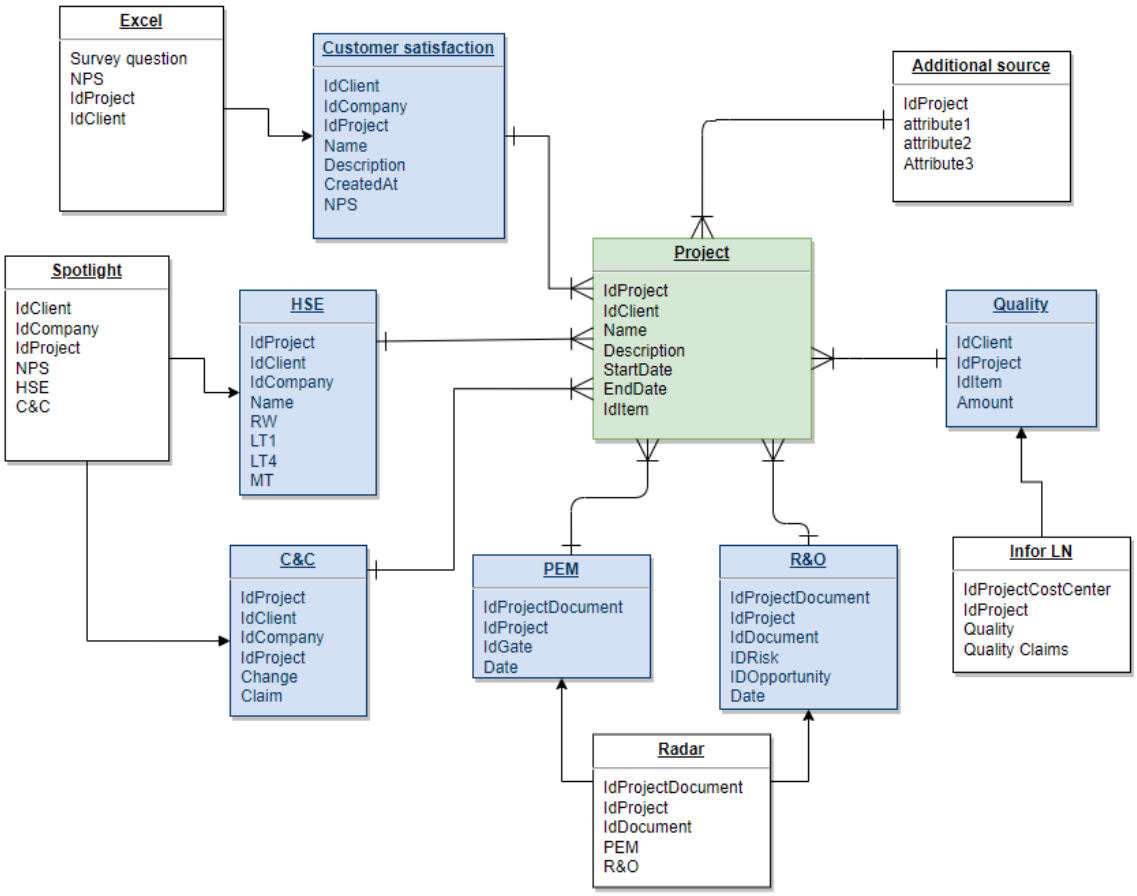

Figure 20 Dataset structure for project delivery monitoring

From the Figure 20 can be noticed that sources (applications) are providing needed data for indicators. Data is imported via specific data tables, because usually application have many more data tables as well that does not have effect on needed indicators. For example, Radar application has a data table “PEM”. PEM data table has several attributes that are relevant to have to implement indicators. “Project” data table should have all the necessary attributes to make comprehensive relationships between other data tables. On the top right corner is a table called additional source. This table is presenting the need for supporting attributes that are not available from original sources. For example, working hours to calculate HSE number could be imported by this way. To make comprehensive and efficient data model each table should have unique attribute that can provide needed filtering for indicator calculations.

In this case, relationships are relevant only when perspective is on needed attributes and data tables. Relevant data tables must include needed attributes to implement indicators that are wanted. Yet, relationships in the Figure 20 are presenting the situation between project and other variables. For example, project has many different PEM gates, but PEM gate has only project.

