DATA VISUALIZATION IN EATON NETHERLANDS BV

(Case Study: Eaton Industries Netherlands BV**)**

Undergraduate Thesis

Submitted to International Program
Industrial Engineering Department in Partial Fulfilment of
Requirements of Bachelor Degree of Industrial Engineering
Universitas Islam Indonesia

Arranged by:
Muhammad Fauzan Mahdy (16522177)

Supervisor:
Muhammad Ridwan Andi Purnomo, ST., M.Sc, Ph.D.

INTERNATIONAL PROGRAM DEPARTMENT OF INDUSTRIAL ENGINEERING FACULTY OF INDUSTRIAL TECHNOLOGY

UNIVERSITAS ISLAM INDONESIA

YOGYAKARTA

2020

AUTHENTICITY STATEMENT

For the sake of Allah, I confess this work is my own work except for the excerpts and the summaries that each of their sources has already been cited and mentioned. If in the future my confession is proved to be wrong and dishonest resulting the violence of the legal regulation of the papers and intellectual property rights, then I would have the will to return my degree to be drawn back to Universitas Islam Indonesia.

Yogyakarta, 17 September 2020

Muhammad Fauzan Mahdy

AUTHENTICITY STATEMENT

For the sake of Allah, I confess this work is my own work except for the excerpts and the summaries that each of their sources has already been cited and mentioned. If in the future my confession is proved to be wrong and dishonest resulting the violence of the legal regulation of the papers and intellectual property rights, then I would have the will to return my degree to be drawn back to Universitas Islam Indonesia.

Yogyakarta, 17 September 2020

Muhammad Fauzan Mahdy

THESIS APPROVAL OF SUPERVISOR

DATA VISUALIZATION IN EATON NETHERLANDS BV

THESIS

By

Name : Muhammad Fauzan Mahdy
Student Number : 16522177

Yogyakarta, August 2020

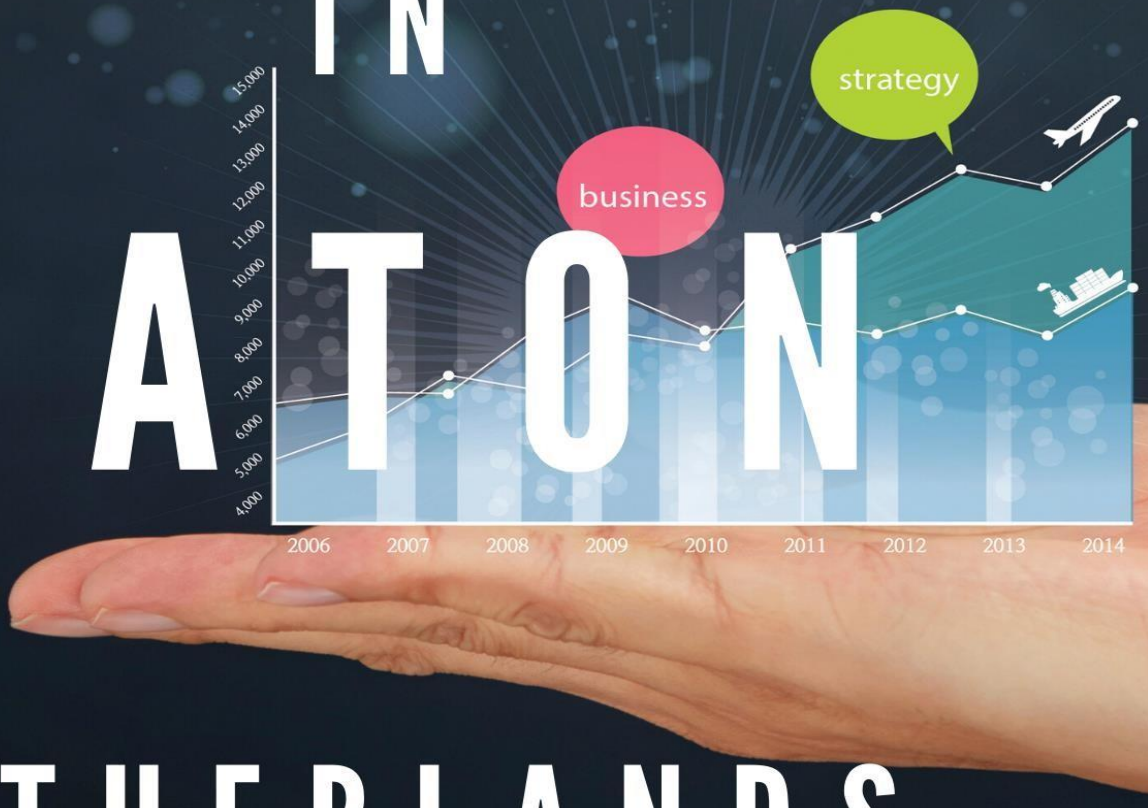
Supervisor

(Muhammad Ridwan Andi Purnomo, ST., M.Sc., PhD.)

Acknowledged by,
Head of Undergraduate Program Department Industrial Engineering
Faculty of Industrial Technology
Universitas Islam Indonesia

(Dr. Taufiq Immawan S.T., MM.)

DATA VISUALIZATION IN EATON



NETHERLANDS B.V

MUHAMMAD FAUZAN MAHDY

ENSCHEDE, NETHERLANDS
2020

DATA VISUALIZATION IN EATON NETHERLANDS B.V

Muhammad Fauzan Mahdy

COMPANY

Eaton Netherlands B.V
Hengelo, Netherlands

COMPANY SUPERVISOR

Erik Hogenkamp
Manufacturing Engineering Manager

UNIVERSITY SUPERVISOR

Jacques Bazen
Saxion Universityof applied sciences
School of Business Building and Technology

SUBMISSION DATE : 16 JUNE 2020

VERSION 1.0

This thesis was written as the graduation assignment of the Industrial Engineering and Management program at Saxion University of Applied Sciences in Enschede under the supervision of Mr. Jacques Bazen. The target audiences of this research are the employees of Eaton Industries Netherlands B.V. under the supervision of Mr. Erik Hogenkamp and the help of Mr. Steffan Sloot. Knowledge about data visualization, management information system, and data analysis is implemented in this research. In the end, the proposed solution of this research can be applied not only at Eaton Industries Netherlands and also other places in the world within Eaton Company.

The framework that is used in this research is based on the gap analysis theory on how to get to the future state considering the current state and the gap to be filled. Several things are discussed in this research, mainly the current state about the process of data visualization in the decision-making process, the problem they faced, and what data they need to make a decision. Then, the future state is discussed to know the gap to fill. After that, the question about what kind of technique can be used, how to design it to be effective, what are the cost and benefit will be analyzed and discussed. The researcher will find the conclusion and recommendations, and it will be written in the last chapter of the thesis. The graduation reflection is attached in the Appendix to cerebrate about the execution of the research.

Muhammad Fauzan Mahdy

Enschede, June 15, 2020

Summary

The company in which the research is done is Eaton Hengelo Netherlands B.V. It was founded in 1911 by Joseph Eaton in favor of the very first gear-driven truck axle. One hundred years passed by, and it became a company with over 21.6 Billion USD in revenue and approximately a hundred thousand employees in 175 countries around the world. Eaton has several business areas such as Electrical, Hydraulics, Aerospace, and Vehicle. Eaton Hengelo specifically handles the electrical product line as its main core business.

Eaton Hengelo has approximately 1061 to handle in its operations, and there must be a way to track and control those orders. On every product line, the staff from every contributing department has a meeting to discuss how the projects are going in the respective departments to control and track the progress. The problem with the meeting was the lack of data visualization and analysis and time-consuming preparation on the manual dashboard. The employee averagely spent 26 minutes preparing and update the manual dashboard with problems on the visual and the data. This dashboard is needed in the daily meeting, which means that every day the employee spent 26 minutes doing the same thing that could be done automatically. The data shown in the manual dashboard was not adequate as it is missing detailed data. The overview of all the projects was hard to understand at a glimpse.

The objective of this research is to increase the productivity of Eaton by developing digital data visualization techniques by increasing the effectiveness of the meeting with the digital dashboard. There are eight research questions in this research which are arranged using the Gap analysis framework. The research questions are mainly about the current state, future state, and actions to minimize the gap. The current state was the manual dashboard with all problems in it. The future state intended is a digital dashboard that is refreshed automatically with the latest data with overview, details data, and trend, and analysis.

The design has already been made using the human-centered methodology, with the development closely followed by the end-users. The final design was created with several iterations with feedback from the end-users. The current problems can be solved by using the digital dashboard that can be refreshed automatically while connected to the Eaton ERP system called Baan.

The implementation of the digital dashboard, according to Roger's theory of diffusion of innovation, would be easy. The digital dashboard looks and works almost the same with the manual dashboard only that it is automatic without human compromise. The direct link and query from the ERP system ensure that the data is the latest and valid.

The cost of the dashboard development and implementation can be compensated by the 26 minutes of the salary of the team leader spent on preparing and updating the

manual dashboard for about three and a half months. The recommendation for the company is to implement the dashboard and continuously improve the dashboard according to the end-user's feedback.

Table of Contents

1. Introduction

The introduction chapter of the thesis described the substantiation of the research and how the researcher conducted it.

1.1 Problem Definition

This paragraph will explain the description of the company, the problem happening there, and the scope of the research. The problem is defined with a gap analysis as the framework of the research.

1.1.1 Company Description

Eaton Industries was founded in 1911 by Joseph Eaton in favor of the very first gear-driven truck axle. One hundred years passed by, and it became a company with over 21.6 Billion USD in revenue and approximately a hundred thousand employees in 175 countries around the world. Eaton has several business areas such as Electrical, Hydraulics, Aerospace, and Vehicle. Eaton Hengelo specifically manufactures and assemble the electrical line of product. The vision of Eaton is "To improve the quality of life and the environment through the use of power management technologies and services" (Eaton, 2020). Eaton has companies all around Europe from every business area. Specifically, in the Netherlands, they have three sites, which are in Zaltbommel, Eindhoven, and Hengelo. Eaton Industries Netherlands B.V., which is in Hengelo, has a main business process of manufacturing and assembling electrical products such as power distribution, automation, and motor control, circuit protection, residential and light commercial buildings, and UPS (Eaton, 2020). The services in the company are divided and handled by two teams, which are the pre-order and post-order team. The post-order team is responsible for all the activities required after an order is made until the order is delivered to the customer. This research will be done in the post order services within the manufacturing and engineering systems department with all the staff who are dealing with the problem daily.

The organigram of the Eaton Hengelo can be seen below.

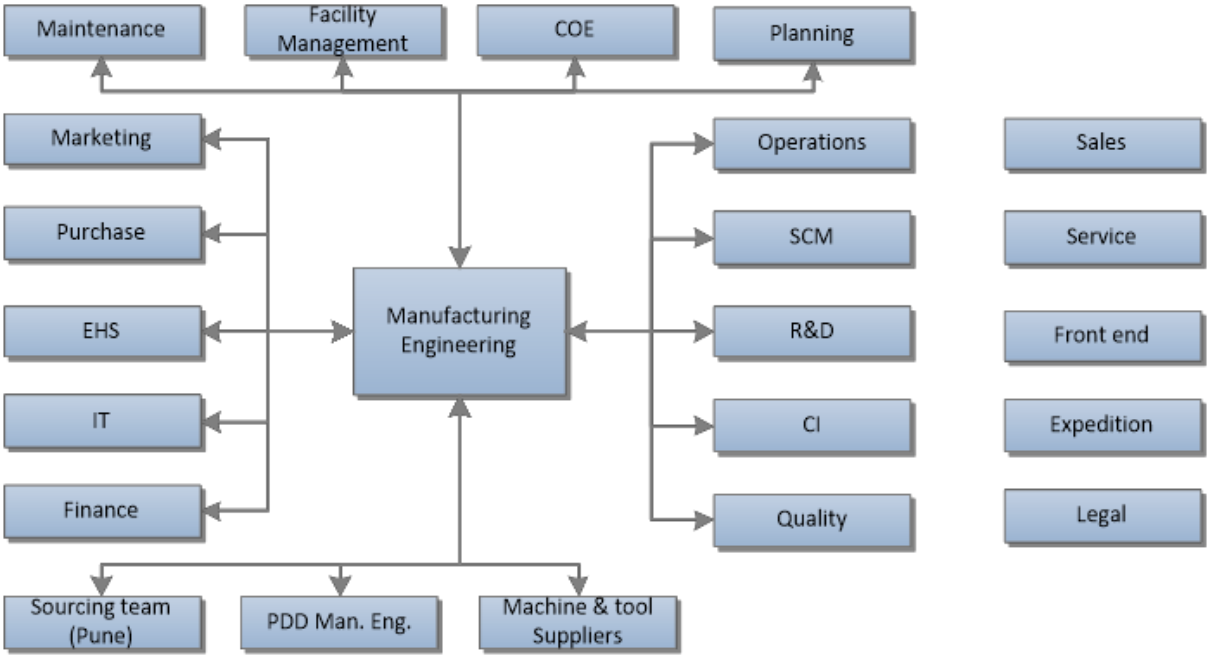


Figure 1: Eaton Hengelo Organigram

Table 1: Stakeholders abbreviation

Table of Abbreviations	
SCM	Supply Chain Management
CI	Continuous Improvement
IT	Information Technology
R&D	Research and Development
COE	Center of Excellence
EHS	Environment Health and Safety

1.1.2 Reason

The reason for this research was the initiation by the company to improve the way they do meetings, in which they are currently using a manual dashboard. This assignment is about investigating the problem(s) with the current one and find a better and faster way to visualize the data.

