



MASTER THESIS

Smart KPI-ORIENTED Decision Support Dashboard for Digital Transformation

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ELECTRICAL ENGINEERING MATHEMATICS AND COMPUTER SCIENCE
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The past eight months in writing my thesis was one of the best experiences of my career which included learning, experiencing and exploring the wide range of topics including both real business world scenarios and the modules taught at University of Twente.

A very interesting opinion among fellow BIT master students refers to journey from the initial two months of the final months of the project. At start, you are trending on unexplored paths and as time goes by it becomes more evident but only to realize it would have been so useful to use this knowledge since the beginning of the project. The main reason for this is the time constrain in which you intend to do everything one wants to do. Recollecting the time, I am in line with the opinion of my colleagues, only if I knew the right path, things would have been straight forward and easy to follow. However, its complete contrast from how the world works.

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Executive Summary

Recent research shows that digital transformation can be a source of competitive advantage and impact organization success. Companies are using technology and digitalization to transform their business strategies and achieve their goals. Despite enormous transformation efforts, the expected productivity gains are often missing in most companies. In addition to this, some companies are uncertain about the future direction of their digital transformation process. This shows that there is a lack of understanding by companies on how to measure digital transformation success. One of the decision-making tools is the dashboard comprising of Key Performance Indicators (KPIs) that give important insights closely aligned with the strategy. The challenge is that the major works or initiatives are focused on digitization, decision-making models, or dashboard design. Additionally, the KPIs for digital transformation described in the literature are domain specific. This indicates that research on defining specific criteria or metrics for measuring the digital transformation success is limited and varied. As a result, the main objective of this research is to identify digital transformation KPIs, as well as decision-making techniques, and then construct a transformation dashboard prototype that may assist companies in developing a plan and tracking their progress.

This research is carried out in collaboration with INPAQT B.V, an organization that specializes in providing AI-supported Decision Support Systems to resolve complex decisions in a fast-changing environment in the field of Business Analytics including areas of Customer analytics, HR Analytics and Medical Diagnostics. INPAQT intends to facilitate these organizations to gain the best insights and analyse the situation effectively and identify the things to act upon and streamline workflow.

To summarize, this research first explores various key performance indicators and decision-making approaches that that can effectively close the gap and highlight the requirements for an intelligent digitalization dashboard. Based on these research gaps, a conceptual framework is created, that is further used as a baseline framework for dashboard implementation. Finally, a KPI-oriented dashboard prototype is designed. Furthermore, two expert interviews conducted as part of the evaluation process indicated that the artifact's results meet the thesis's main research objective. A Design Science Research Methodology (DSRM) is used to structure the research. The prototype for Digital Transformation is put together based on the findings and evaluation. A number of enhancements to the current framework are suggested. Finally, conclusions are drawn, limitations are described, and practice and research significance are discussed. The contribution of this report can be divided into theoretical and practical relevance:

Theoretical:

- Conceptual framework that can be used for digitalization dashboard development.
- A list of Key performance indicators for measuring digital transformation as a whole.
- Extending the limited research on intelligent decision-support dashboard for digital Transformation.
- Extending the limited research on list of digitalization KPIs as digital transformation keeps evolving.

Practical:

- A smart KPI-oriented Dashboard proposal for INPAQT B.V. which can be used for their clients who are in first stages of digital transformation.
- Dashboard prototype can be integrated in Innovation Management Suite of INPAQT B.V.
- Interview Scripts that can be used as part of requirement gathering for digital transformation Success

Document Change Control

Document version	Revision Date	Description of Change
Version 1.0	07-07-2021	The initial version of the document containing the first three chapter. Chapter 1 Introduces the background, motivation of this thesis. Chapter 2 sourced from a "Literature Review" written by the same author of this research. The remaining chapters are yet to be written.
Version 2.0	15-07-2021	The finalization of Chapter 4. The addition of Chapter 5. Chapter 6 and 7 is yet to be written.
Version 3.0	02-08-2021	Research Methodology was added to introduction. First draft of the Report was submitted.
Version 4.0	08-09-2021	Each chapter has an introduction and a summary. In the previous edition, Chapter 1 and Chapter 2 were separated. As a result, the document is structured as follows in this version: The first chapter provides some fundamental concepts of digital transformation as well as a research strategy. Research Methodology (Chapter 2) The literature review is presented in Chapter 3. The concept and development of the artifact are covered in Chapter 4. The artifact's implementation is demonstrated in Chapter 5. The item is evaluated in Chapter 5 utilizing the TAR Methodology. Finally, Chapter 7 summarizes the findings, limitations, and suggestions for further research.
Version 5.0	12-09-2021	Addition References and change in reference style, Punctuations, Spell check, Merged Chapter 4 & 5 into Artifact Design and Demonstration
Version 6.0	29-09-2021	The final version of the document. Grammar and plagiarism checked. The content is the same as the previous version.

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1 Introduction

The chapter delves deeper into the context of an organization's digital transformation journey and expands on the challenges that form the foundation for this research. The research goals and the research question are defined in section 1.2 and 1.3 respectively. Finally, section 1.5 provides a clear overview of the thesis report's structure.

1.1 Background

INPAQT B.V. specializes in providing AI-supported Decision Support Systems to resolve complex decisions in a fast-changing environment in the field of Business Analytics including areas of Customer analytics, HR Analytics and Medical Diagnostics. INPAQT thrives on the motto, “we live in the Age of Innovation” where Digital Transformation (DT) is a well-known concept. For instance, the emergence of smart industry (also known as industry 4.0) and smart cities, are both being powered by digitization and digital transformation. Most of the sectors are disrupted by disruption of production and value chains and disruptive business models made possible by the application of new technologies. In INPAQT’s view, digital transformation of an organization requires managing combined innovation in the following areas: business model, process, technology and control or management. Speed of learning and monitoring the progress is crucial and considered as core competencies here. INPAQT helps firms learn rapidly and be effective and efficient in the digital transition by assisting management with smart decision-making processes and tools in numerous domains.