5.4.2 Data quality in practice

Hypothetical situation could be that project manager would like to know, what are the numbers from each defined indicator regarding his own project. This type of situation would be good for noticing issues regarding each project and how to avoid making those in the future projects. According to findings in this study, indicators have many sources and many reporting tools used. So, for having all the indicator numbers from each report, project manager must open many reports. This may cause confusion, because data is heterogenous and use of attributes may have variation. Variation between attributes means that one attribute can have different marking techniques and style even if it has same purpose. This is also issue regarding data quality.

From the project delivery perspective, the most critical attribute for project manager is project name and ID. Project name and ID attributes should be found from all the sources and reports. Without name and ID, manager does not know, what are the numbers from the project. Situation is examined by exporting data from each reporting tools to Excel. Export includes all the attributes that are available from the data tables. In this case there are need for six exports.

According to indicator hierarchy presented in chapter four (Figure 11), manager should track the indicators based on the project results from customer satisfaction perspective. Customer satisfaction (NPS) is strategic level indicator that gives information from whole projects success. First sight from poor data quality appears when exporting data from NPS report, there are no project ID available from the data. That is a big challenge what becomes to the dataset structure presented in Figure 20. Also, in this case there are no “project” table available, so even if other indicators’ data has project ID, it cannot be connected to NPS indicator.

Connection between other indicator results must be done by project name attribute. After exporting all the data from other reports, conclusion can be made that project name attribute has variation between data sources. Variation between project name -attribute is presented in Table 7.

Table 7 project name variation

NPS	OTD	COPQ	HSE	R&O	PEM
Amadeus	Amadeus	Amadeus	ASA059AMADEUS PD	Amadeus LDC Pulp Dryer SDU Baling I 641+119703 Sub	Amadeus PDU 634+ASA059
Ursus TP11	Ursus TP11	URSUSTP11	URSUSTP11	Ursus TP11 RBO 210 110435-A Total	Ursus TP11 RBO 210 110435-A Total

1. 2.

These two example projects tell that project attribute has no standard type between applications. Even a minor difference between attributes causes problems in data connections. For example, in OTD has marking “Ursus TP11” and in COPQ it is marked as “URSUSTP11”. It can be deduced that those means same project, but data structure may need 100% similarity and for that reason it won’t work. Difference can be also found between markings in projects. Comparing type in HSE, it can be noticed that markings are not structured by same way. Reason for this can be different hierarchy levels used in the projects or manually input for project name attribute in the application. Conclusion from the findings in Table 7 is that manager must have knowledge of used project hierarchy structure and names. There are differences in 1. horizontal and in 2. Vertical directions what becomes to analyzing project name data in Table 7. Horizontal similarity is more important for one single project manager, it helps to track project indicator numbers more easily. Vertical difference gives information from that there is no standard naming guidance for projects.

In vertical direction it is more important that data quality is good what becomes to results from used indicators. In this case for making for example performance measurement system and better analysis for project management in common level, results from indicators should has same format and index. Yet, minimum requirement is that result from indicator is available from each project. To examine data quality from the indicators in common level, there are randomly chosen 50 projects. Because of many sources, analyzing is started from NPS

indicator. For starting data quality analysis from NPS is ensuring that there is project name available from each result. Other reason for basing analysis on NPS project names is that NPS is only indicator in strategic level, so from project management perspective in corporate level it is the most important to analyze.

Collecting results from the indicators by projects requires manual labor, reason for that is previously presented differences between project names. From one single project manager perspective this task can be done quite fast, but when collecting data from 50 projects, task takes a lot of time. example data quality from six projects is presented in Table 8.

Table 8 indicators' data quality

Project	OTD	COPQ	HSE	R&O	PEM	NPS %
Moorim DeNox	On/Off	Empty	Empty	%	%	%
Nippon Dynawave Pulp Dryer	Empty	€	Empty	%	%	%
Obbola Fiberline	Empty	€	On/Off	%	%	%
OULUFGT	On/Off	€	On/Off	%	%	%
PT Tel CoC G3 Rebuild	Empty	Empty	Empty	%	%	%
MF Kemi BTT PD - Total H0007	Empty	€	Empty	%	%	%

Table 8 gives information from the average situation of all the 50 projects. OTD indicator is available only for a few projects. Reason for that is manual calculation and reporting. Because of big number of projects, it takes too much time to calculate and report OTD for all the projects. HSE are reported by number of cases. PEM, R&O and COPQ can be found for almost all the projects. Reasons for missing data can be that data is not collected from all the projects on purpose to calculate indicators. Other reason can be that project name difference between sources is too big to find numbers to each project name used in NPS report. Real values in Table 8 are replaced by the used reporting format. Real values are not essential to show in this research.