1.1.3 Problem Situation

Eaton has approximately 1061 orders to handle in its operations for a year as of 14 June 2020, and there must be a way to track and control those orders. The staff from every contributing department has a daily meeting to discuss how the projects are

going in the respective departments after an order was placed. The problem of the company is the lack of proper data visualization and analysis and time-consuming preparation on the manual dashboard that can be used in the operational, managerial, and even strategical decision making. Most of the data that are explicitly used in the meeting are presented in a physical form on the whiteboard. The problem that the staff faced in a session is that every project is represented in a small card approximately eight by 8 cm. It records the information about the project number, due date, and the date that it finished the stage as there are many steps in the project. There are chances of human errors such as the card has been misplaced or falsely written, which invokes doubts on the reliability of the data. Mostly, the projects that will be focused on are the overdue ones or the ones that are known to have a problem. If this problem continues to occur in every meeting, then valuable time is wasted, which can delay other tasks. If a problem occurs because of the misinformation in the meeting due to the card, then it would potentially lead to longer lead time, which eventually reduces the On-Time Performance (OTP) and may dissatisfy the customers. There is also no digital data visualization for the middle and top management to guide them in decision making. These tools to aid decision making has an aim to improve scores on the so-called "high five" of the company, which are safety, quality, delivery, inventory, and productivity (Eaton, 2019).

1.1.4 Scope and Preconditions

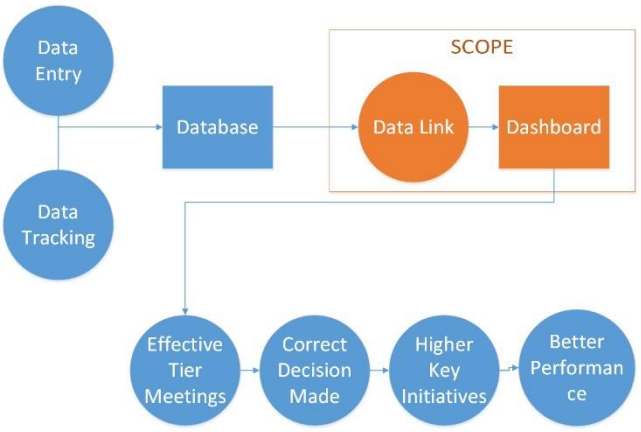


Figure 2: Conceptual Causal Model Decision Making with Dashboard

For this research, the scope has been defined below. The key aspects include:

1. Limited to the visualization of data to help stakeholders make decisions.
2. It only applies to the employees in Eaton Industries Netherlands B.V. in Hengelo.
3. It concerns the data extraction, design of the dashboard, implementing, and controlling.
4. This research will not include the design and construction of the database.

5. Due to time constraints, this research only focuses on the operational dashboard, with suggestions on how to design middle and top-level dashboard.

1.2 Objective

This research aims to increase the effectiveness of the decision making process in the orders project at Eaton Industries Netherlands B.V. by analyzing data and developing data visualization technique the decision-making process for every level of management, which may lead to improved key initiatives which include customer satisfaction, contract profit performance, and predictability. This research was set to be finished by the end of June 2020.

1.3 Research questions

"How to increase the effectiveness of the decision-making process in the orders project at Eaton Industries Netherlands B.V. by analyzing data and developing data visualization technique to improve key initiatives which include customer satisfaction, contract profit performance, and predictability by the end of June 2020?"

1.4 Sub-questions

This research was qualitative research on the area of data visualization as a decision-making aid. This research uses the GAP Analysis as the framework.

Current State:

1. What is the current process of data visualization as decision-making tools?
2. What is the problem with the current processes?

Future State:

3. What kind of data is necessary by the stakeholders to make the decision?

Actions:

4. What kind of digital data visualization technique can be used?
5. How to get reliable and valid data?
6. How to design an effective information flow aid by the dashboard?
7. How to implement and maintain the dashboard?
8. What are the costs and benefits of the proposed solution?

1.5 Description of the structure of the report

There are six chapters in this report starting from the introduction and finished with the conclusion and recommendations. Introduction, the first chapter introduces the

problem definition along with company description, reason, problem situation, and scope, and preconditions within one subchapter. The second subchapter is the objective of the research, the third one research questions followed by sub-questions in the next subchapter. The last subchapter in the introduction is the description of the structure of the report. The second chapter is the research design where all sub-questions are described: on how the data will be collected, the result, and theory applicable to it, followed by a discussion about reliability and validity. The next chapter is the substantive orientation, with an explanation of the theory used in this research. There are seven theories and one research reference to answer all eight sub-questions of this research. The fourth chapter consists of data visualization results which aim is to answer every sub-question with its applicable model or theory.
6 of 8 sub-questions are answered in this chapter. The last two sub-questions are answered in the next chapter named implementation and cost-benefit analysis. The last chapter is the conclusion and recommendations which conclude this study and give recommendations to the problem owner.

2. Research Design

This chapter describes the design of the research for every sub-question and a discussion on reliability and validity.

2.1 Sub-Questions Design

The research design explains the sub-questions, data collection method, result, and theory/model used. The design can be seen below.

Table 2: Research design

Research design table			
Research questions	Research & data collection method	Result	Theory / Model
1. What is the current process of data visualization as decision-making tools?	To describe the current process, the researcher distributes a survey for e mployees involved in the decision-making process (tier meeting and middle management). An interview is used to complement the data from the survey.	The current process of data visualization as a decision -making aid	Flowchart
2. What is the problem with the current processes?	To investigate the problem that occurred in the usage of data visualization, the researcher surveys emplo yees involved in the decision-making process (tier meeting and middle management). An interview and observation may be used as complementary.	Problem Over view	Fishbone diagram

Research design table			
Research questions	Research & data collection method	Result	Theory / Model
3. What kind of data is necessary by the stakeholders to make the decision?	To explore the required data by the stakeholders to aid their decision-making process, A survey is created for stakeholders who will use the future data visualization design from the tier meeting and middle management. An interview is done to complement the survey.	Digital Data Visualization Content	MoSCoW Prioritization
4. What kind of digital data visualization technique can be used?	Literature Analysis is used to find suitable techniques for data visualization that will help to make more effective meeting decisions.	The Digital Data Visualization designs	Human-centered Design Methodology
5. How to get reliable and valid data?	Literature Analysis is conducted to analyze how to get reliable and valid data to be presented in the data visualization	Data extraction method	Reliability and Validity
6. How to design an effective information flow aid by the dashboard?	Literature analysis is used to study how to design an effective information flow using the dashboard as the tools.	Information flow design	Flow Chart

Research design table			
Research questions	Research & data collection method	Result	Theory / Model
7. How to implement and maintain the dashboard?	Literature Analysis is used to formulate a plan to implement and maintain the dashboard over time.	Implementation plan	Diffusion of Innovation theory
8. What are the costs and benefits of the proposed solution?	Desk research is conducted in the form of cost-benefit analysis to calculate the cost of running and maintaining the proposed solution and also the benefits that the settlement gives.	Cost of running and maintaining the data visualization	Cost Benefits Analysis

2.2 Reliability and Validity

On the topic of validity, this research is based on information that is retrieved from multiple sources, such as surveys that can gather possibly more data from a more significant population of people at a faster rate. The researcher is sending the questionnaire to 12 stakeholders to ensure reliability. The response rate is 58 percent. Three personal interviews and 2 group interviews have been done to collect the data. The validity is ensured by using sources from peer-reviewed journals, as well as frequent discussions with the staff from Eaton to understand that the issues studied and designed are in accordance with the problems they experience. Respondents of both the survey and interviews are the employees that are dealing with the problem as a daily routine. This will ensure that their input is based on the real situation in the office.

3. Substantive Orientation

This chapter explains all the theories and models used by the researcher to complete the research. The theories and models are described below.

3.1 "Developing a Dashboard to Aid in Effective Project Management"

Borden, Murray, and Yorkos have researched the development of a dashboard for project management. They made a dashboard to monitor KPIs and gives alerts for the manager. The dashboard was made in SAS/GRAPH and SAS BI. The result of the research is an improved management tool to coordinate multiple projects effectively and efficiently (Borden, Murray, & Yorkos, 2008).

3.2 Gap Analysis

Gap analysis is a way of assessing the difference between the state "where we are" and the state "where we want to be." This analysis will help to identify the problems and develop a strategy to move the organization from the current state to the desired future state (Ball, 2020). This model is suitable for this research as the current state and future state of the situation can be determined in the beginning. Then, discovering the gaps can ease the problem identification and action formulation.

3.3 Flow Chart

A flowchart is a type of diagram that represents a workflow or process of events that any product or service follows. It can also be defined as a diagrammatic representation of the algorithm, a step-by-step approach to solving a task. This diagram is suitable to describe the current situation of the order monitoring activities in the research as it will systematically define the process (Bureau, 1995).

3.4 Fishbone Diagram

The fishbone diagram is a cause-and-effect diagram that can be used to identify the potential root cause(s) for a problem. It provides a structure for a discussion around the potential causes of the problem. Fishbone diagrams are often used in needs assessments to assist in illustrating the relationship among several potential or actual causes of the problem. This diagram is useful for research to identify the main ground of the problem (Ishikawa, 1976). This model is suitable for this research as it can be used to get the root causes of the problem to get a suitable solution.

3.5 MoSCoW Prioritization

MoSCoW prioritization is a framework for agile project management based on the dynamic systems development method. In this framework, all the project tasks have to be assigned by the importance. It ensures the efficiency of a task, feature, and functionality that has a certain deadline. This is useful for the research to decide

which data are essential for the stakeholders in the data visualization. (Saher, Baharom, & Romli, 2018)

3.6 Human-centered Design Methodology

Human-centered design is a methodology that is an approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques. It can be used in this research to design the interface and information flow on the data visualization to ensure that it can be used by people efficiently and effectively (IDEO, 2015).

3.7 Diffusion of Innovation Theory

Adoption of a new idea, behavior, or product does not happen instantly in a social system. It is a process whereby some people may adopt the innovation better than others. This theory will analyze how the new idea may be adopted by the society. This will help the researcher understands more about how to make the proposed solution be adopted and implemented easily (Rogers, 1983).

3.8 Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) estimates and totals up the equivalent money value of the benefits and costs to the community of projects to establish whether they are worthwhile. In order to conclude as to the desirability of a project, all aspects of the project, positive and negative, must be expressed in terms of a standard unit (de Rus, 2010). This analysis will be useful, particularly in this research, to decide whether the project is worth implementing or not considering the cost and benefits.

4. Data visualization results

This chapter explains the results of the research with its findings. Six research questions are answered in this chapter. The question about the current process of data visualization is answered using the flowchart method with data acquired from surveys and interviews. The overview of the problem was found using a survey and interview, which is translated into a fishbone diagram. The data necessary for the stakeholders is answered by using data from surveys and interviews, which subsequently prioritized using M.O.S.C.O.W prioritization. The digital data visualization technique, which resulted in the design of data visualization, was created with the basis of a literature review with the topic of Human-Centred methodology and benchmark. The question about how to get reliable and valid data is answered using a literature review on reliability and validity topic resulted in the data extraction method to ensure the quality of the data. The question about information flow design is answered using a literature analysis, which presented using a project management flowchart.

4.1 The current process of data visualization at Eaton Hengelo

Eaton has an ERP system called Baan, which compiles all of the data in the company in the form of a database. All data in the company, such as factory data and order management data, are stored in Baan. Although some information from order management is captured through SharePoint, it is later also incorporated into the Baan system. The flowchart for the current process of creating a manual dashboard as described below in figure 3.

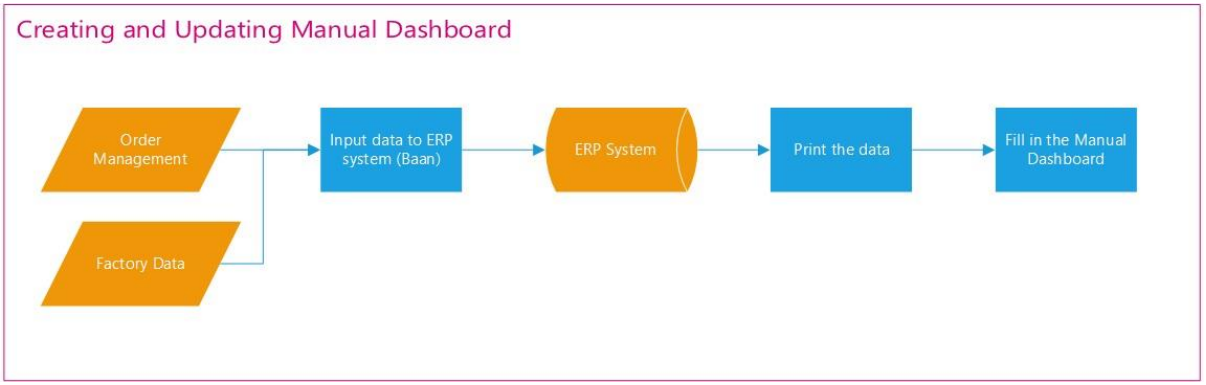


Figure 3: Creating and Updating Manual Dashboard Flow Chart

The flowchart of figure 3 consists of different colors and shapes. Orange with a parallelogram shape means that it is data. Blue rectangular means that it is a process, while an orange cylinder means a database or compilation of data. This overview of the process was gathered using interviews and surveys, which can be seen in appendix B for the interview transcription and appendix C for the questionnaire. The process starts with the data from Order Management and the factory data. This is

inputted into the Baan system. It is then stored in the Baan database until someone needs it. Then, it will be printed as a reference to make the manual dashboard. In the case of the first level of the dashboard, the data are filled in the cards and placed on the dashboard. Also, there is a kind of rule when the department has done their tasks; the employees responsible for the meeting should come to the dashboard and update it accordingly. According to the questionnaire (see Appendix C), as can be seen in figure 13, about the frequency of updating the dashboard, the dashboard is required to be updated every meeting, which is daily to ensure they get the latest data. According to Interviewee 1, there are no procedures on how to update the data. People are usually updating the data about the planning of the project when they have done the tasks. What Interviewee 1 usually does is print the data before the meeting and take it to the meeting room to update the manual dashboard. It took him about 10 to 15 minutes daily just to update the dashboard for every meeting. While according to Appendix C, figure 15, the number is rather different for everyone. In this research, the means of the data from the survey are used, which is 26 minutes.

4.2 Problem Overview

There are some major and minor problems in the current process of data visualization at Eaton. The input for the overview of the problem is gathered from surveys and interviews with the stakeholders, which can be found in Appendix B for the interview and appendix C for the questionnaire. The stakeholders defined as the end-users of the dashboard, which are the tier meeting team, team leader, and manager. Also, an observation of the daily meeting on the Xiria and LVS line has been done by the researcher to validate and gather more information about the method conducting the meeting, visual, and data needed in the dashboard for the discussion in the meeting. The problems explained in this chapter are the problems identified by the stakeholders while conducting the meeting. The essential parts of data visualization like dashboard are preparation means that the data must be reliable and valid; the method used to display the data needs to be effective. The visual is what people see to help them decide and gain insights into the current project.