INPAQT has been extending and renewing their tools for innovation and change management since 2020, a group of products that together create a kind of workbench for supporting innovation and change management and is known as the "Innovation Management Suite," or "IMS." They began with a set of tools aimed at supporting larger businesses and corporations with their digital transformation. The toolset aids in the diagnosis of organizations, the selection and planning of actions, and the tracking of progress. “Digitale Transformatie Diagnose - Actie – Monitoring” Tool, or DAM, has been the internal term for these tools. DAM is also part of a larger set of innovation and change management tools being developed better known as SLIM. Therefore, the integrated Diagnostic, Intervention and Monitoring toolset is designed to support innovation processes such as the digital transformation and energy transition. The 'hard' aspects of the organization such as finances, business processes, protocols and organizational structure are enriched with the 'soft' aspects of the organization such as leadership style, culture and informal structure. The target organisations are SME and corporates. To summarize, INPAQT wants to assist the companies to gain the best insights and analyse the situation effectively and identify the things to act upon and streamline workflow. INPAQT's monitoring toolset is designed to help organizations in the early phases of digital transformation to discover easy-to-implement innovations, define a plan of action, and measure digital transformation progress.

1.2 Problem Definition

Generally, Digital transformation (DT) is about adopting disruptive technologies to increase productivity, value creation, and social welfare (Ebert and Duarte, 2018). Leaders across multitude of sectors are implementing DT strategies and innovative ideas to enhance the way their businesses operate and grow. As an enabler, digital transformation brings together vision and intelligent technologies to help businesses stay competitive in a continually changing market. In the initial stages of digital transformation, organizations often make significant investments in this area but strive to maintain control and track their success. Despite enormous transformation efforts, the expected productivity gains are often missing in most companies during their transition from conventional to digital platforms(Wengler et al., 2021). Taking the right decision might be challenging due to a lack of technological alignment and clear understanding among leaders about how to execute against a digital transformation strategy. Nonetheless, there is evidence that many attempts miserably fail. Moreover, DT also tend to be wide in scope(Reich, 2018). As a result, despite investing time and money, several organizations continue to do same old things with new equipment and new job titles, lagging behind in market competition(Reich, 2018). Hence, these organizations are uncertain about the future direction of their digital transformation process.

To gain the best insights and analyse the situation effectively, companies need to identify the things to act upon and streamline workflow. Furthermore, it is important to consider various critical decisions for which different decision-making support tools are suggested. Dashboards are one of the decision-making tools designed to quickly display the picture a company's performance since manual processes require scanning through large volumes of data and reporting (Tamhankar, 2019). Key Performance Indicators (KPIs) remain the best way of assessing results. The dashboard includes the set of indicators – measures that provide critical feedback to ensure that actions and results are well aligned with the Strategy (Udilina, 2017). Therefore, a performance evaluation of an organization requires the selection of performance indicators. This is considered as an integral part of the planning and control process, providing data that can be used as information in the decision-making process. Thus, a system of performance indicators is a set of measures integrated at various levels (organization, processes, and people) that facilitates the process of decision-making.

Regardless of size and sector, organizations in today's market are rushing to join the journey of digital transformation.(Jonathan, 2020) Thus, organizations that find themselves in the first stages of the digital transformation need an easy way to achieve improvements, make an action program and monitor the progress. The strategic plans, benchmarking, and performance management systems are noticeable paradigms that utilize the performance indicators(Nyamsuren Purevsuren, 2020). However, there is limited research on identifying specific factors or KPIs for digital transformation - majority of works focus on digitalization or decision- making or dashboard development(Udilina, 2017). Therefore, goal of this research is to design a smart dashboard that can help organizations to make better decisions in their digital transformation process. This entails conducting extensive research to identify key performance indicators (KPIs) and analysing decision-making models related to digital transformation (DT) that INPAQT can use to assist their clients in making better decisions

about how to measure the success of their digital transition. In general, this framework's concepts comprise organizational design elements - people, processes, and technology as aspects of strategy.

According to one of the findings in the earlier literature study, there is a lack of research on developing KPI-oriented dashboards that focuses on the general purpose of digital transformation. The literature review conducted is based on collection of existing methods, frameworks, and techniques of decision making and digital transformation KPIs. Moreover, most of the dashboards are designed explicitly for "Marketing & Sales" domain. Despite the fact that digital transformation has been around for quite some time, there is limited literature and research on a standard digitization dashboard. This research gap is explained in depth in section 3.4. These findings are supported by a similar study conducted by Elina (2017), which sheds insights and addresses the gap between dashboard development and digital transformation KPI. This study further lays some groundwork that researchers can apply in a variety of business scenarios.

1.3 Research objective

The high-level goal of this research is to design a smart decision-support dashboard to support organizations in monitoring and tracking digital transformation process. This entails conducting extensive research to identify key performance indicators (KPIs) and analysing decision-making models related to digital transformation (DT). This can be used by INPAQT to assist their clients in making more informed decisions about how to measure the success of their digital transformation. In theory, the principles in this framework include organizational key features such as people, processes, and technology as well as strategy. As a result, high-level purpose of this research is translated into the following central research question:

Main RQ: How can organizations monitor and track their digital transformation success?