6 Future of data in project delivery process

Business based on projects has a great value for Valmet's success. It has a big affect on income and customer satisfaction. Nevertheless, many indicators are not done based on the project delivery needs. Research made in this study shows that there are a lot of development needed to achieve proper and efficient data usage for project delivery. This includes usage of attributes, indicators, applications and data architecture. All of those factors need to be properly implemented to have benefit for project delivery process and get rid of silo-based data usage. In this chapter is presented what are the main areas to focus on to make project delivery process more data driven.

To construct clear and understandable way to achieve targets, it should be supported by vision and mission. With strategy, vision and mission is presented in this chapter also to ensemble picture of data usage in the future in project delivery management. Data strategy, vision and mission are also supporting answers for this study's research questions.

6.1.1 Data vision

Vision for data should have answer to the question "how managing data should look like in near future?". From the project delivery process perspective there are a lot of areas to develop. One major step towards efficient data usage is that data should be considered as a supporting tool. First it should be supporting existing business models. This can be achieved by making data more accurate and reliable. Without trust on data, there cannot be any major development towards data driven processes. Like in chapter 5.4.2 presented there are gaps in reporting project delivery numbers.

By making data more reliable and accurate, stakeholders will use it more. More users for company data bring forth more needs from the data and this will increase development towards data driven company. Stakeholders from each process part will use their data more and more and by the time barriers between process parts are recognized regarding the data in operational level.

Vision for data in project delivery can be consider of two main topics in near future. First topic is that corporate level data management should pay attention for data architecture from project delivery perspective. Other key topic is that quality of the data must increase. Without good quality, other topics are not relevant.

6.1.2 Data mission

Mission for the data is supporting targets that are presented in the vision part. Data mission should give answers to the question "Which targets are we planning to meet to achieve out vision?". This can be considered as a step towards to achieve situation presented in the vision. Good data mission has measurable and concrete actions that needs to be done for achieving vision. According to findings during this study, there are three key topics to do:

1. Standard data handling guidance for project delivery process parts
2. Measure data quality development (attributes, data tables, relationships)
3. Make sure that business people and data management have same principals for developing project delivery data

All the three topics are related to data quality and engagement of the data usage. Development can be measured by the same review made in chapter 5.4.2. Business people is needed to ensure calculation methods and verifying the quality of the data. Data management's purpose is to fill the gaps that appeared in data quality during this study.

Perhaps the greatest challenge for implementing mission is to ensure what are the benefits for project delivery process when the data maturity is on the right level. Without knowledge of the data as an asset, stakeholders do not see the whole potential of the data. This will lead lack of effort to increase data usage and quality. To achieve this master's thesis targets regarding data development in project delivery, it is important to convince right people from all process parts in project delivery (Table 6).

6.2 Data strategy

Data strategy should have answer to the question “What are business priorities and how to get there?”. One main key to achieve efficient data strategy is that it is supporting organization strategy. In this case data strategy should be supporting targets based on project delivery management’s strategy. This also helps commit stakeholders to execute tasks needed to implement data strategy.

Organization strategy is in the lead what comes to implementing data strategy. That is a reason for this study’s indicator research structure. Indicators are focusing on company’s strategically important topics. One indicator (NPS) is strategic level indicator and other six indicators are tactical level indicators (Figure 11). Yet, all the indicators presented in this study can be considered as a KPI’s for organization strategy. KPI’s are supporting company’s strategic targets, so data strategy and company’s strategy are supporting each other. Yet, this study is focusing on how to develop data usage for project delivery process perspective.

Business priorities regarding project delivery data strategy is focusing on how to get rid of silo-based data usage. How to move from silo-based data to data driven company is related mainly to the application, attributes and data management. To make this master’s thesis outcome more accurate and actionable, there should be a ranking for targets to develop. Because of great number of applications and attributes, it is necessary to focus on the most important things. One reason for accurate targets is that developing takes a lot of time and if the end result does not satisfy stakeholders, they are not so eager to continue development based on the data strategy. In this chapter is presented the main business priorities based on project delivery perspective from strategic point.