The fishbone diagram of the problems can be seen below in figure 4.

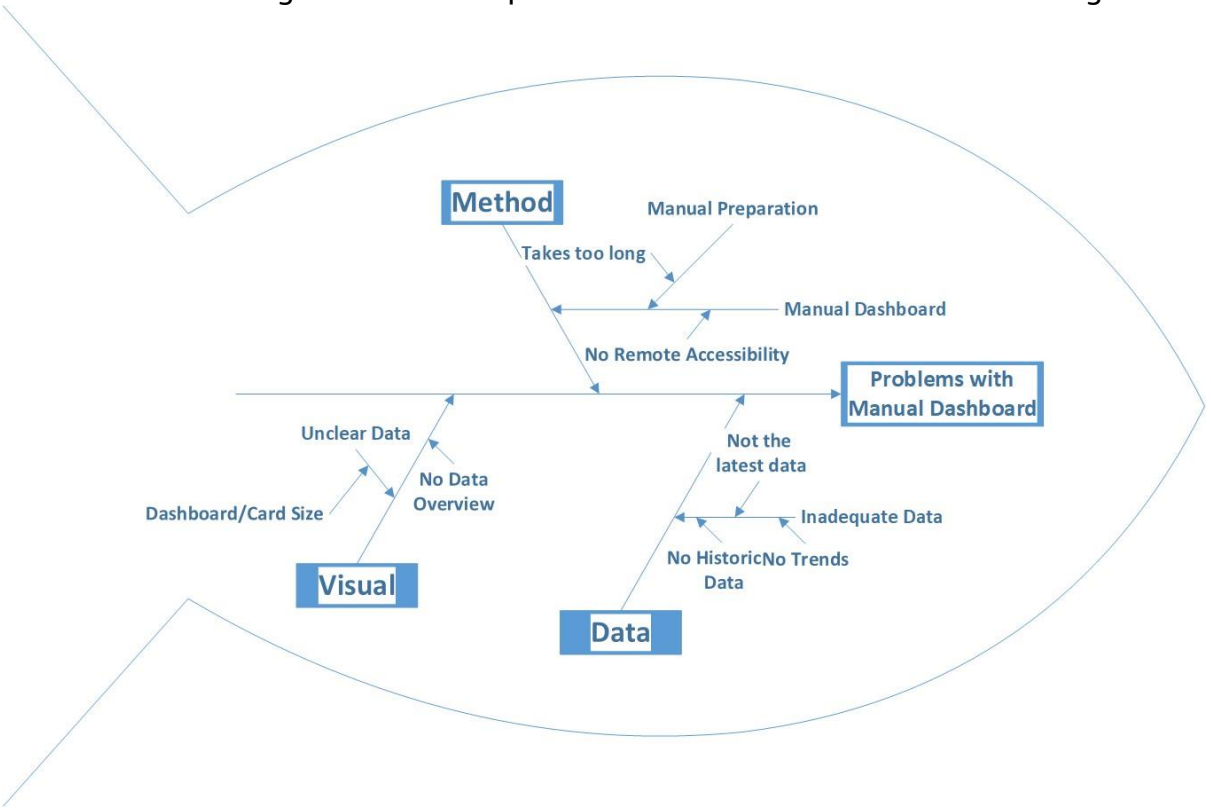


Figure 4: Fishbone Diagram of the problems with current Manual Dashboard

According to the survey result in appendix C table 9 and 10, there are some problems with the current manual dashboard, which categorized into three parts based on the method, visual, and data. The first category is the method. The major problem with the method is the manual updating of the dashboard. Firstly, the dashboard is manually prepared, which means that it takes a longer time. The employee needs to dedicate some time to prepare it as it is manual. This routine is done every meeting, which is daily. Secondly, there is no remote accessibility for the dashboard as it is physical.

The second category of the problems comes from the data itself. The data is not adequate to some extent, because the dashboard can only display the data about the planning date of the project, the project name, and value. Displayed data is limited due to the size of the card. Furthermore, there is no guarantee whether the reported data is the latest available data or not. Another issue was that every employee in the team meeting brings additional data from their own department regarding the technical issues and reasons for the delay in the execution of the project, as such information is not available in the Baan system. The current manual dashboard for the Xiria product line can be seen in figure 5. According to the group interview of the LVS meeting in Appendix B, there is no historical data at the moment, which might be useful in the future for trends and analysis.

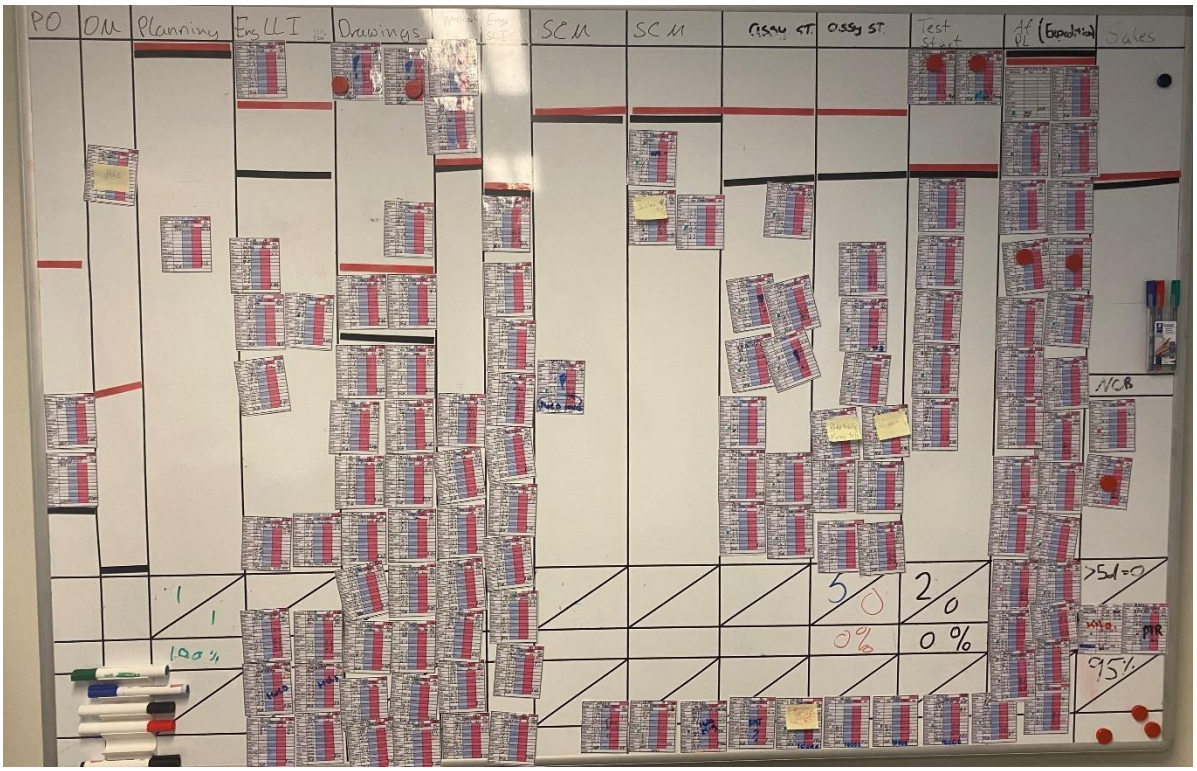


Figure 5: Xiria Manual Dashboard

In this dashboard, the planning for every project in every stage is tracked. According to Interviewee 1, the dashboard is only a guide for the discussion to find a solution to the problems that arise because not all the necessary data is included in the dashboard. Detailed planning of the project is needed in the meeting, which should be included in the dashboard as well. In the LVS (Low Voltage System) tier meeting, the dashboard includes drawings that are necessary for every project.

The third category of the problems is visual. The first problem is that the data is not clearly visible as the data is written on small cards. One needs to get closer to the dashboard to see the details on the card. Secondly, there is no overview of the overall picture of the project. Cards are stacked in the dashboard without knowing the figures like the total number of projects delayed or the number of projects that need to be done on that day of the meeting. There is a number without header, and sometimes the row for analysis on the bottom of the dashboard is covered by cards causing the number to be hidden.

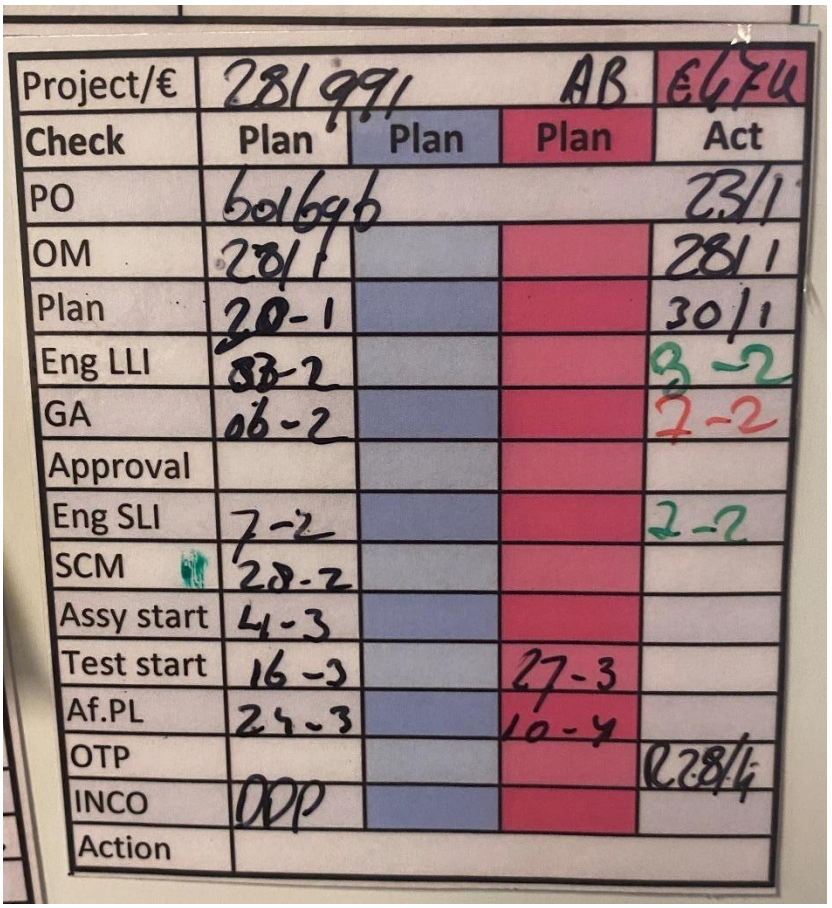


Figure 6: Card in the Dashboard

Table 3: Abbreviations of the department name

Table of Abbreviations	
PO	Pre Order
OM	Order Management
Plan	Planning
ENG LLI	Engineering Long Lead Time
GA	General Arrangements
Approval	Approval
ENG SLI	Engineering Short Lead Time
SCM	Supply Chain Management
Assy Start	Assembly Start
Test Start	Test Start
Af. PL	Ready Product Line
OTP	On-Time Performance

INCO	Incoterms

This means that all the members of the meetings must print some papers which will be wasted afterward. There are also problems with the visual of the dashboard mainly because the data cannot be seen clearly in the dashboard. It might be caused by the size of the dashboard or card, which makes the details of data become too small to be seen. There is no overview to compensate for this as making each time a manual overview would be too time-consuming.

4.3 Digital Data Visualization Content

This paragraph analyzed the data needed by the stakeholders to make decisions during the daily meetings, which result in the content of the dashboard. The inputs from the interviews, survey, and presentation from the company (which can be seen in Appendix B, Appendix C, and Appendix F), have been used to make a Moscow prioritization table. In this table, "must-haves" are key requirements, without which the service has no value. "Should haves" are important requirements that must be delivered but can be delayed for the future. The service will retain its value without these features. "Could haves" are useful requirements to have if the cost and time constraint allows it. "Won't haves" are not needed now, but could become necessary in the future (Kuhn, 2009).

Requirement	(M)ust Have	(S)hould Have	(C)ould Have	(W)on't Have
Planning data from every department (Planned date)				
Comment data for issues in the project				
Value stream overview				
Details about the project (Number, value, and INCO)				
Milestone data				
History or data log				
Data about the capacity of the factory				

Requirement	(M)ust Have	(S)hould Have	(C)ould Have	(W)on't Have
Trends data				
Remote Accessibility				
Indication of the project based on the task				

From the current manual dashboard, it can be inferred that the data about the value stream overview of all the projects within one product group is the most important part. The planning data and details of the project complete the overview. The planning data, value stream overview, and details of the project are a must-have as it is requested in the milestone proposal in Appendix F. The staff needs the data to track the progress of a project with its planning details and solve the issues that arise in the company. The trends data, milestone, history, and comments are data that are not available in the manual dashboard but can contribute to the meeting. As the result of the questionnaire in the Appendix C survey result on the table of answers on the most pressing problem, one of the most pressing problems for them is the lack of trends in the dashboard, history of data, and milestone. That is the reason why the trends are categorized as something that should be on the dashboard.

4.4 Digital Data Visualization Design

This paragraph explains the software that will be used and the design of the dashboard based on literature analysis. It is based on the human-centered methodology is used for the design of the dashboard. According to the outcomes of the literature analysis, which can be seen in appendix D, an exploratory study has been conducted to find software that mostly used in businesses for data visualization.

The researcher decided to use Power BI as the software tool to design and create the dashboard as, according to the observation of the researcher, Power BI is the software that is widely used in Eaton companies all around the world.

Power BI is an online service offer from Microsoft. It can display interactive dashboards that can be created and updated from many different data sources. The visualization of graphical information can greatly help the interpretation of complex data imported from the data source (Negrut, 2018).

According to the literary analysis in Appendix D, the construction of such a dashboard can be accelerated using user-centered design or human-centered design. It is also to ensure that the design meets the needs and desires of the end-users. There are four steps which are capturing the personas of users, translate the feedback from the user on what was essential for them to develop the dashboard and send it to users,

and then pilot testing. This framework is used in the creation of the dashboard. The process of capturing the personas will be explained in this section, and a description of what was important for the users can be found in chapter 4.3, in which the data needed is prioritized using MosCoW Prioritization. In this section, the first, the third and fourth step on the human-centered methodology is discussed.