Furthermore, the central research question is further decomposed into two main research objectives consisting of sub-research questions:

Research Objective 1 (RO1):

- To investigate the suitability and the feasibility of Digital Transformation monitoring dashboard according to published literature
- To compare existing KPIs and methods for Digital Transformation further analysing their weak and strong sides;
 - **RQ1**-What steps are followed in identifying the key performance indicators (KPI) in the digital transformation process?
 - **RQ2**-What are the various Decision-making approaches/methods used in an organization?
 - **RQ3**-How can we relate an IDSS (Intelligent Decision Support System) with decision-making for the digital transformation of the organization?

Research Objective 2 (RO2):

- To design a transformational prototype to measure the Digital Transformation success which can be integrated in INPAQT IMS Suite and used by its clients
 - **RQ4-** How to design a smart decision support dashboard for digital transformation?
 - **RQ5-** How well does the smart digitalization dashboard perform in above context?

The sub-questions above were developed in order to merge and contribute to a conclusive solution. RQ1, RQ2, and RQ3 are knowledge questions that will be answered using secondary sources (publications by other authors), whereas RQ4 and RQ5 are Design questions that will be answered by designing an artifact that aligns the perspective of INPAQT and empirically evaluating its usefulness and usability (Wieringa, 2014). The sub-questions are made in an order that they were answered sequentially during the research and presented in this report.

1.4 Report Structure

This thesis research was carried out broadly in two courses; the research topics course covered a systematic literature review (SLR) along with problem investigation. This is described in the Literature review chapter, which includes identifying the requirements needed for designing a smart decision support. After sufficient background knowledge was acquired to begin, the design of the artifact was started as the second part of this study. It was conducted using Design Science Methodology (DSM) approach. The research performed during this phase is described in Design, Demonstration (Prototype) and Evaluation chapters. This report covers information generated from both the courses and the following table shows the organization of chapters in this report. Table 1 gives the summary of the overall structure of this report.

Chapter	Topic	Methodology	Research Question
Chapter 2	Research Methodology	DSRM	-
Chapter 3	Literature review	Systematic Literature Review	RQ 1, RQ 2, RQ3
Chapter 4	Artifact Design	DSRM	RQ 4
Chapter 5	Prototype Evaluation	TAR	RQ 5
Chapter 6	Conclusion & Future Work	DSRM	All RQs

Table 1 Thesis Report Structure

2 Research Methodology

This chapter describes the methodology used during this study. It adheres most of the guidelines of the Design Science Research Methodology (DSRM) by (Peppers, 2007) which follows the five steps: problem identification and motivation, define the objectives for a solution, design and development, demonstration, evaluation, and communication. This approach was chosen due to its suitability with the goals and the research questions of the research as elaborated in the previous section (1.3 and 1.4).

2.1 Design Science Research Methodology Approach

The DSRM methodology was proposed by Peppers et al. (2007) as a production and a presentation of design science in information system research. It is driven by the findings of study on the development of information system research in their early 1990s. Peppers et al. (2007) argue that the results from information system research were inadequate since the findings are primarily descriptive. The trend might lead to the deficiency of the essential part of the information research in creating solutions to problems, in other words, a design science. Therefore, DSRM integrates the processes that have been done by the researcher that could incorporate the design science process into the field of information science research. This process is illustrated in below figure 1.

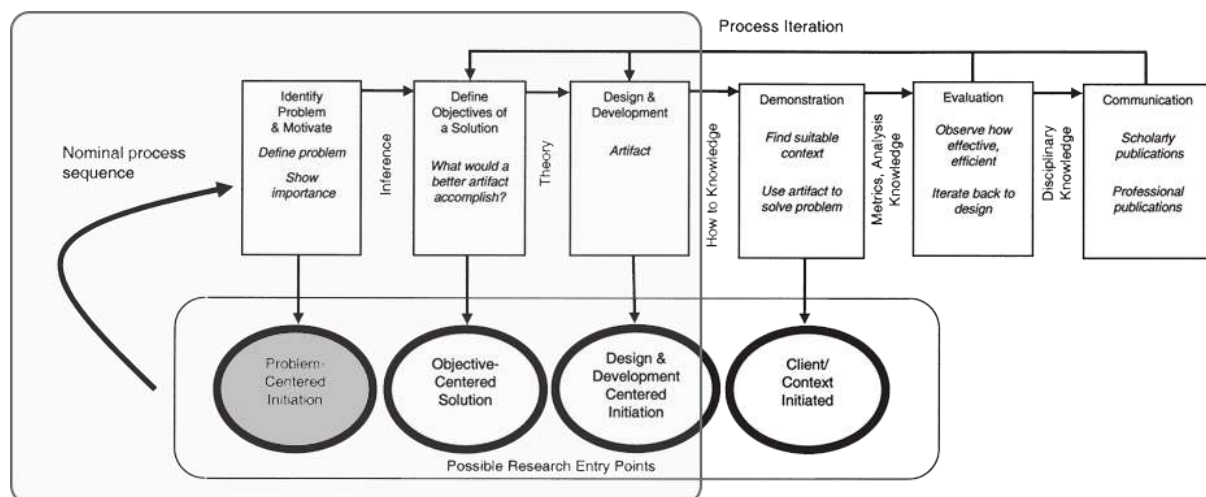


Figure 1 DSRM Process (Peppers, 2007)

The complete processes in the DSRM w.r.t. thesis is listed in below sections

2.1.1 Problem Identification and Motivation

The first activity of DSRM is defining the problem and justifying the solution. The activities eventually help develop the artifact and evaluate whether the solution could fathom the complexity of the problems. The thesis aims to offer a clear overview of the problem identification and motivation behind it, which can be found in Chapter 1, and a factual investigation, which takes place in Chapter 3. Furthermore, chapter 3 provides a partial response to the questions of RQ1 and RQ2. The research approach followed throughout this thesis is elaborated in detail in following sections.