6.2.1 Critical success factors

Previously in this study is presented indicators that are defined to the most important for project delivery. Yet, regarding the research, indicators are poorly constructed for project delivery. In a common level there are reports available, but when looking for one particular

project, data quality is low. In this chapter is done correlation analysis on which indicators are the most important for customer satisfaction. This analysis gives also direction on what data sources should be paid attention first. Analysis is based on “critical few” -method that is presented in theory section of this study. Data for the analysis is collected in the chapter 5.4.2.

Indicator’s correlation between each other can be found from Appendix 4. Only correlation to NPS indicator is presented in Figure 21. Reason for that is data quality. Many projects are missing data from HSE and OTD indicators. Because of that, results may not be reliable. Other reason of correlation for NPS is that it gives information from the projects’ whole success from the customer perspective. Good NPS value can be considered as a target for project delivery. In the Figure 21 R&O measurement is realized risks.

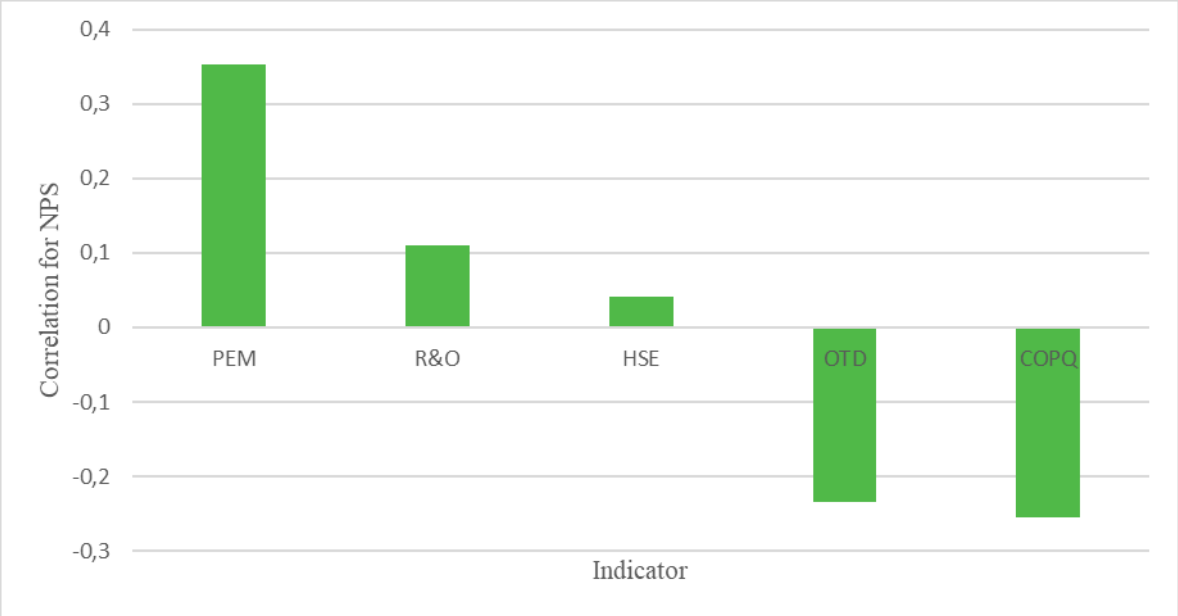

Figure 21 correlation analysis for customer satisfaction

According to the Figure 21, strongest correlation for NPS has PEM and COPQ indicators. These results can be considered reliable, because data quality between these three indicators were good. OTD calculation is available only for the most important projects. In this study it has third strongest correlation for NPS. OTD is focusing more for measuring internal success, and therefore it may not have strong effect for customer satisfaction. In this analysis good OTD result has negative impact for NPS. Results from OTD cannot consider to be reliable, because scarcity of data.

Yet, from the Figure 21 can be noticed that time and money are the most relevant topics what becomes to the customer satisfaction. This finding is also supporting results from interviews and previous findings. Figure 21 shows that COPQ and PEM has the strongest correlation for NPS. These are also connected to each other, because with low quality there are usually delays. Low quality with delays causes extra costs for manpower and spare parts. Based on this analysis, critical success factors are PEM and COPQ from the defined indicators. In a common level, indicators highly connected to time and money are relevant for customer satisfaction.