4.4.1 Capturing the personas of the user

These personas are captured by the researcher by doing an observation while in the meeting to gain information about the common characteristics and needs of the user. These personas have been checked by the team leader of engineering.

Table 4: Personas of the users

Personas	Characteristics and needs
Department Appointee	- People assigned from each department to join the meeting to consolidate the project progress - People from different principal knowledge, such as finance, engineering, and supply chain. - Reporting issue they faced in their department - They need detailed data.
Team Leader	-Lead the meeting and discussion. -Set the target for people in the meeting. -Ensure the project goes according to the plan. -Need an overview of data. -Need dashboard as a tool to brings the meeting and discussion of issues.
Manager	-They do not go into the meeting. -Get a report from the team leader -They need an overview of the project progress. - Focus on the number of projects finished on time.

Every persona has different characteristics and needs, but they are aiming for the same goal in this case, which is to finish the project as planned. Department appointees are people who are assigned from their department to go to the meeting and discuss the issues faced in the project. They are going to the meeting and led by the team leader. This team leader ensured that the meeting and discussion go effectively with the help of a dashboard as a guide. Then, the team leader will report an overview of the progress to the manager.

4.4.2 Dashboard Design Development

The third step on the human-centered methodology is developing the dashboard and send it to the users. The researcher has already come up with the content of the dashboard. This sub-chapter explains how the design was created. The requirements for the dashboard are the value stream overview of data and details of the project. According to the digital data visualization content result from the previous subchapter. The slicer was added as functionality as the dashboard should be used for not only one product group. The heat-tree map chart was chosen as the visualization for the overview. It gives an overall look at how many projects there are in the company categorized by every department. Combining a heat map and a treemap chart gives the option to differentiate between the state of the project. Heat map enabled the data to be shown with the variation of colors to defined the state, which in this case, about the finished data that is overdue, today, or in the future. Treemap gives the ability to show the overview of data based on their category, which in this case, is the department with projects represented as blocks. In the overview page, there must be details of the project displayed under it, with data about project number, department, task, and finish date. The slicer must be there to select the appropriate product line and state of the project, whether it needs to be done in the future, today, or overdue. The second page of the dashboard is a drilled-down detail on the planning of the project includes the project number, department, task, and

start and finish date, which translated into a planning timeline. The first mockup of the design is as follows.

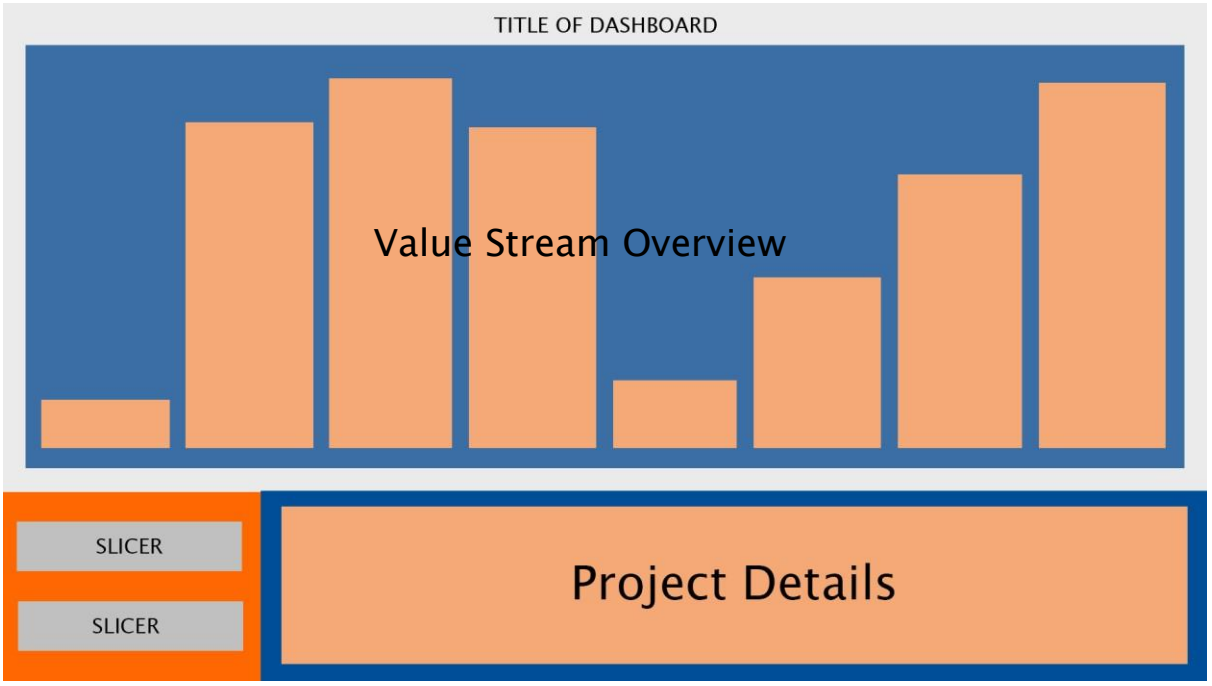


Figure 7: Mockup Design of the Dashboard Page 1

The Value stream overview became the most important thing in the dashboard takes the most space out of the report page. The project details show the project number, finish date, department, and task. The two slicers are located next to the project details to select the product group and state of the project.

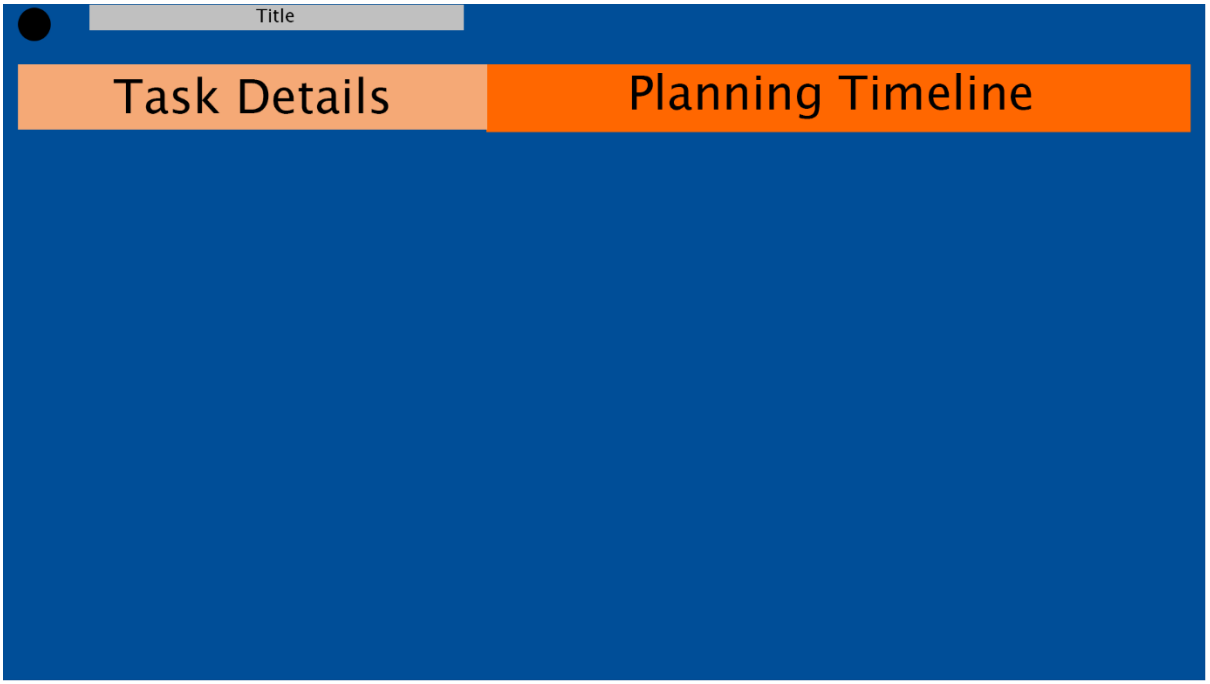


Figure 8: Drilled Through Mockup

The second page of the report is a planning detail for the task selected. The details include a project name, department, and task number. The planning timeline shows the start and finish date of the task within the timeline.

The researcher came up with the design, as shown in Appendix E. The Heat-treemap chart was chosen for the value stream overview to show the overall look at how many projects are ongoing. The ability to differentiate the color for a different state of the project enabled the users to focus on a certain project that needs more attention. The task or project is divided on every department with its respective state defined by the colors. On top of the stack of the task, there is a total number of projects/tasks within that day. The name of the department indicated by the code is located under the stack of the tasks. There are legends of the colors in the top-left of the heat-treemap chart and title in the center. The card under it, which gives the details of a task, shows the project number, department, task, and finish date.

Then, the design was sent to the end-users to gather feedback. There are several feedbacks on the dashboard design 1.0.

There are some feedbacks on the meeting and interview that are in Appendix B on the presentation of 1.0 dashboard and interview of Erik Hogenkamp, the manager of engineering. The first one is to change the department name to the description or name of the department. This will ease and clarify the overview rather than just the number shown. This department name should be arranged according to the value stream in the company, according to Appendix F. The second feedback is to include the comment box and trend analysis page. The third one is to improve the dashboard visually by making a darker background and inserting the logo of Eaton to personalize the dashboards towards Eaton company. The final design of the dashboard consists of three pages, which are the overview page, drill-through planning page, and the trend analysis page. The design can be seen in Appendix G. There are some changes to the final overview of the dashboard. The background is now darker, department name is sorted based on the proposal, and the Eaton logo is now incorporated in all pages. The comment box can be seen in the planning details on planning per project or department, which enables the end-users to input and see the comments on the project. Lastly, there is a dedicated page for trend and analysis, which now served to display the total project per product group to see the workload of the factory.

4.5 Data Extraction Method

This subchapter explains the process to ensure data quality in the extraction and creation of the dashboard. The data quality depends on the sources of data, which, in this case, is the Baan in Eaton. The data quality within the Baan itself is outside of the scope of this research. This subchapter, therefore, only discusses and analyzes

the steps to retain or improve the data quality while it was transformed into the dashboard.

According to a literature review in Appendix D on the preliminary study on data quality in the ETL process and ETL best practices for data quality, both agreed that to get the highest quality of data in the dashboard, it has to go through ETL processes. ETL stands for Extract, Transformation, and Load. There are several processes that can be used to get the highest quality of data, while some of them are not applicable to the dashboard creation. Firstly, the whole process is described below.

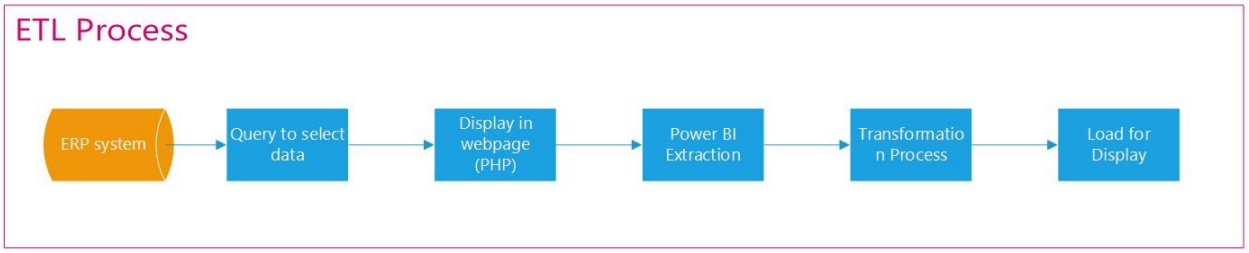


Figure 9: ETL Processes

The query and displaying process in the webpage are done by the company IT department. The extraction link is done by Power BI using the connect data function from the webpage. Therefore, the predecessor steps from Power BI extraction are not discussed in this subchapter.

The transformation process in the creation of a dashboard includes the elimination of syntax inconsistency or adaptation of data types, separation, and the combination of attribute values and aggregation. All the data are adapted to its data types to ensure that the dashboard shows valid data types to show the information. The adaptation of data types includes the data about date, number, and text. Secondly, separation and combination of attribute values, the date is separated into the day, month, year, and a quarter to show the user if they need to filter on a certain month, year, or quarter. The third process is aggregation, which is shown in the dashboard with the SUM function on total projects.

There is also a transformation process that is not mentioned in the literature but requested by the user, which is to label some of the data. It can be seen in Appendix B on the presentation of the 1.0 dashboard. Therefore, a query is done to label the department name accordingly.

The table for the labeling of department names can be below.

Table 5: Department code conversion

Department Code	Description
21Z	Sales support
42K	Exit
A01	ATO_Assemblage_Primair
A02	ATO_Assemblage_Secundair
A03	ATO_Keuring
50T	Magnefix_SCHEMATEKENEN
X15	UIT DIENST 2015
55P	SER_Mechanical Engineering_LV
55S	Exit
55T	Exit

There are more than 600 records of department codes. The transformation is done by making a relationship between the department code in the planning data to the department code and description in the statistics data. The data can be refreshed by using a schedule, for example, before the meeting to ensure the latest data is displayed.

By doing this transformation process, the data displayed in the dashboard retain validity and reliability. The validity means that the data shows as intended; for example, the project planning shows according to the planning for that specific project. This transformation process is repeated every time the data is refreshed, meaning that every time, the data will produce the same level of data quality, which increases reliability. The data is extracted directly from the Baan, meaning that there is no human compromise in the process, which can ensure that the data is not changed for the one benefit.

4.6 Information Flow Design

This subchapter explains the proposed information flow design for the company to support the digital dashboard. It will be based on two pieces of literature, which can be found in Appendix D with the title Information flow problems and causes and Improving information flow with web services. The result of this subchapter is a flowchart of the information flow.

According to the literature review, there could be several problems in the information flow. The problems mentioned are: not understanding the big picture, missing information provision, and information distortion. These problems about lack of

awareness and missing information provision can be easily solved with a daily meeting. People gather to track their progress and plan the tasks that need to be done. Feedback can be given, and information is shared through discussion. Information will not be distorted as the information is discussed directly with the members of the department. But there is a need for a data visualization to aid the meeting to effectively share the data. Based on the literature about information flow with web services, there is a framework that can be used to improve the efficiency of specifically a planning system with web services. The improvement in connectivity enables the system to be accessed remotely and easily. With the guideline of the framework from this literature, an information model is created, which can be seen in the figure below.