2.1.2 Define the objectives for a solution

This stage of the research decides whether the study's objective is quantitative or qualitative. The input for the stage is the problem specification, current situation, and the effectiveness of the solutions. Research objectives must be established based on the problem definition. These objectives can be regarded as quantitative when they describe how the proposed solution can outperform existing ones or when they describe how the suggested technique can help solve problems that have never been addressed before. According to Peffers et al. (Peffers, 2008), the resources needed to undertake this task include knowledge about the current state of research and possible solutions. Chapter 3, where the available literature is thoroughly reviewed, provides detailed responses to all of the knowledge research questions RQ1, RQ2, and RQ3.

2.1.3 Design and development

A design research artifact can be any artifact that embedded the research contribution. The stage includes defining the feature of the artifact, its architecture, and then develop the artifact. This stage includes defining the feature of the artifact, its architecture and then develop the artifact. The artifact in this study is the smart KPI-oriented dashboard. Based on the literature review, this stage will determine the functionality and dashboard design. This activity is be shown in Chapter 4 of this thesis, where the conceptual framework is established and used as the base architecture for the artifact's design. This DSRM activity contributes to the solution of the design research problem.

2.1.4 Demonstration

This stage shows how the artifact could solve the defined problem in an experimentation, simulation or case study. To establish the ability of the proposed method, it must be proven. Experimentation, simulation, case study, evidence, and other methods can be used to accomplish this. For this research, a prototype is developed for demonstration of the artifact. It will walk through the shortlisted key performance indicators which are implemented in the proposed design. The requirements initially identified is further checked, if they are satisfied and to what extent in this stage.

2.1.5 Evaluation

Evaluate how the artifact supports a solution to the problem. The form of the evaluation could be various; it depends on the nature of the problem and artifact. In order to see if the proposed strategy is effective, it must be evaluated how nicely it accompanies the issue. This requires comparing the research aims to the demonstration activity's observable results. The evaluation of suggested approach is presented in Chapter 6. This DSRM activity contributes to the solution of the core design research question RQ5 mentioned in section 1.3.

2.1.6 Communication

The last part of the research is to communicate the process of the research and its results. The report includes the problems, artifacts, novelty, and other relevant information that can help the researchers and audiences understand the research problem and solutions in a nutshell.

2.2 Research Methodology Summary

This section summarizes the implementation of DSRM in this study. The study was started by doing the systematic literature review as stated in the previous subsection. The literature review can be considered as the problem identification and motivation. In this process, several gaps in the digital transformation dashboard are retrieved. In addition, several KPIs, decision making approaches and dashboards & frameworks are described for the motivation to do further research. Considering the research limitations, the author has identified the gaps that can be investigated in terms of digital transformation KPIs and smart dashboard construction. An artifact is developed after the research goal has been determined. Finally, the artifact demonstration is evaluated in the Chapter 4 and Chapter 5 respectively. Below table 2 demonstrated the Mapping of DSRM approach to this thesis.

Sr. No.	Thesis Chapters	DSRM phase Mapping	Research Question
Chapters 1, 2, 3	1- Introduction 2- Research Methodology 3- Literature Review	Problem identification and Motivation Define the objectives for a solution	RQ 1, RQ 2, RQ3
Chapter 4	Artifact Design & Demonstration	Design and Development	RQ 4
Chapter 5	Prototype Evaluation	Evaluation	RQ 5
Chapter 6	Conclusion & Limitations	Communication	All

Table 2 Thesis Mapping to DSRM approach

3 Literature review

The literature review conducted by author is to determine the prerequisites for a smart decision support dashboard in the context of the digital transformation process. A Systematic Literature Review (SLR) approach is utilized based on Kitchenham approach applied by (Buksh et al., 2020), which is similarly built on the SLR guideline in software engineering. In order to understand the requirements, a list of published papers related to key performance indicators, decision-making methodologies and dashboards especially for the digital transformation domain were collected as a part of SLR. These elements can be used to identify problem areas, improve decision-making process, and catalyse further exploration in organization’s digital transformation success.

3.1 SLR Research Questions

The main objective of the literature review is to identify the requirements and practices for a smart-digital transformation dashboard that can assist organization for faster and smart decision-making. To achieve this goal, three knowledge questions have been formulated,

- **RQ1**-What steps are followed in identifying the key performance indicators (KPI) in the digital transformation process?
- **RQ2**-What are the various Decision-making approaches/methods used in an organization?
- **RQ3**-How can we relate an IDSS (Intelligent Decision Support System) with decision-making for the digital transformation of the organization?

3.2 SLR Search Strategy

A set of keywords pertaining to the research questions are used to create the search query. The primary keywords selected are based on their relation to the main purpose and research question. Furthermore, synonyms of these keywords are shortlisted as mentioned in table 1.

Main Keywords & Synonyms			
Key performance indicators (KPI)	Digital Transformation	Intelligent decision support systems	Dashboard
critical success factors (CSFs)	Digitalization	Decision support systems	Performance dashboard
Key Success factors	Digital transformation strategy	Decision-making	
		IDSS	

Table 3 SLR Keywords & Synonyms

A digital library is utilized to collect relevant academic articles and answer the defined research questions. These libraries contain articles from important journals and conference proceedings, providing access to a wide group of articles on the subject. The scientific databases selected for this review consisted of IEEE (<https://ieeexplore.ieee.org>) and Scopus (<https://www.scopus.com>). A series of keyword combinations were evaluated using the

synonyms as used in literature (Bukhsh et al., 2020) in order to develop a search string. After multiple iterations four search queries were obtained and the final results final results against each database are mentioned in table 4. In order to filter relevant studies that are directly related to the research questions, inclusion and exclusion criteria were created for the resulting search query which are applied to both databases. The list of inclusion and exclusion criteria identified from literature (Charters, 2007) are mentioned in Figure 2.