6.2.2 Balanced scorecard for project delivery indicators

For the future development it is necessary to have right indicators for project delivery. Previously correlation analysis shown that three of the defined indicators are relevant to measure success regarding customer satisfaction. Key topic for efficient performance measurement system is that it has right indicators. Yet, right indicators depend on the target. In a corporate level project managements target is to deliver project as it is agreed. If the target is not achieved, NPS will be low.

In a theory section of this study is presented balanced scorecard method. Purpose of BSC is to have focus on right indicators to construct efficient performance dashboard. BSC has four dimensions to cover. Those dimensions are 1. financial, 2. customer, 3. internal business process and 4. learning and growth. According to this study's target, NPS is naturally indicator for customer dimension. Indicator for internal business process could be PEM. Like theory of BSC, internal business process is a primary driver for customer satisfaction. Other two dimensions are not so clear to cover based on this study's findings. Financial indicator should give answer for question "How do we look at our stakeholders?". COPQ can measure that, but it is focusing only for negative impacts. Learning and growth indicators should have answer for question "Are we able to sustain innovation, change and continuous improvement?". According to this study, best indicator for this dimension would be R&O. R&O has secondary influence on customer satisfaction. Also, R&O can be considered as an indicator for innovation, change and continuous improvement. In the Figure 22 is presented balanced scorecard for project delivery.

Figure 22 BSC for project delivery

Figure 22 presents the most relevant indicators for each dimension according to this study's findings. Yet, cost of poor quality is in brackets, because there should be more comprehensive indicator for financial. COPQ can be one part of the financial indicator in the project's performance measurement system, but by its own it is not enough. Also, NPS is not a primary driver for COPQ (lines in the Figure 22), so there should be more relevant indicator discovered to that position.

Financial indictor for project delivery's performance measurement system should be done in cooperation with stakeholders. Business oriented people knows better what the indicator for financial dimension could be. Technically oriented group will know how to transfer right information from the data sources to the reports and available for stakeholders.

7 Conclusions

As an overview, this study has shown that company's data architecture is not done based on project delivery perspective. Findings from the application usage, indicators and reporting techniques supports the conclusion that there are a lot to develop regarding data in project delivery process. This master's thesis target was to make research from the situation of data usage in project delivery process and how to use data in more efficient way. Because of complex organization with many stakeholders and applications, achieving the target was challenging. Therefore, because of multiple hierarchies and functions, this study is applicable for many other parts in the company. This chapter presents answers for the research questions and how to implement results in the company. Also, data strategy implementation in practical is considered as well with estimation of limitations and future actions based on this study.

7.1 Answers to research questions

This master's thesis research questions are focusing to support the data strategy. To simplify, data strategy should have answers for 1. What are business priorities and 2. How to achieve those business priorities. This study's research questions one and two are focusing to recognize the business priorities. This study is based on the indicators, applications and data structure in the project delivery process. Answers to the research questions are combination from these three categories. Each answer has simplified format with more specific explanation.

1. *What are the indicators that are the most efficient to measure success in project delivery process?*
   Answer: Net Promoter Score, Project Execution Model and realization of risks and opportunities

It should be considered that question number one is focusing on what the indicators that are measuring project delivery process, not single project. That is a reason for example that OTD is not one indicator in the answer. OTD could be if it is calculated for all the projects and therefore valid to estimate success in process. NPS, PEM and R&O are valid indicators for

measuring whole process. Reasons because data quality is good and BSC analysis is supporting relationships between these indicators. Answer includes only already defined indicators; it does not define that there cannot be better indicators.

2. *What are the main applications for execute project delivery process?*
   Answer: Infor LN (ERP) and Lotus Notes

Answer for the question number two is based on the interviews, Valmet handbook and data research. This answer does not have an affect from the sources for indicators. Second question is focusing on the operative working and how data is managed during the project delivery process. Answer has only two applications, because these are highly controlling most parts of the process. ERP and Lotus notes are also main sources for the data in process execution.

Third research question is focusing on the second part of data strategy. Answer for this question is explaining how to modify tasks and variables during the process to control business attributes by the way as desired. Answer for the question number three is more complex than the previous ones. That is because it has many possible variables and stakeholders included.