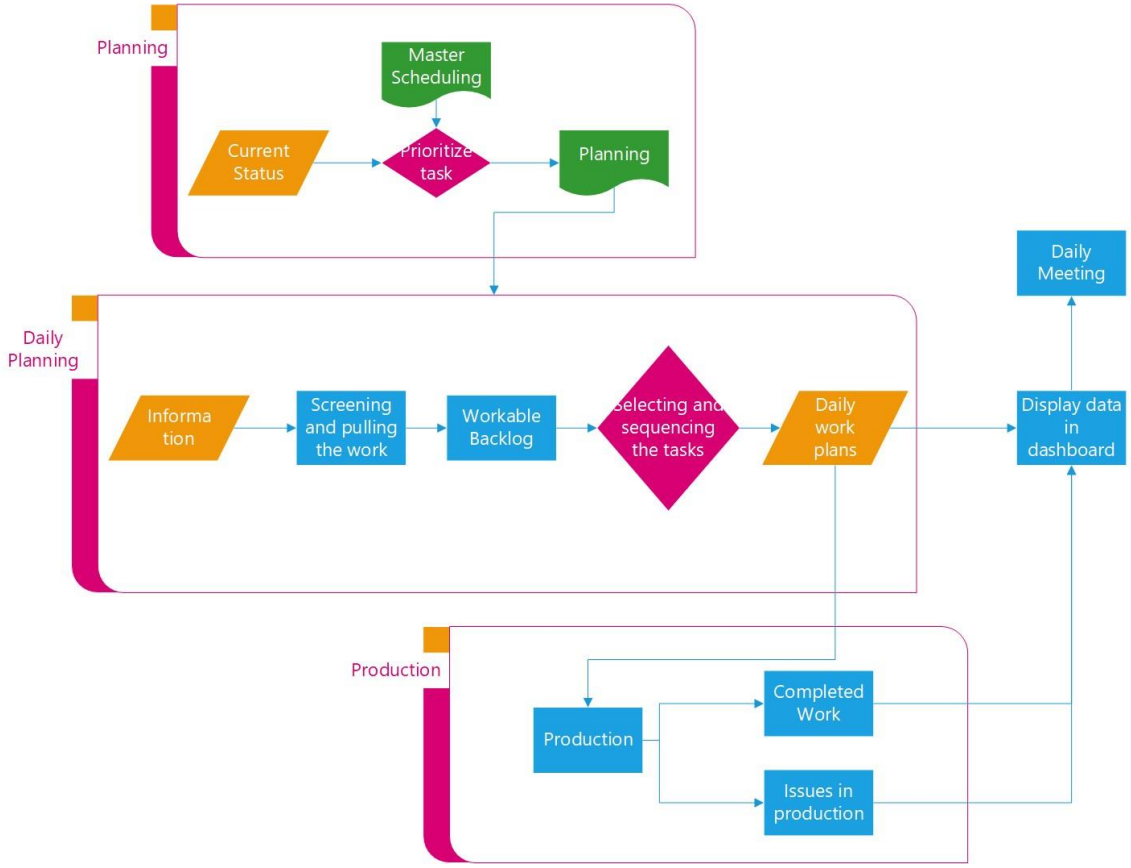


Figure 10: Information flow framework

The color and shape in this flowchart represent its function. The orange parallelogram means that it is data, the blue rectangle represents a process; purple squares represent a decision, while the green shape is a document. The information flow is started with the current status and master schedule that is stored in the ERP system. The task then prioritized and became planning. Information about the current capacity is used to screen and pull the work and workable backlog to select and sequence the tasks. It then became a daily work plan. The daily work plan is used in production. The completed work is updated, and issues in production are sent to the system. The data from daily planning and production is then displayed on the

dashboard. The dashboard is used to discuss issues and the progress of the project at the daily meeting. By using this framework, all of the data goes through the system without the compromise of people, and all of the people can see the data. Information distortion is minimized as the data given to all people is the same. Issues in production can be seen directly in the dashboard without having to explain it in the meeting, and it is recorded in the history of the system. This history then computed for the trends and analysis required by the end-users further in the development. It cannot be done now in the design of the dashboard as the history needs to be stored first.

5. Implementation plan

The implementation plan is divided into four sub-chapters which are objective, organization, planning, and cost and benefits analysis. This implementation plan explains how to implement the dashboard based on the theory of diffusion of innovation with the data from the literature review in Appendix D, a multi-site case study using diffusion of innovation theory and the book of diffusion of innovations by Rogers.

5.1.1 Objective

According to the multi-site case study, there are two reasons why the implementation will be successful, namely the tension for change and slack resources. The tension for change is the tendency for people to accept the change because they really want it. In the case of the digital dashboard, it is supported by the survey result in Appendix C with the figure of a survey on the need for a digital dashboard. The second reason is the slack resources, which means that the time freed up by the introduction of the new system can be used for other tasks that they really need to do.

The velocity of innovation acceptance is dependent on five innovation characteristics. The table of innovation characteristics, description, and analysis of the case is presented below.

Table 6: Roger's diffusion analysis

Table of Roger's Diffusion of Innovation analysis		
Characteristics	Description	Analysis
Observability	The degree to which the results of an innovation are visible to potential adopters.	Score: + The innovation can be observed in the daily meeting later after the deployment.
Relative Advantage	The degree to which the innovation is perceived to be superior to current practice.	Score: + The digital dashboard retains all the functionality of the manual dashboard, and gives additional features that allow it to be automated, shows the latest data, least

		maintenance, and remotely accessible.
Compatibility	The degree to which the innovation is perceived to be consistent with socio-cultural values, previous ideas, and/or perceived needs.	Score: ++ The new dashboard is almost identical to the ideas of the manual dashboard; therefore, the compatibility cannot be doubted.
Trialability	The degree to which the innovation can be experienced on a limited basis.	Score: + The development of the dashboard is closely followed by the end-users, and the prototype has been shown to the users as a trial.
Complexity	The degree to which an innovation is difficult to use or understand its simplicity.	Score: + The new digital dashboard is simpler as it shows data without requiring the users to set up or update it manually.

According to the analysis above, the digital dashboard should be accepted by the end-users easily as the product is created and designed from the input of the users using the human-centered methodology. The communication channels that will be used are interpersonal channels in the daily meeting. The digital dashboard will be explained on how to use and the features of it. The feedback from the users can then be gathered for further development. The other way to saturate the adoption to a healthy point is by doing re-invention as the implementation process goes along (Rogers, 1983).

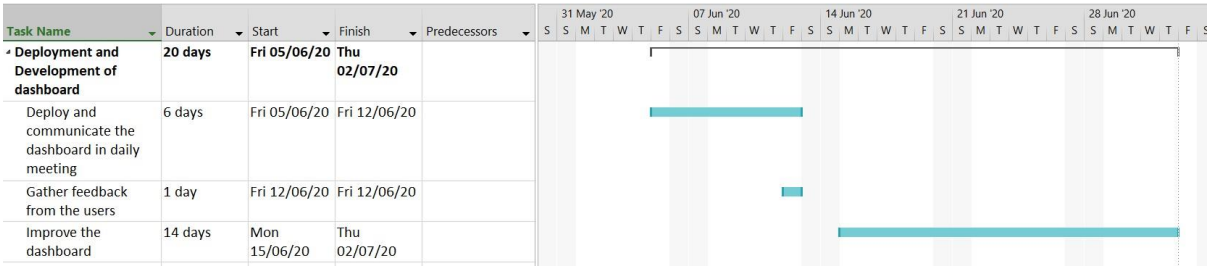
5.1.2 Organization

There are some key stakeholders that are needed to implement the dashboard. The first one is the manager who has the authority to approve this kind of project both financially and in the level of decision making. The manager must be convinced that the new digital dashboard brings benefits to the company, which will be discussed in the cost-benefit analysis. The second stakeholder is the team leader who runs the meeting using the dashboard. These team leaders need to be given the knowledge

on how to run, maintain and debug the dashboard. The team leaders then can spread their knowledge to other team members as they are the ones who oversee the meeting and discussion.

5.1.3 Planning

After assessing the potential of acceptance and the people that will implement the dashboard, scheduling is created to deploy the dashboard. It also includes a plan for development. The schedule is described in the figure below.



Task Name	Duration	Start	Finish	Predecessors
Deployment and Development of dashboard	**20 days**	**Fri 05/06/20**	**Thu 02/07/20**	
Deploy and communicate the dashboard in daily meeting	6 days	Fri 05/06/20	Fri 12/06/20	
Gather feedback from the users	1 day	Fri 12/06/20	Fri 12/06/20	
Improve the dashboard	14 days	Mon 15/06/20	Thu 02/07/20	

Figure 11: Implementation and development schedule

The dashboard will be deployed on the fifth of June. On the first day of the deployment, the researcher will explain the digital dashboard, its features, and how to use it. One week from the deployment date, the researcher will gather feedback from the end-user to further develop the product. The researcher will then develop the digital dashboard for two weeks and will be resulting in a new version of the product that will align more with the end-users.

5.1.4 Cost Benefits Analysis

The cost-benefits analysis is a part of the implementation plan where the expenses and benefits of implementing the system are analyzed. This analysis will assess if the project is worthwhile or not financially. Some of the benefits can not be quantified in currency, such as less frustration among the staff because of being busy with repetitive types of work. Overhead costs and indirect costs are not mentioned here, neither the rent and utilities, these are considered fixed for the company. The table of the costs and benefits of the project can be seen below.

Table 7: comparison of costs and benefits

Costs and benefits comparison table		
Components	Cost	Benefits
Direct Cost		
Display Media (Samsung UHD display 65 Inch 4K)	EUR. 679 one time.	
Hiring designer to build the dashboard	EUR. 468 one time.	
Benefits		
Slack resources		EUR. 38 per hour
Automated (Scheduled refresh)		Bring the latest data in second with no compromise by humans.
The lower workload for team leader		The team leader does not have to worry about preparing and validating the data in the dashboard.

Table 8: Breakeven point calculation

Breakeven point calculation table		
Component	Calculation	Result
Cost savings	26 minutes / 60 minutes * 38	EUR. 16.47 per day EUR. 82.35 per week EUR. 329.4 per month
One-time cost	679 + 468	EUR. 1147
Breakeven	1147 ÷ 329.4	3.48 months

There are two direct costs of implementing the dashboard. Based on the quotation in fiverr.com, which is one of the online media which provides services, for a Power Bi dashboard like the researcher have designed, it will cost 468 euro. This cost is based on if an external service is procured to make the dashboard. The price of Power BI is

not taken into account as it already used in the Eaton environment. As listed in the online marketplace for electronics named Mediamarkt, the price for a display media with 4K resolution and 65 inch in size is 679. There are some benefits of implementing the digital dashboard. The first one is that the team leader can be doing another job for that half an hour, meaning that the company may save half-hour of salary daily. It is about 16.47 euro saved every time the team leader does not have to prepare the manual dashboard as calculated from the 26 minutes taken multiplied by the base salary per hour, which can be in the form of fewer overtime costs. The digital dashboard is automated, meaning that the latest data is assured without the compromise of human in the preparation. Also, because the team leader does not have to prepare and validate the dashboard, the workload may be decreased, resulting in less stress and more productivity. They can focus more on the meeting and discussion.

6. Conclusions and Recommendations

The conclusions and recommendations chapter will answer every sub-question in this research and recommend some action to be taken for Eaton company. The conclusions are as follows:

1. The current process of data visualization in Eaton company basically involves the data to be taken from the Baan, and then it is printed. The team leader then spent 30 minutes preparing and update the manual dashboard, which is a bunch of cards with project details stick on the dashboard.
2. The problems with the current processes are divided into three categories. The first one is the method with the problem with manual preparation that takes too long, use paper, and there is no remote accessibility. The problems with data are not getting the latest data, inadequate data, no trends, and no historical data. The problems with visuals are the data is unclear, the card size is too small, and there is no overview of data.
3. There are 3 data that are necessary for the stakeholders. Firstly, the project details, including the project number, value, state of the project, whether it is due, must be done today or in the future, and INCO terms. Secondly, the planning details on every task in the project. Lastly, the trends and analysis of the performance.
4. The digital data visualization technique that can be used is Power BI by Microsoft that gives the ability to design the dashboard according to the specifications of the end-user.
5. How reliable and valid data is acquired is insured by the data extraction method. The ETL process cleans and transforms the data to prepare it for the dashboard.
6. The proposed information flow is designed with the help of a dashboard to display the data. The data from the master and daily planning is compared to the data from production to give information on the dashboard.
7. The digital dashboard has a lot of similarity from its predecessor, which is the current manual dashboard such as the data, the purpose, and the flow. According to Roger's diffusion theory, it could be easily accepted. The scheduled plan has been created in the implementation plan.

8. The cost of acquiring the display and hiring the designer for the dashboard can reach a breakeven point in only three months. Also, the benefits on the less workload and having a dashboard that is always showing the latest data is a major plus, which can result in higher productivity.

The company is recommended to implement the digital dashboard to increase the efficiency of the company. The dashboard must be continuously improved to better serve the purpose and adapt to the end-user requirements, which can change over time. The future direction for the company is to automate the data feed from the production and machine so that the dashboard can be real-time.

Bibliography

Ball, J. (2020, March 3). Gap Analysis. Retrieved from ProjectManagement.com: https://www.projectmanagement.com/wikis/233055/Gap-Analysis

Borden, P. M., Murray, M., & Yorkos, A. (2008). Developing a Dashboard to Aid in Effective Project Management. SAS Global Forum, 1-13.

Bureau, C. Q. (1995). Philips Quality Memory Jogger. Methuen: GOAL/QPC.

de Rus, G. (2010). Introduction to Cost-Benefit Analysis: Look for Reasonable Shortcuts.

Eaton. (2019). Post Order KPIs. Eaton.