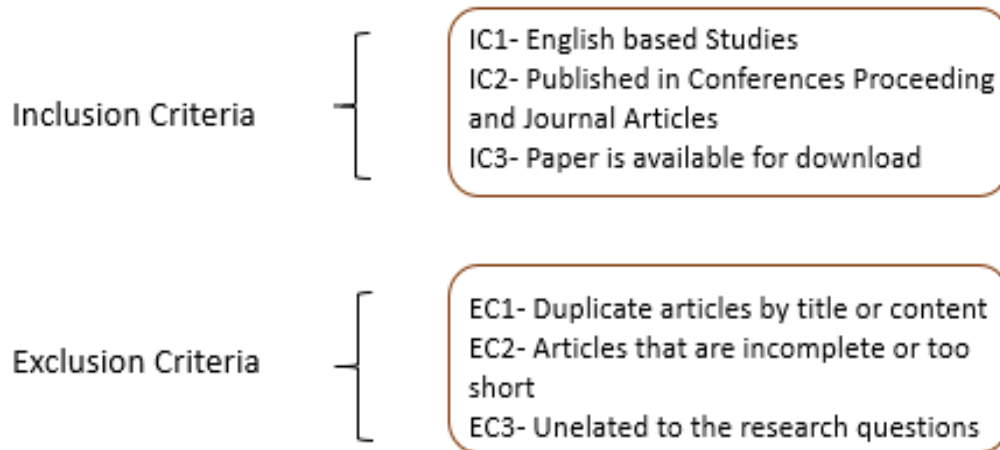


Figure 2 SLR Inclusion & Exclusion criteria

Articles obtained from Scopus database were vast in number, hence additional restrictions were added to define the boundaries of this study: (ii) limit by subject area, i.e., Computer Science, Engineering or Business.

ID	Search Query	IEEE	Scopus
SQ1	("Key Performance Indicators") OR ("critical success factors") OR ("key success factors") AND (digital transformation)	94	61
SQ2	("Decision Support System") AND (components OR framework OR models OR approaches) AND (Digital Transformation) AND (dashboard OR "performance dashboard")	1	28
SQ3	("Decision Support System" OR "decision support" OR "intelligent Decision Support") AND ("Digital Transformation")	50	1480
SQ4	(Decision support OR intelligent decision support) AND (dashboard OR performance dashboard) AND (organization*)	20	630

Table 4 SLR Search Query

After comparing the results from both databases, first search string (SQ1) was selected and a total of 155 articles were shortlisted. This initial set of shortlisted articles were further cleaned in the following 3 steps. (Bukhsh et al., 2020)

- **Step 1 - Duplicate Check:** After scrutinizing the 155 publications, no duplicate articles were found.
- **Step 2 - Inclusion Criteria:** Most relevant papers based on the titles and abstracts of 155 publications were further analysed. The application of the above steps reduced the set to 32 papers.
- **Step 3 - Additional articles:** There were, however, only a few articles about intelligent decision support dashboards. As a result, search string SQ4 and IEEE papers were assessed. Steps 1 and 2 were then repeated to these set of papers, and 8 articles were shortlisted.

The output from above steps is illustrated in below figure:

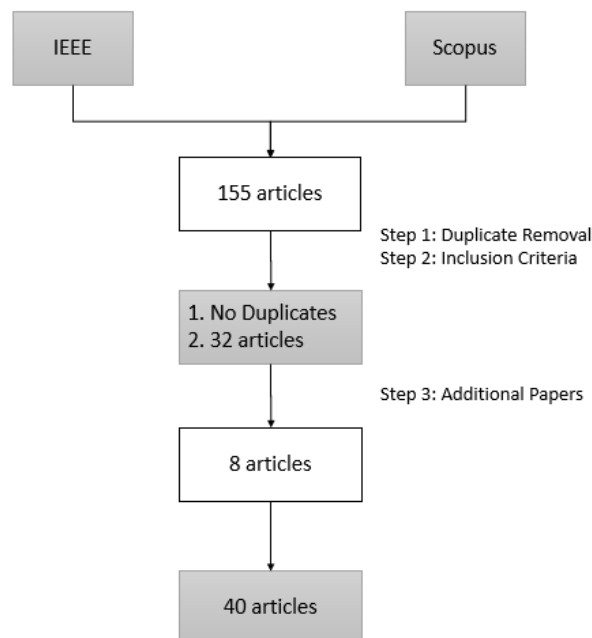


Figure 3 Shortlisted Articles

In total, 40 articles were analysed during the exploration phase of this research to answer research questions 1, 2 and 3.

3.3 SLR Results

This section shows the findings of the data extracted from the articles in line with the defined research questions. A complete list of the 40 papers analysed is listed in Appendix F. The results are structured as follows: Section 3.3.1 presents the findings for research question RQ1 which contains the key performance indicators. Section 3.3.2 present the decision-making methodologies extracted from articles related to digital transformation. Finally, results gathered from the relevant literature for research question RQ3 are summarized in section 3.3.3.