3. *How needed indicators and applications should be modified to be get from silo -based measurement to process based measurement?*
   Answer: Changes in key attributes in each process part to build needed relationships between data tables and so too between process parts

Key role in this study has project name and ID. ID is more relevant to be the key attribute, because it is more accurate than name. Changing usage of applications has a bigger role when company is trying to move away from silo -based measurement. Transparency between process parts can done by comprehensive data platform and connections between data tables. To do that, there should be standard naming for projects in each application. Also, one big issue for process -based measurement is data quality. To raise data quality there are a lot of things that should be done. The most important thing is to get rid of manual reporting and indicator calculation. To do that, there needs to be done a specification for all the needed

attributes and calculation methods. In a long run, making reports working automatically saves employers' time massively and by that has a big effect on company's performance. One major reason for making definitions from attributes and calculation methods is to avoid making work multiple times. By the definition of calculating methods and attributes many reports can be replaced when data is available from the data platform.

7.2 Data strategy implementation

Project delivery process data strategy implementation should be started by thinking how financial dimension could be measured in the project delivery process. According to findings in balanced scorecard analysis, there are no relevant indicator defined to be a financial indicator. Financial indicator should be linked to company's strategic indicators, but it should have capability to be linked also for one single project. Financial dimension indicator must be decided by cooperation of stakeholders in project delivery process. One possible indicator for financial dimension is measuring change and claim management.

When all needed indicators are defined, it is more efficient to analyze needs for modifying attributes. All changes done in same time is more effective than making changes by each indicator's attributes separately. Specification is also important if there are required changes in the applications by other indicators. In that case there needs to be a solution that supports both indicators' needs. Also, adding new attributes to the applications may be needed and this can be efficiently done after all needed indicators are defined.

From the data platform perspective, it is important that relevant data tables can be connected between each other. To do that, it helps a lot if there are a similar logic for project name and id in each application. This helps also employees to understand better how the process works. It also supports BPMN work, because standard naming techniques make notation work easier. Naming and formatting for project ID should be done by the format used in company's ERP system. That is because ERP is the most important application for project execution. This solution also supports further development to get rid of silo -based working and measurement. The most efficient way to get rid of silo -based working with data is centralized data platform. It means that data is not in a "row", like process parts after each other. Two major variables for project delivery process execution are schedule and item data. These

should be considered as a key variables when data platform development is done for project delivery process. ERP is also producing great amount of data related schedule and time. That is also a reason for using the same project id and name format in other applications than ERP is using.

Regarding this study's findings, maturity of the project delivery data is quite low. Because of that, first tasks for data strategy implementation should take care of data quality and indicators that are defined already. Based on this study's findings, suggestion is that automating indicators that are already defined for project delivery has the most efficient impact for whole project management team. This will also raise data quality and the same time comprehensive specification for indicator calculations can be done. This will give solid ground for the data development in the future regarding project delivery process.

7.3 Future of the project delivery data strategy

This master's thesis company is one of the largest technology companies in Finland with many stakeholders and applications. Data transfer from the applications to the data platform is a hot topic in the company. Company has noticed the potential and need to automate reporting. That is a good what becomes to the target of data driven company in a common level. Yet, it does not mean that data is manipulated and transferred by the project delivery process perspective. Company is making data transfers by the "topic", not by one single application or indicator. This kind of activity has up- and downsides. For example, company's one topic regarding data transfer to data platform was "project delivery". This includes data tables from many applications and has many needed attributes. Yet, it does not take care of the needed relationships to make for example performance measurement dashboard. To make performance measurement dashboard all the needed data must be available from the data platform with needed relationships between data tables.

Automating reports is done by replacing old reports with automated data. For this reason, there are no major development regarding reports' informativeness in a short term. Replacing old reports with automated data is not going to be a solution to get rid of silo -based data reporting. Yet, in a long term this activity will lead to that all necessary data is available from the data platform. In that situation, building comprehensive performance measurement

systems needs to have right connections between data tables. When reaching that situation, this study's analysis has a key role for constructing valuable reports for project delivery management.

This master's thesis is done from the top-level perspective of the project delivery. To make company's project execution accurate and data driven in all levels, there is a need for further research. Because of complex and tailored products, some parts of the process may have different needs and specific indicators. Company has also many business lines with many business units and technology units. Each of those has a bit different way for operate and has specific indicators. This master thesis gives a good premise for further research focusing on the more accurate parts of the project delivery process.