Eaton. (2020, March 2). About Us. Retrieved from Eaton.com: https://www.eaton.com/nl/en-gb/company/about-us.html

Eaton. (2020, March 2). Global Leader in Power Quality - Eaton Electrical. Retrieved from Eaton: http://www.eaton.nl/EN/nederland/Productenoplossingen/Electrical/index.htm

IDEO. (2015). The field guide to human-centered design: design kit. San Fransisco: IDEO.

Ishikawa, K. (1976). Guide to quality control. Tokyo: Asian Productivity Organization.

Kuhn, J. (2009, November 4). Decrypting the MoSCoW Analysis. DITY Weekly Newsletter. iTSM Solutions LLC.

Negrut, V. (2018). POWER BI: EFFECTIVE DATA AGGREGATION. Quaestus.

Rogers, E. M. (1983). DIFFUSION OF INNOVATIONS. London: Collier Macmillan.

Saher, N., Baharom, F., & Romli, R. (2018). A Review of Requirement Prioritization Techniques in Agile Software Development. Knowledge Management International Conference, (pp. 242-246). Sarawak.

Appendices

Appendix A Graduation Reflection

The sources of resources in this report are coming from reliable sources with a valid topic. Most of the journals are peer-reviewed. In the process of doing the research, there is some choice I am confronted with, whether to create a dashboard that is really different from the current dashboard or making something that looks similar but better. I chose to make it similar to the visual reworked so that the dashboard can give more useful information. The reason behind this is that people might be too familiar with the current dashboard, and sudden changes might not attract them. I would make the same choices if I had to do the research again, but only, I would focus on things that really matter to the end-users. Feedbacks from them are helpful in the design phase of the dashboard and ensuring the dashboard is suitable. All the research questions have been answered in this research. Although some could have been explained deeper, due to the situation and time limitation, it cannot be done. The coronavirus stopped all the daily physical meetings, which made it hard to observe directly. The research is set up objectively as the researcher gain the information from the end-users, which are not only the team leader but also the members of the team. This ensures that the opinions are not one-sided. The research result should satisfy the client as the design phase is closely followed by the company and the employees, which will be the end-users. In professional practice, the researcher wants to improve the system as simple as the meeting and data visualization, which has to be supported in order to increase productivity. I am satisfied with the way I carried the researcher, although there are some parts that need to improve next time. Firstly, the planning stage of the research should be done quickly, and gathering information for preliminary knowledge could be done better by interviewing a lot of people. Secondly, the collaboration between the IT department and me could be done sooner so that the data can be ready faster, which would accelerate the development of the dashboard. There are some aspects that are explored and connected in this research, mainly business intelligence and operational management. The insight and knowledge from business intelligence can support operational management on how to plan with less error margin and how to run the production efficiency, which contributes to the overall productivity of the company.

Appendix B Interview

Stef Schulte, Engineering Team Leader – 7 May 2020

Interviewer: Hello, in this interview, I just want to have further information from the questionnaire I sent you. The first question about the current process of the making of the dashboard. Are you getting every data from the ERP? Is there anyone who is tasked to update or replace the cards on the dashboard or just people collectively updating the dash?

Interviewer: What is the procedure?

Interviewee: Rules? Because it was already for me about three months ago, the process was more or less like if the person before was complete and depending on if a project needs to be started today and of course if there is which I forgot or are not on my list, it always stays in the bottom and also if I forgot to place a call to the next station. He should be aware of this. It is normal in his job list, you should be identified there, but if he is not using such a kind of this. He is just using the cards like this dashboard, but they also have a list of their own.

Interviewee: One way of getting all the information to get to you and maybe also showing information in a different way beneficial for them.

Interviewee: Yeah, it could be. What is the best thing about the decision was not the dashboard, but the team is meeting together. The discussion that everybody is aware of the issue in each department on a quick base issue.

Interviewee: The best way to do it and the board was for me. I realize more than 10 to 15 minutes to put it. It is the right tool to keep the guys on the right path. To show it to other people that I have it under control, and I need to have a way to explain it.

Interviewer: What kind of data do you need in the meeting?

Interviewee: You can refer to the presentation about the milestone proposal that I sent you.

Group Interview LVS Meeting – 11 May 2020

The LVS dashboard is quite similar to the Xiria dashboard, although it is bigger as we often put drawings on the card to understand the project quickly. Compared to the xiria dashboard, we divide the task between per week, which means it is divided into three categories, which are overdue, this week, and next week. The most important thing for us is the drawings and planning of the project. It is better if there is a comment box on the dashboard and has a history of the comment to track it later in the future.

Ronnie Damink, MES team leader – 11 May 2020

Interviewer: I have some questions regarding the dashboard manual. The first one is, is there someone assign to update the dashboard, or is it like every people in the team has the responsibility to update the dashboard?

Interviewee: Everybody in his own discipline has to update the dashboard. So, everybody is assigned to his own task. Not everybody can update every field of expertise.

Interviewer: So, if you are from the planning department, and then you can only change what is in your department.

Interviewee: I am coming from engineering, so I update the dashboard concerning the engineering activities and the same for other fields.

Interviewer: On the Xiria meeting, they bring their own list of data from their department, for the example supply chain. Is it also happening in the LVS meeting?

Interviewee: Yes, of course, a lot of information is available in Baan. As I understood in the future, we are planning to make a digital dashboard with a direct connection to Baan.

Interviewer: I am asking if they are bringing their own data because it has more details compared to the dashboard or because the data is different from the dashboard.

Interviewee: you see in the practice; you always have issues. To discuss those issues and to solve those issues, you need meetings, and that is the reason we have them. If you are looking at the planning, if they are behind or not, at least there is something you can see in Baan directly. But you have to get people together in the meeting to discuss the issue and come up with actions at the end. The strong points of monitoring in the future should be that you can see the planning and discuss the day after the last meeting.

Interviewer: Yeah, it is like looking for the history of the project. I am wondering, so the data needed is basically the data on the dashboard now so as the date and details data from every department.

Interviewee: What you get from the ERP is only planning data, and in the real world, you have technical issues and reasons why the planning is late or should be changed. That data is not available in the ERP.

Presentation of 1.0 Dashboard – 15 May 2020

The feedback from this presentation is to change the dept numbering to a label of the department name. The dashboard 1.0 needs some changes regarding the design, which needs the comment box to further facilitate the meeting and figures for trends and analysis. It would be better for the user to have the ability to get the planning per project and per department.

Erik Hogenkamp, Manager of Engineering – 28 May 2020

Erik Hogenkamp has given some feedbacks regarding the dashboard design 1.0. He asks to set the background color to be darker to attract end-user so they can focus on the content. Also, the visualization of the dashboard could be improved with the personalization of the Eaton company, like the logo or picture of the company. The functionalities like the comment box could be added and a page about trend and analysis. Lastly, the department name should be arranged according to their position in the value stream.

Appendix C Survey Result

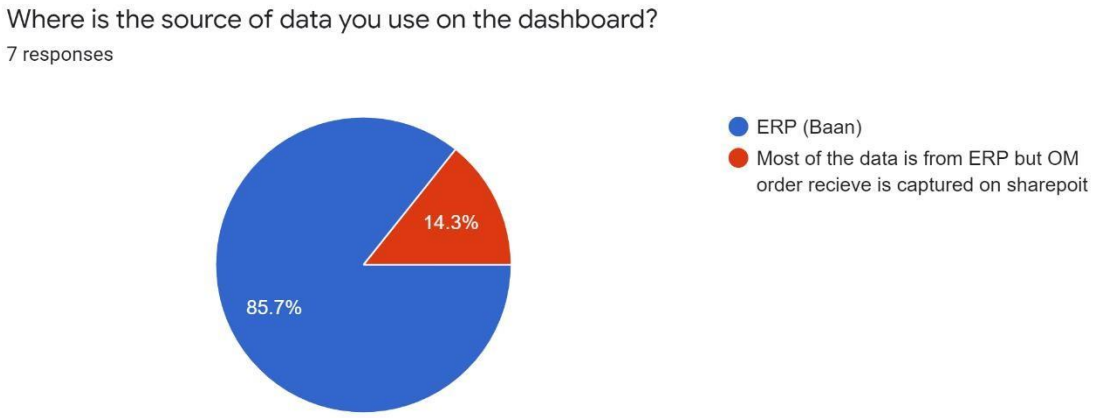


Figure 12: Question about the source of data

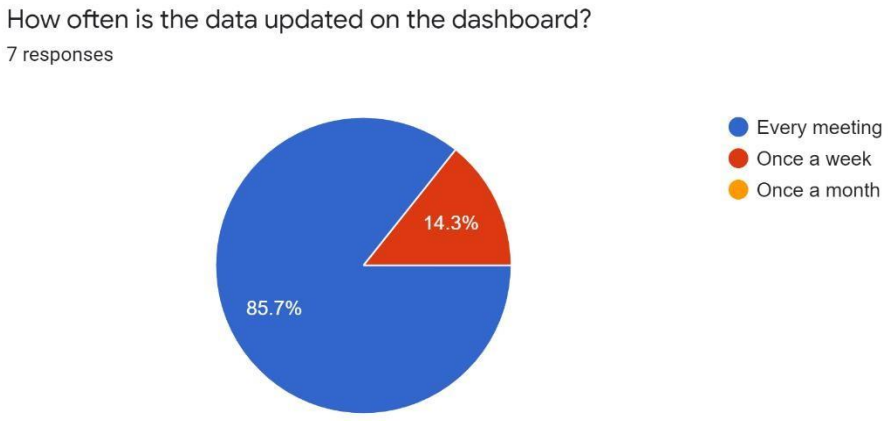


Figure 13: Frequency of updating the dashboard

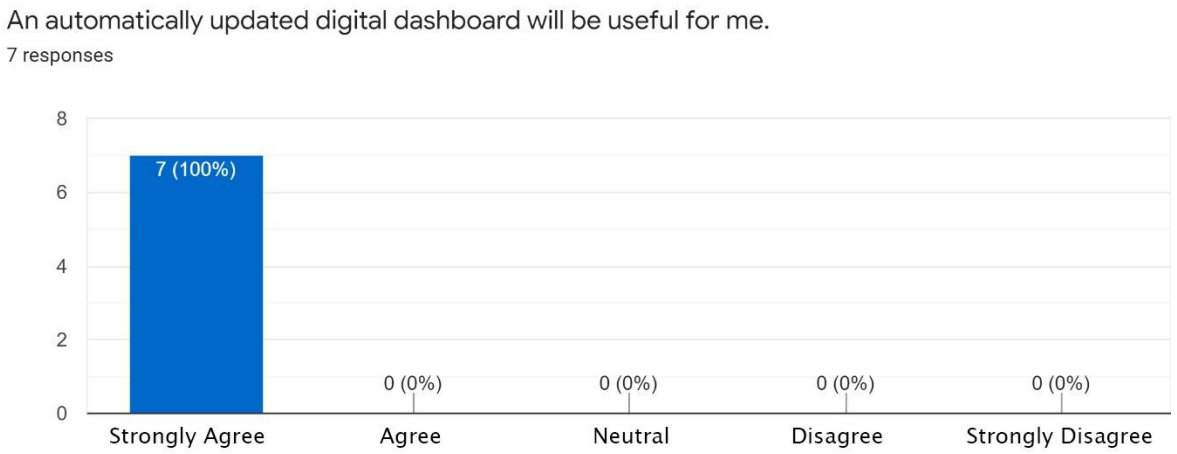


Figure 14: Survey on the need of the digital dashboard

Table 9: Problems on accuracy and reliability

Table of Answers on Accuracy and Reliability	
No	Why is the dashboard not accurate and reliable?
1	Please are not following the corrected that what which reflected the actual status
2	Filling the board is handwork. History is gone.
3	Can't see trends or reasons
4	Someone did not update their data in time
5	N/A
6	In the manual version, the cards are not 100% filled and maintained

Table 10: Most pressing problems

Table of Answers on Most Pressing Problems	
No	Most pressing problems with the current dashboard
1	Lack of good overview without a lot of details.
2	Filling the board is handwork. History is gone.
3	Missing trends and the reason why something is late.
4	it is not accessible remotely, and information is not captured for later analysis

5	We do not stick to the issued schedule planning
6	The time spent by the team members to update the board (a manual process)

Figure 15: Time spent to prepare the manual dashboard

Appendix D Literature Review

Data visualization software Literature Review

Research Article	Data Visualization: an exploratory study into the software tools used by businesses.
Problem Addressed / Identified	The skills needed to do data analytics with a variety of data visualization software packages.
Research Contribution	Compared to several data visualization software packages based on functionality and skills needed.
Aim and Objectives	Explore the functionality of the various software packages for data visualization purposes and skill level for various levels of business school students to influence the instruction and curricula
Novelty / Rationale and Significance	The reason for the study is the growing importance of big data in the working environment.

Limitations and Weaknesses	The limitation is that the researcher only compared 4 of the software packages with the most hits on websites.
Implementations Details / Experimental Setup	The researcher used advanced search on google with software, college, and university. Then, the software with the most hits is compared with the same data set to come up with the dashboard—the comparison factors, including skills needed and functionality.
Findings and Conclusion	The four software packages with most hits are Microsoft Excel, Microsoft Power BI, Tableau, and IBM Watson Analytics. Microsoft excel was a straightforward application for the creation of the dashboard. The obstacles that the researcher found is labeling the sale amount in dollars, correcting the units, and grouping the data. An extension called PowerPivot is needed to manipulate the data, add a slicer, and grouping to separate the data. Microsoft Power BI is a way for Microsoft to raise a higher level of business intelligence tools. The two large obstacles while creating the dashboard are data labels and trend lines. It requires a higher level of technical knowledge to break the data into quarters. Tableau has similar functionality with Excel, but easier to create graphs. Drag and drop functions allowed the quick creation of the dashboard. The trend lines were not able to be a connected moving average but did show moving average by month. Any other lines may require more advanced programming skills. All labels were able to be created along with the slicer.