3.3.1 RQ1 Digital Transformation Key performance indicators

Key Performance Indicator (KPI) is an important measurement for organizations. In particular, the KPI is a measurement of a destination, including improvement direction, benchmark or target, and the time frame that is associated with specific activities to achieve long-term goals.(Kosala, 2017) In order to answer the first research question, using the keywords, a data extraction table is developed as mentioned in Appendix F. After thorough analysis, it was observed there are most researchers identified KPIs in 2 steps- Expert Opinion and Literature. Identification of Critical Success Factors or KPIs should point out the main areas of activity of an organization, hence, a new column “Domain” was added to understand the different domain areas of digital transformation studied in the literature. A total of 4 popular areas namely, “Marketing & Sales”, “healthcare”, “Human Resources” and “Education” were identified.

3.3.1.1 Experts based KPIs

The value of a metric lies in its ability to influence business decision-making.(Moore, 2019) Almost half of all organizations have no metric to measure digital transformation. However, selecting the right KPIs from the literature can be inferred as complex decision-making because it involves numerous factors and associated interdependencies(Harrison, 2020).

According to one researcher, incorporating important stakeholders throughout the process aids in the creation of a common understanding, mitigate resistance and gain support. Another contributor emphasized that due to the width and breadth of the topic of digital transformation, an exploratory research study was conducted based on expert interviews. (Riebling, 2017)He further added that the collaboration between organizations embarking in digitalization needs to extend to other stakeholders who might possess the expertise of innovation, enabling that the collaboration between organizations embarking in digitalization needs to extend to other stakeholders who might possess innovation-enabled digitalization transformation(Riebling, 2017).

Building upon findings of previous studies and data collected from interviews with experts, most digitalization initiatives fail to produce the anticipated results. Overall, vast number of researchers think expert opinion emphasizes on the significance of the selection of right KPIs to provide business performance measure and identify bottlenecks in the digital transformation journey. Therefore, expert opinion is an important step in identifying key performance indicators.

3.3.1.2 Literature based KPIs

Apart from the expert opinions, an in-depth literature analysis is conducted to create the preliminary list of potential KPIs to be included in the dashboard for digital transformation. Examining available literature on the topic of digitalization is important to gain results with stronger internal validity, higher conceptual level, and wider generalization (Udilina, 2017). Though digitalization has been since a very long time, it was observed that very few articles stated key indicators for digital transformation or digitalization. As a result, additional

research was carried out by reading blogs about digital transformation tracking measures. According to literature and blogs, some important KPI groups for measuring digital transformation success are shortlisted and listed in Table 3.

KPI Group	Indicators
Focused on the organization	Company contribution and involvement in digital
	Revenue from digital channels
	Marketing expenditure in digital channels
Customer experience	Promotion & Retention
	Usability
	Engagement in digital channels
Technology & Innovation	Rate Of Innovation
	Strategic innovation
	Cloud Application Deployments
	Level of integration of systems
Employees	Multidisciplinary
	Digital-oriented culture
	Team Morale

Table 5 SLR Result- Key Performance Indicators

Additionally, Innovation-focused KPIs to be considered are stated below:

- New products or services launched on the market
- New business models adopted for different markets
- New applications, technologies and innovative solutions applied
- Innovative methodologies and adaptation to new situations or markets
- Innovative ideas being implemented and their level of success

3.3.2 RQ2 Current Situation Analysis: Decision making approaches

This research question aims to find the current decision-making approaches and methods used in an organization. One of the main findings from this research is the 9 popular decision-making methods in terms of the digital transformation journey. The method name and the article Id mentioned in table 4. Each article can be referred to Appendix F. These methods distinctly provide ways in which decisions are made by the various authors, which are further summarized in this section. The number of articles retrieved for each method can be seen in table 6. It is evident from the chart that most organizations prefer either having a dashboard or a Balanced scored card for decision-making. The least method used by companies are complex analytical methods such as artificial neural networks (ANN), data mining or ETL process. Dashboard is a diagnostic tool designed to quickly display the picture a company's performance, especially prepared for the busy leaders. (Vijayalakshmi, 2018)It can be any kind of existing decision support tools or even a simple spreadsheet. The concept of a balanced scorecard (BSC) was proposed by Kaplan and Norton in 1992 (Peng, 2008). The objective was to provide a controlling tool that provides a holistic view to control the implementation of a company's Strategy. For this purpose, four perspectives, i.e., financial perspective, customer

perspective, internal business perspective, and innovation and learning perspective, are defined. Even though there are other advanced multiple criteria decision-making tools, analytical hierarchy process (AHP) method is used to simplify complicated systems into a hierarchal systems (Yasser et al., 2020).

	Method	Article ID
1	MVC Model, design patterns object-oriented Joomla framework	1,10,22
2	AHP method	2,3,26,36,40
3	Dashboards	9,14,30,31, 32,34,35
4	Simulation Analysis-MSPM methods, TEP benchmark	4
5	Artificial Neural Networks (ANN)	5
6	balanced scorecard (BSC) framework (Kaplan/Norton)	1,6,8,25,33
7	Data Mining	7,13
8	Bottleneck Analysis	13,17
9	Extract, Transform, Load	42,18

Table 6 SLR Result – Decision making Approaches

3.3.3 RQ3 Intelligent Decision Support System Dashboard

Most intelligent decision support system (IDSS) contains Business Intelligence (BI) tools. In this context, Business Intelligence is a term commonly used to describe the total effect of gathering and processing data, generating useful and relevant processed data, and reintegrating it into daily operations in order to make efficient decisions and smart future goals (2020, Piamsanga). BI is aimed on fulfilling management needs and assisting in decision-making. A BI dashboard's goal is to assist in understanding company's reality clearly so one can make the best decisions possible at the right moment. Dashboard design in the business world isn't terribly exciting. Competitive organizations have implemented systems of business intelligence in order to help employees in the process of evidence-based decision-making.