This thesis writer believes that focusing data and its value will grow near future. It takes a long time to automate current reports and even longer to make new reports with new capabilities. When publishing new report, it should be working properly, because by that stakeholders believe that data platform development work is necessary and fruitful for company's execution. This study has shown that there are a lot of potential to make better results by developing data usage. Also, referring to Bernard Marr (2022, 1), it may be necessity to do so: "Those companies that view data as a strategic asset are the ones that will survive and thrive".

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Appendix 1. Project execution milestones and gates (Valmet Radar)

Milestone/Task	Baseline Finish	Finish	Finish Variance
PD0 Decision to set up project	03/12/2018	03/12/2018	0
PD1 Decision to start delivery project	09/12/2018	09/12/2018	0
- MS1A Identification of Long Lead Items (LLI)	09/12/2018	09/12/2018	0
- MS1B Product splits are confirmed	09/12/2018	09/12/2018	0
- MS1C Project schedule has been issued	09/12/2018	09/12/2018	0
- MS1D As-Sold pricing issued	09/12/2018	09/12/2018	0
- MS2A Machine Section Layouts are certified	10/10/2018	10/10/2018	0
- MS2B Internal orders to other delivering units sent	10/10/2018	10/10/2018	0
PD2 Decision to start detail engineering	11/27/2018	3/31/2019	-124
PD3 Decision to start site operation preparations	5/15/2019	5/24/2019	-9
PD4 Decision to start main shipments	8/28/2019	8/28/2019	0

- MS7A Machine start-up has been completed		6/30/2021	
- MS8A Performance guarantee discussion has been held with customer		6/30/2021	
- MS8B Start-up punch list has been completed		6/30/2021	
- MS8C Performance guarantees have been verified		6/30/2021	
- MS8D Stock and paper samples have been received		6/30/2021	
- MS8E Production follow-up has been completed		6/30/2021	
PD5 Decision to start construction/installation	1/28/2022	1/28/2022	0
PD6 Decision to start commissioning and start-up	5/20/2022	5/20/2022	0
PD7 Decision to start performance testing	6/18/2022	6/18/2022	0
PD8 Decision to close project	5/16/2023	5/16/2023	0

Appendix 2. Applications with inputs and outputs in project delivery process

Input information source	Input	Process part Primary software	Output	Output information source
Compass	Sales documentation	1. Establishment, lotus notes	Project main schedule	Lotus Notes
Lotus Notes	Defined project dimensions (financial and product)	2. Engineering, comos	Engineering item details	Infor LN
Infor LN	Item details and project schedule	3. Procurement, Infor LN	Ordered item information (price, schedule, quantity)	Infor LN
Infor LN	Project breakdown structure and item details	4. Production, Infor LN	Schedule and planned purchase orders	Infor LN
Infor LN	Shipping plans, item details and project schedule	5. Logistics, VLS insite	Shipping documentation (schedule and contents)	Infor LN
Comos, LN infor	Installation documents and delivery schedule	6. Construction & Installation, Safran	Installation progress	Safran
Site worker	Installation progress	7. Comissioning & start-up, Omega pims	Information of succesfull start-up	Lotus Notes
Lotus Notes	Start-up or take-over certificate	8. Warranty period	Agreement of project closing	Lotus Notes

Appendix 3. Interview template

Interview of project delivery process control

Softare usage

1. What is the main tool/software to implement your tasks during the project delivery process?
2. Do you need to use another tool/software to enrich data to have necessary information?

Information flow

3. What is the input information to your tasks regarding project delivery? (attributes, columns etc.)
4. What is the source of input information (function/tool)?
5. How you handle and process that data?
6. What is the output information from your tasks regarding project delivery? (attributes, columns etc.)
7. How the information is reported to next steps/functions in the process?

Data-driven company

8. What is/are the target function(s) of the output information?
9. Do you think you have necessary information available easily to implement your tasks?
10. Is manual labor needed to collect the data/information to implement your tasks?
11. Do you feel that information is reliable?
12. Do you know the target in your work (financial, operational)?
13. Do you know the current values (regarding the target)?
14. Additional comments?

Appendix 4. Indicators' correlation table

Indicator	OTD	COPQ	HSE	R&O	PEM	NPS
OTD	1					
COPQ	-0,35	1				
HSE	0,15	-0,76	1			
R&O	0,18	-0,17	0,89	1		
PEM	-0,10	0,24	0,16	0,28	1	
NPS	-0,23	-0,26	0,04	0,11	0,35	1