	IBM Watson Analytics uses a wizard in the beginning to decide the type of research question from the data. The difficulty arises when the labels from the spreadsheet needed to be utilized to create a correct chart. Without the wizard, the user interface is straightforward. The third chart was not able to be placed sideways while the other chart was not able to be split up into quarters. To view all data, the user needs to scroll for each month. The creation of the charts and other functions were relatively slow. To conclude, it is best to prepare students for their employment opportunities by meeting the market demand for such software packages.
Areas of Improvement and Future Direction	-

Human-Centred Methodology Literature Review

Research Article	Employing User-Centered Design to Accelerate the Construction of a Business Intelligence Dashboard
Problem Addressed / Identified	How to provide real-time data to decision-makers in the form of an electronic dashboard in a way that is effective in communicating information in a rapid development cycle.
Research Contribution	Apply user-centered design to the design of the application in order to effectively and efficiently present the information.
Aim and Objectives	To accelerate the construction of a business intelligence dashboard application using user-centered design. The objective is to create a business intelligence dashboard using user-

	centered design to meets the needs and desires of the end-users.
Novelty / Rationale and Significance	The reason for the study is the need for the rapid development of an application in the management of complex systems by providing real-time data to decision-makers.
Limitations and Weaknesses	The research is limited to a very small number of participants with a single department within singe corporation. The participants were those who are most interested in the project. This serves only as illustrative in character. The weakness of this study is that it may not be applicable to all of the departments as it cannot be generalized for all cases.
Implementations Details / Experimental Setup	Capturing personas of user Develop use cases Prototyping Pilot testing
Findings and Conclusion	Step one: Capturing the personas of the user. Users are divided into three personas, which are chiefs, counsel, and support. Chiefs are people who were most interested in an overview of the data. Counsel interested in a smaller part of what chiefs interested mainly in the regions or their respective department. Support are specialist, paralegal, and administrative assistants with concerns about upcoming court dates and activities on the cases they have been assigned. Step two: The use cases is the translation of the user feedback on what was important for the users. Step three: Developing the dashboard and send it to the users. Then, the researcher asked the users for feedback. Chiefs appreciated the broad view, but

	counsel would like to see the subset of the data. Step 4 Pilot testing. Once again, the researcher sent the prototype to the users and conducted a follow-up group discussion. Then the prototype revised in accordance with the feedback. The researcher deployed the prototype for one week, then conducted a survey for the usability, ease of use, and user control. Conclusion: The use of user-centered design can ensure that the design of the system is adequately and meaningfully meets the needs of end-users. It can speed up the interface and application design.
Areas of Improvement and Future Direction	A new application and other tools should be created with emphasis on input from the end-users. These findings must be tested on a broader spectrum of participants in order to generalize the solution.

Preliminary Study on Data Quality in ETL

Research Article	Data quality in ETL process: A preliminary study
Problem Addressed / Identified	The accuracy and relevance of Business Intelligence and analytics rely on the ability to bring high data quality from the sources using the ETL process.
Research Contribution	The paper provides ETL quality characteristics and existing processes.
Aim and Objectives	Present the main ETL quality characteristics, and overview of the existing ETL process data quality approaches.
Novelty / Rationale and Significance	The reason for the study is to identify and discuss challenges to be addressed in future research.

Limitations and Weaknesses	-
Implementations Details / Experimental Setup	Experiments using an ETL dedicated solution (Talend Data Integration) and a data quality dedicated solution (Talend Data Quality)
Findings and Conclusion	Data quality defects withing the ETL process: 1. Lack of integrity constraints 2. Poor schema design 3. Embedded values 4. Duplicate records 5. Missing values 6. Variety of data types 7. Naming conflicts 8. Syntax inconsistency 9. Wrong mapping of data 10. Wrong implementation of the slowly changing dimension. Data quality approaches in the ETL process 1. Process-oriented approaches 2. Data-oriented approaches: A. Syntactic oriented approaches B. Semantic oriented approaches C. Context oriented approaches
Areas of Improvement and Future Direction	From the outcome of our investigation of ETL tools, it is clear that further integration of semantic recognition would be of interest to resolve DQ problems. The second issue to tackle is outlier detection.

ETL Best Practices for Data Quality

Research Article	ETL Best Practices for Data Quality Checks in RIS Databases
Problem Addressed / Identified	Ensuring information quality is becoming increasingly challenging for the research institutions as several internal and external data sources are loaded for integration into the RIS.
Research Contribution	Data transformation to ensure information quality
Aim and Objectives	Presents the process of data transformation in the context of RIS which gains an overview of the quality of research information in an institution's internal and external data sources during its integration into RIS.
Novelty / Rationale and Significance	The reason for the research is increasing challenges to ensure information quality
Limitations and Weaknesses	-
Implementations Details / Experimental Setup	There are four measures that are taken in this research: 1. Pass the entry without error (ignore), 2. Pass the entry and mark the affected column (flag), 3. Discard/sort out the entry (detect/extract), 4. Stop the ETL flow (raise a critical error).
Findings and Conclusion	A practical guide in terms of the context of RIS are: 1. Key treatment: Keys from external data sources can usually not be transferred to RIS as they must be globally unique. During the transformation, the source keys are mapped to surrogates.

	2. Adaption of Data Types: If the data type of a source attribute does not match the corresponding target attribute, then a conversion of the attribute values is required. 3. Conversion of Encodings: A conversion is necessary for attributes that have an encoding if the encoding standards are different in source and target. 4. Unification of Strings and Dates: The strings can be unified by the transformation. 5. Separation and Combination of Attribute Values: Sometimes, it may happen that attribute values, which are summarized in the data sources, must be split into individual attributes in the target system. 6. Connecting (Join) and Combining (Union) Data from Multiple Data Sources: Sometimes, it can happen that two data sources need to be linked together. 7. Calculation of Derived Values: Sometimes, it makes sense to derive new values from certain attribute values of the source. 8. Aggregation: The data can be grouped according to relevant analysis criteria such as the age group of researchers, funding of projects, or region. Conclusion: The success of a RIS depends to a great extent on the quality of the data, which are determined by the extraction and transformation components.
Areas of Improvement and Future Direction	-

Information flow problems and causes

Research Article	INFORMATION FLOW IN ENGINEERING COMPANIES: PROBLEMS AND THEIR CAUSES
Problem Addressed / Identified	Providing everybody with the right information at the right time is one of the greatest challenges facing all organizations.
Research Contribution	Observations of how failure to achieve appropriate information flow in large-scale engineering design processes contributes to a variety of problems for designers and decision-makers
Aim and Objectives	Highlight the importance of minimizing distortion, by ensuring so far as possible that information is conveyed by people who fully understand it, and that information can be traced back to its sources.
Novelty / Rationale and Significance	The reason for the research is the rising difficulty and challenge of information management in large-scale engineering design.
Limitations and Weaknesses	-
Implementations Details / Experimental Setup	Case studies in two large UK engineering companies. Interview 2 engineering managers, 23 engineers from the aerospace company, and 15 engineers from the automotive company.
Findings and Conclusion	Manifestations of communication breakdown 1. Not understanding the big picture A. Lack of awareness of tasks that need to be done. B. Lack of awareness of information history.

	C. Lack of awareness of how information is applied. D. Lack of awareness of changes to processes. 2. Missing information provision A. No feedback on the information provided. B. No status information. C. Power structure excludes viewpoints. D. Information is consciously withheld. 3. Information distortion. A. Information is oversimplified. B. Chinese whispers. C. Hierarchical communication paths. D. The expertise of intermediary. Conclusion: Ensuring the accurate and timely delivery of appropriate information is a less tractable problem. In complex processes, information flow is always problematic and difficult to support. Only if designers know where information is coming from and where it needs to go can they communicate effectively
Areas of Improvement and Future Direction	Tools for planning and managing dynamic design processes based on parameter values exchanged between tasks and developing visualization techniques for the design process that make these dependencies and connections salient.

Improving information flow with web services

Research Article	IMPROVING INFORMATION FLOW WITHIN THE PRODUCTION MANAGEMENT SYSTEM WITH WEB SERVICES
Problem Addressed / Identified	Inefficiency in the planning system due to the information flow.
Research Contribution	Improving information flow in the production management system with web service as a tool.
Aim and Objectives	Create a conceptual framework based on web services to improve the information flow.
Novelty / Rationale and Significance	The reason for this research is to give a solution to provide a flexible way to integrate disparate systems.
Limitations and Weaknesses	These web services require network connectivity.
Implementations Details / Experimental Setup	Identifying the current state of web services, web services in construction, and propose a framework to integrate the information in a production management system.
Findings and Conclusion	The challenge is to integrate data from numerous remote providers with local site data in real-time to allow for up to date forecasts of releasable work in the weekly and look-ahead planning periods. To this end, we do not propose to adopt existing heavy-weight electronic business messaging standards for our needs. Rather, we intend to create our own interfaces for the information we need to feed our application. A framework has been created with the abilities of local/remote data. The application relies heavily on the

	integration of data from third parties via web services. The business object model represents tasks, resources, people, etc. Application logic represents the controller in the MVC pattern and is responsible for managing requests from the view and translating them into method invocations with data sources. Graphical User Interface provides the user's view of the system and its current state.
Areas of Improvement and Future Direction	Test the framework on a construction project to identify potential benefits and the feasibility of implementing this framework in the industry.

A multi-site case study using diffusion of innovation theory

Article Title	Introduction of shared electronic records: a multi-site case study using diffusion of innovation theory
Problem Addressed / Identified	There are substantial differences between pre-adoption estimates of the results of software innovations and actual outcomes.
Research Contribution	Analyze the common errors and future issues of diffusion theory and adoption
Aim and Objectives	To explore the introduction of a centrally stored, shared electronic patient record (the summary care record (SCR)) in England and draw wider lessons about the implementation of large-scale information technology projects in health care.

Novelty / Rationale and Significance	Give a multi-site case study using diffusion of innovation theory as a guideline.
Limitations and Weaknesses	-
Implementations Details / Experimental Setup	Multi-site, mixed-method case study applying utilization-focused evaluation. s Data included 250 staff interviews, 1500 hours of ethnographic observation, interviews and focus groups with 170 patients and carers, 2500 pages of correspondence and documentary evidence, and incorporation of relevant surveys and statistics produced by others.
Findings and Conclusion	The mixed fortunes of the SCR program in its first year were largely explained by eight interacting influences. The first was the SCR's material properties (especially technical immaturity and lack of interoperability) and attributes (especially the extent to which potential adopters believed the benefits outweighed the risks). The second was adopters' concerns (especially about workload and the ethicality of sharing "confidential" information on an implied consent model). The third influence was an interpersonal influence (for example, opinion leaders, champions, facilitators), and the fourth was organizational antecedents for innovation (for example, past experience with information technology projects, leadership and management capacity, effective data capture systems, slack resources). The fifth was organizational readiness for the SCR (for example, innovation-system fit, tension for change, power balances between supporters and opponents, baseline data quality). The sixth was the implementation process (including the

	nature of the change model and the extent to which new routines associated with the SCR aligned with existing organizational routines). The seventh influence was the nature and quality of links between different parts of the system, and the final one was the wider environment (especially the political context of the program).
Areas of Improvement and Future Direction	–

Appendix E Design of the dashboard.