As decision-support tools, dashboards have been used successfully in several industries for varied purposes. The boards of leadership in any organization definitely require a lot of information resources in their decision-making process to determine the future direction of the organization that they lead. For example, university's board of leadership as one of the tools in the decision-making process to win the increasingly competitive market.(Santoso, 2014) The complexity of the logistics requires advanced graphics, and the use of AI techniques to support planners and decision-makers are proposed to support the decision making at different hierarchical levels of the organization. Moreover, many private firms use a dashboard as a decision support tool(Jonathan, 2020).

Good decision-making must be supported by the speed of information availability and accuracy. If error information is received, such an event might have a fatal impact on the

decision-making process itself. A good presentation of information in visual form that enables decision-making easily is something highly desired by the leadership of the organization(Haddud A., 2018). BI is the process that obtains a large number of data, analyse them, and to present a set of high-level reports that condense the essence of the data to the basic of business action, that allow management to make daily business decisions. The dashboard screens provide a visually engaging drill-down approach from the strategic initiatives to action items grouped under them, along with details such as the individuals responsible for action items, target dates, and current status(Weiner J., 2015).

3.4 Research Gap

The literature review reports the SLR process of findings state-of-the-artwork related to available metrics to measure digital transformations success. Following the systematic methodology, vast topics were covered to retrieve 40 relevant studies and additional research to get enough information that falls under the research concepts. This research was carried out in a systematic approach, with 40 papers relevant to the research objective 1 (RO1) being analysed. The knowledge gained from articles contribute to identifying the requirements of KPI-oriented smart decision support dashboard for digital transformation. A concept-centric approach was followed which provided a holistic view of the topics covered in this report.

Research Questions RQ1 & RQ2 involved collecting start-of-the-art related to identifying the Key performance indicators and current decision-making approaches. A closer look into the findings of these studies reveals that success from digital transformation endeavours is realized when firms manage to make necessary adjustments to their business and IT strategies, organizational structure, and processes. Meanwhile, RQ3 focused on how a dashboard allows decision-makers to monitor multiple performance indicators at the same time, helping to make the decision-making process.

This is evident from the distribution of articles on the concept of dashboards, KPIs, and decision support tools. This may be attributed to the formulation of search queries based on keywords in the research questions. During the exploratory phase of literature review some analytical methods such as AHP method, dashboards development, BSC strategy, etc. were observed that answered current decision-making approaches. Coherently with what already stated, a balances scorecard and conceptual framework can be designed by combining these findings that would help in monitoring the digital transformation process. This is explained in brief in Section 4.1.

To summarize, in this literature search, knowledge about the different methods, metrics, and frameworks related to digital transformation was gathered. However, majority of current literature research focus on either digitalization or decision support systems. In SLR result section a collection of metrics and compares various decision-making approaches and that fill the gap between key performance indicators and dashboards for digital transformation. Finally, this research provides baseline for measuring digital transformation success by presenting a conceptual framework in section 4.1. that can assist organizations for faster and informed decision-making.

4 Artifact Design & Demonstration

The next phase in the DSRM is to design one or more artifacts that could treat the problem. The design is built based on some requirements that arise from the problem that the stakeholders would like to improve. The requirements contribute to the stakeholder goals. Before designing a new artifact, existing solutions available needs to be considered that can be applied to in the given problem context. If there are no existing artifacts that can satisfy all the requirements, then the next step is to design a new one, which may be a combination of existing options available which satisfy stakeholder requirements. As part of the prototype design, it is also important to specify requirements for the artifact that should be satisfied.

As a result, this chapter outlines the steps involved in designing the smart decision support dashboard. The prototype design can be divided into two categories: First, a balanced scorecard and conceptual framework are created based on the results of the literature review, which are briefly detailed in section 4.1. The first phase of design is used as reference model to design the dashboard in second phase. According to literature, there was no available dashboard for monitoring digital transformation as a whole. Second, section 4.2 focuses on “Interviews” that is described as a part of data collection.

4.1 Reference Model

During the exploratory phase of this research as described in Chapter 3, some analytical methods such as AHP method, dashboards development, BSC strategy, etc. were observed (Section 3.3.2). Coherently with what already stated, a conceptual framework can be designed by combining these findings that would help in monitoring the digital transformation process. The developed framework has been composed of three major modules, as illustrated in figure 3. According to the SLR, the first module is domain area for digital transformation, which can be categorized in 4 areas: HR, Marketing, Sales, Education, or Healthcare. These domains are, therefore, considered as an integral part of the dashboard. Hence, while the requirement gathering of this study, these 4 domains were explored in depth which is described in upcoming section 4.2.

The second module consists of 2 components that are responsible for data collection and the assessment of the status of the digital transformation process of the facility. The process of KPIs selection has been carried out by considering not literature study but also other aspects mentioned in various blogs. A Balanced Scorecard can be used to present the initial KPIs shortlisted in the literature review phase (see chapter 3.1.). Measuring KPIs from four different business viewpoints is possible with such a balanced scorecard approach. These include the financial perspective, internal perspective, customer perspective and innovation/learning perspective. It has been illustrated in figure 3.