Dashboard design 1.0

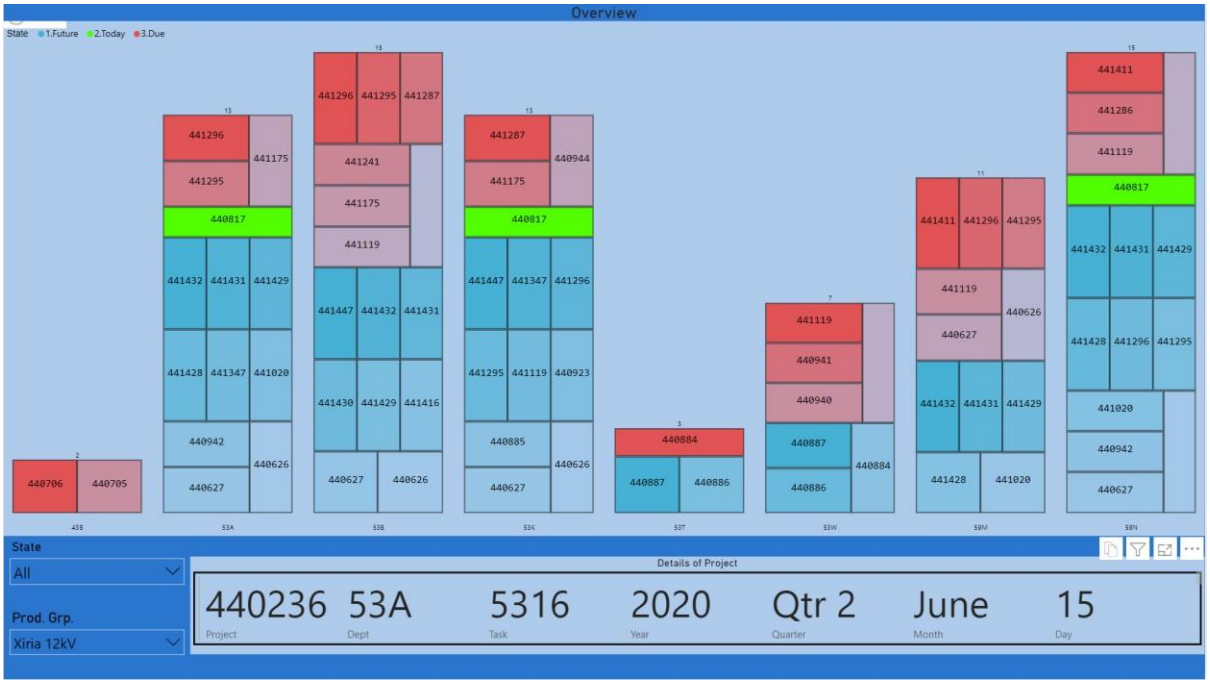


Figure 16: Overview 1.0

Figure 17: Planning Drillthrough 1.0

Appendix F Milestone Proposal

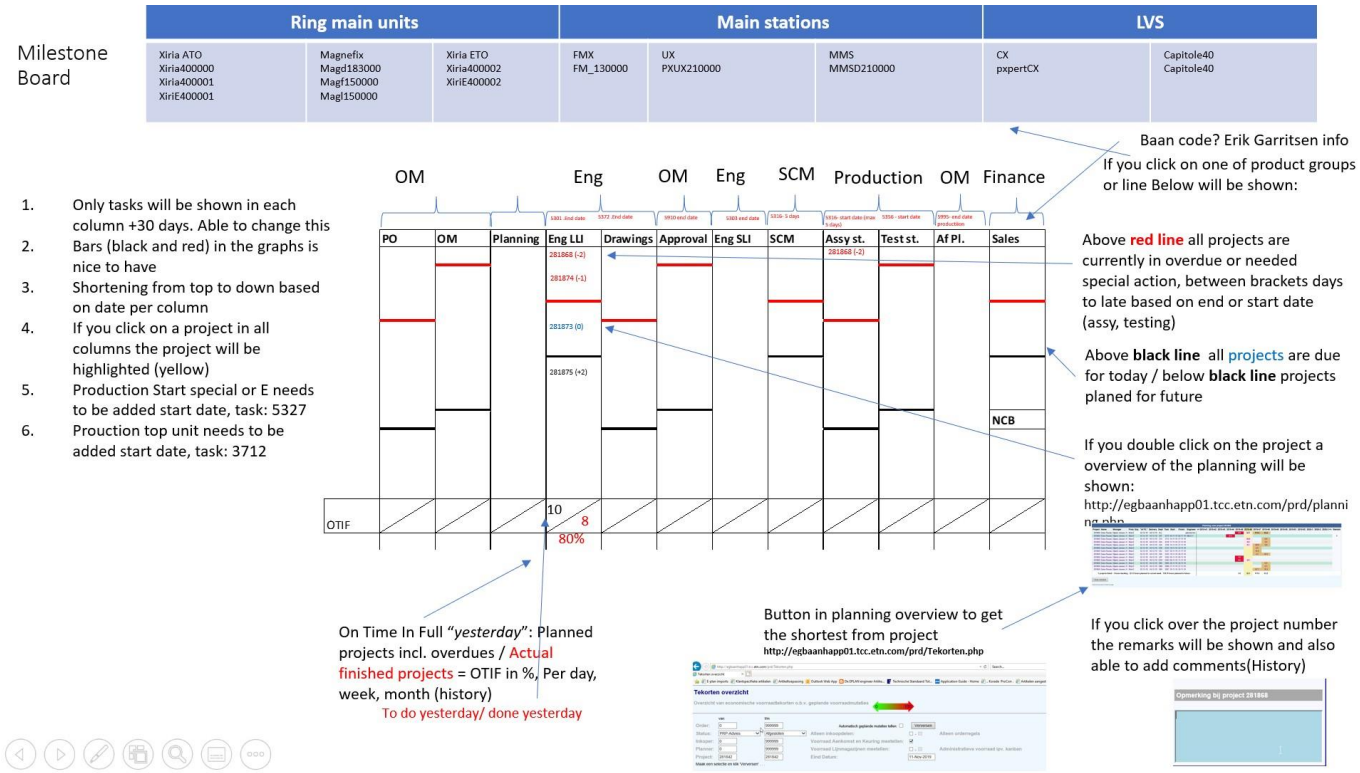


Figure 18: Milestone Proposal

Appendix G Final Design of The Dashboard

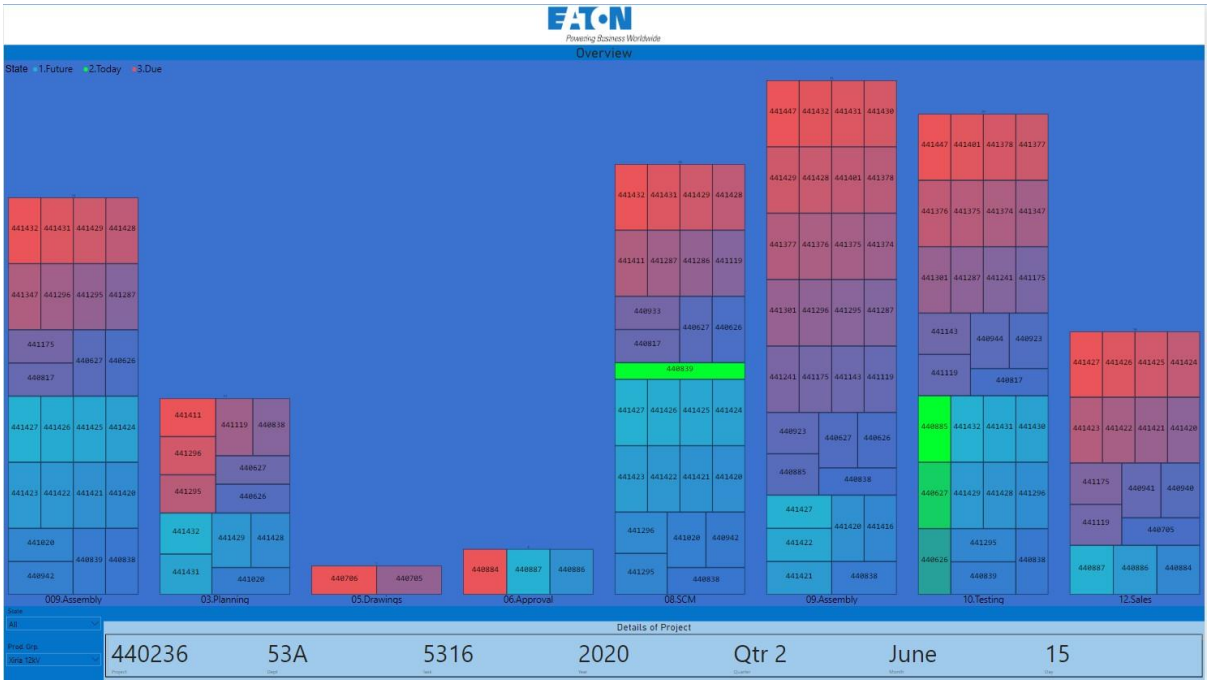


Figure 19: Overview Design 1.1

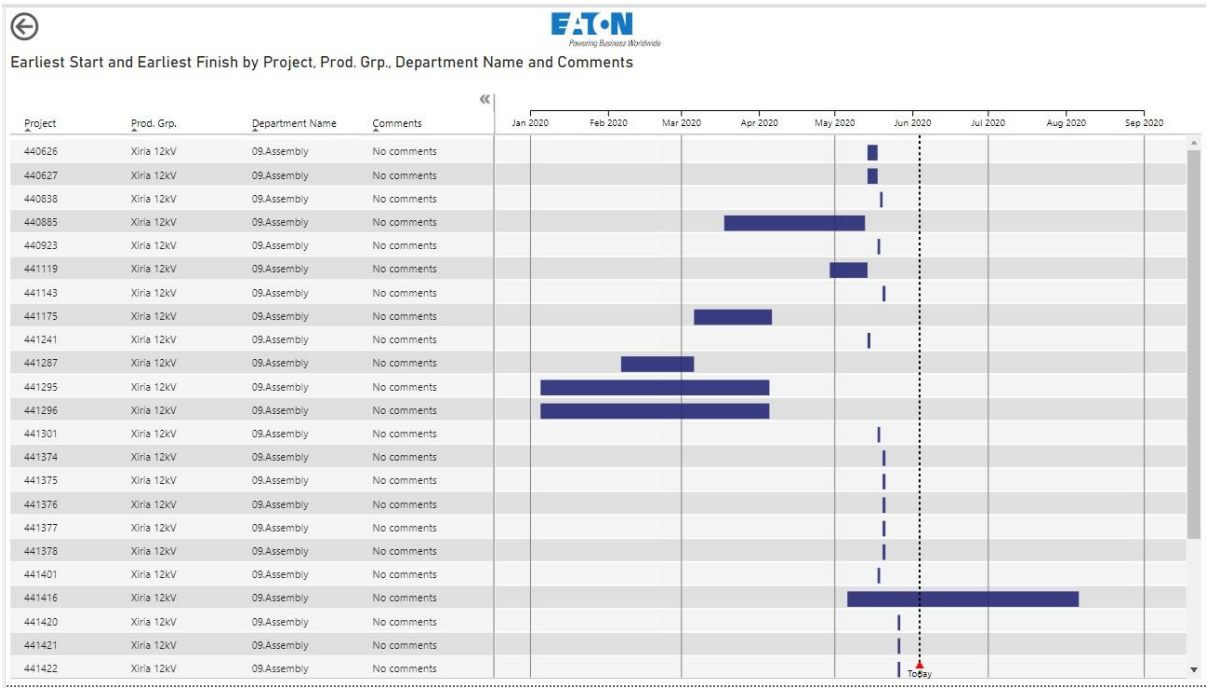


Figure 20: Planning per Department

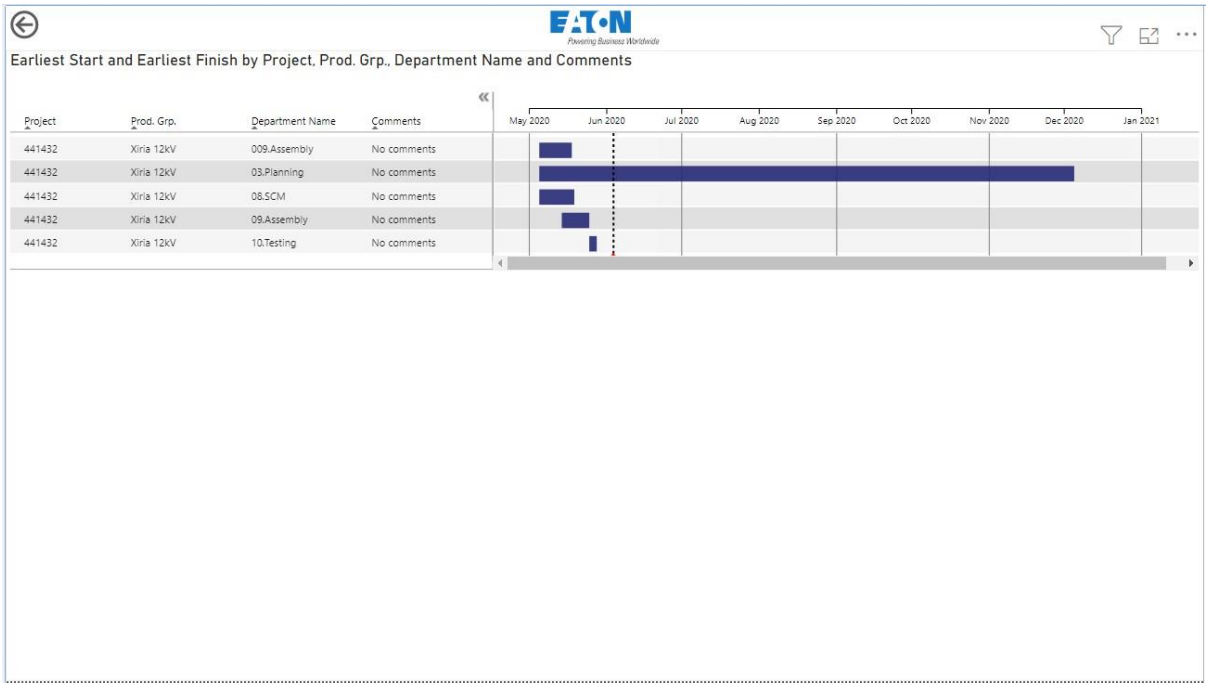


Figure 21: Planning per project

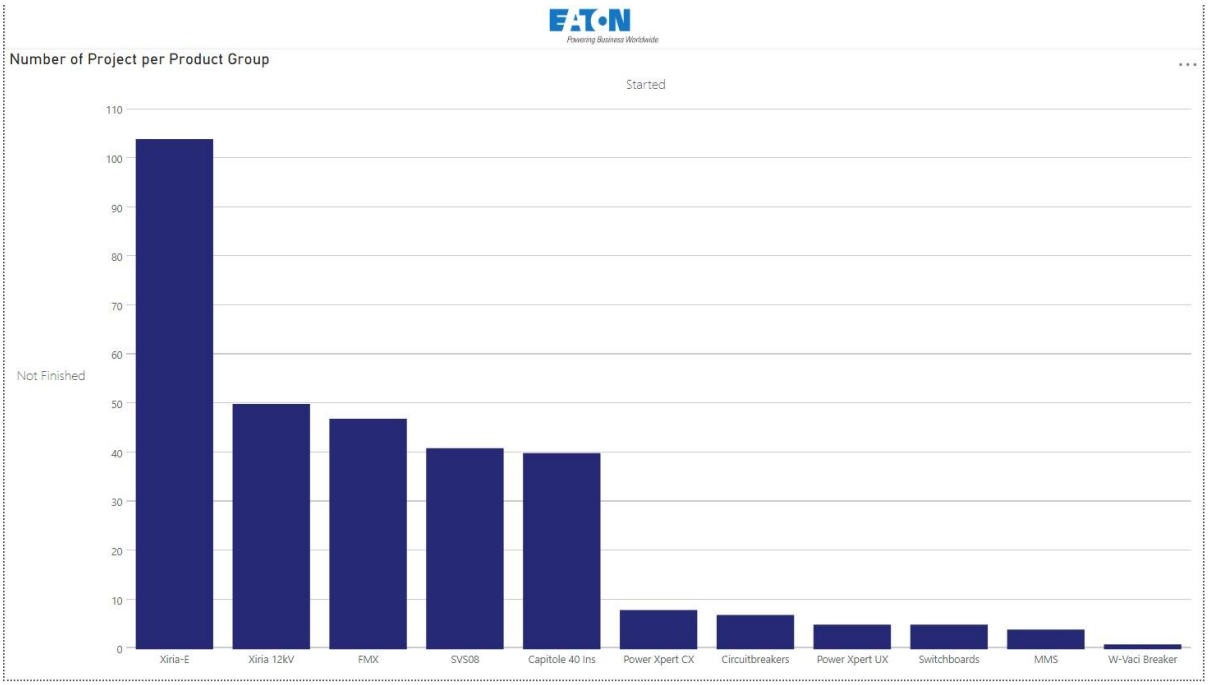


Figure 22: Total project per product group chart

AUTHENTICITY STATEMENT

For the sake of Allah, I confess this work is my own work except for the excerpts and the summaries that each of their sources has already been cited and mentioned. If in the future my confession is proved to be wrong and dishonest resulting the violence of the legal regulation of the papers and intellectual property rights, then I would have the will to return my degree to be drawn back to Universitas Islam Indonesia.

Yogyakarta, 17 September 2020

Muhammad Fauzan Mahdy