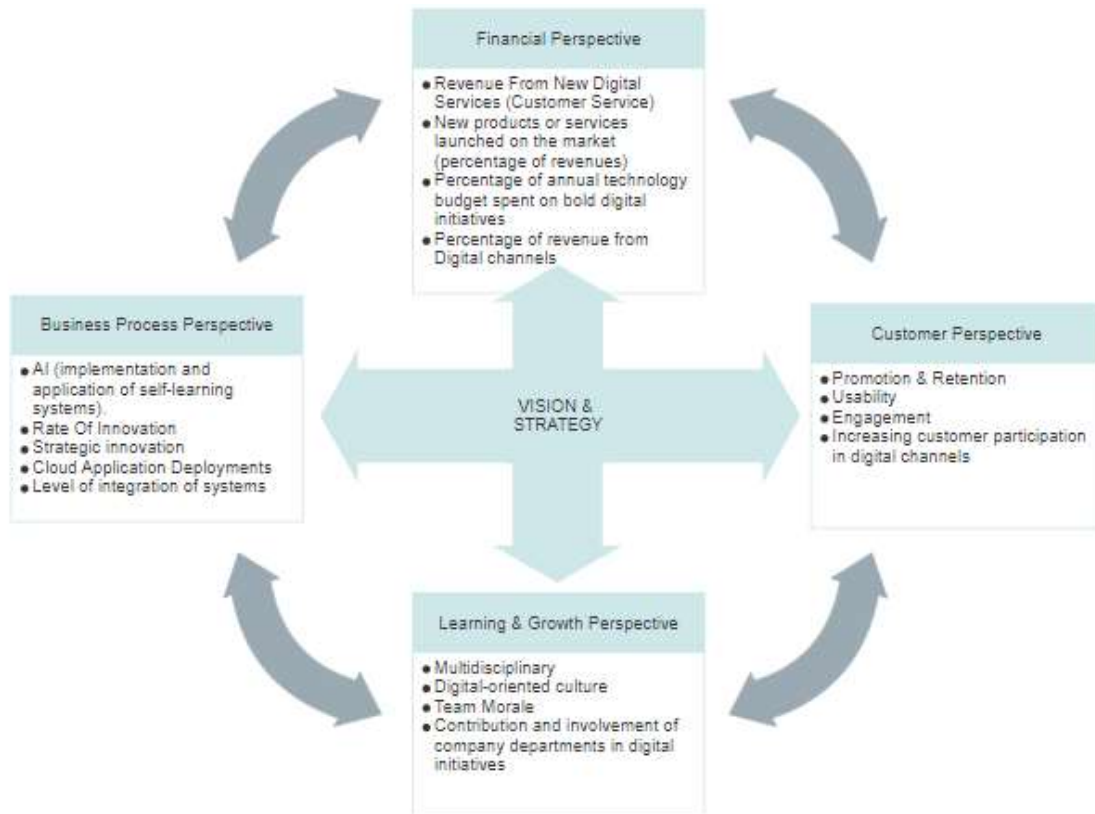


Figure 4 Balanced Scorecard for digital transformation

The boards of leadership in any organization definitely require a lot of information resources in their decision-making process to determine the future direction of the organization that they lead. Based on Research question RQ1, KPIs can be gathered based on expert Opinions. Following to this, it can be incorporated to the initial balanced scorecard. The framework is demonstrated in below Figure 4.

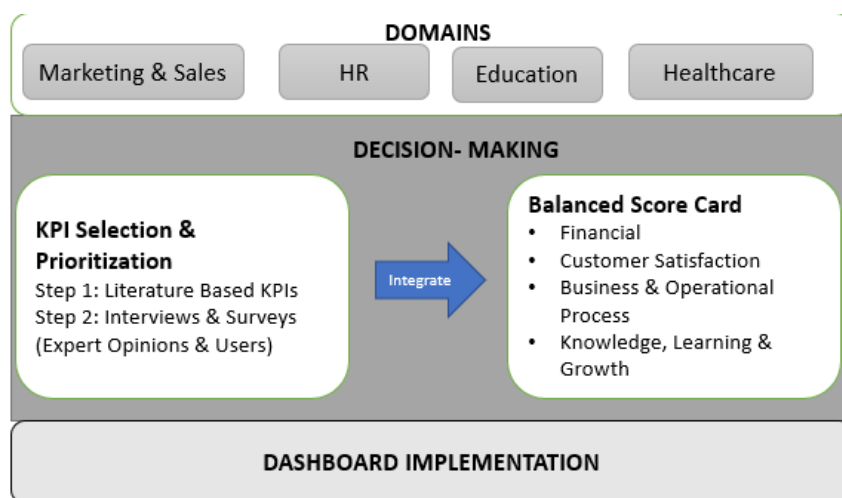


Figure 5 Conceptual framework for DT Dashboard

However, the authors do note that there is future scope for work on the prioritization of countermeasures [25]. The final module is the dashboard implementation and some BI tools can be used for it. Dashboard is a diagnostic tool designed to quickly display the picture a company's performance, especially prepared for the busy leaders. The final dashboard for data visualization tools should have drill-down capabilities designed to provide complex information to decision-makers at a glance. For instance, KPI groups can be categorized into smaller divisions. However, these are only theorized in the study and were not empirically tested yet. The drill-down capabilities allowed managers and administrators to inquire into the root cause of various problems and engage in a data-driven approach to decision-making.

4.2 Data Collection

Based on the conceptual framework defined in above section 4.1, expert Opinions required for identifying the Key performance indicators are explained. This chapter discusses the qualitative interviews that were conducted as a part of data collection phase. This phase starts with interview setup and progressing through interview findings with a succinct evaluation that allows for an empirical analysis of the current digital transformation scenario in the Netherlands.

A qualitative research methodology was carried out in this study and semi-structured interviews (Appendix A&B) were conducted for the purpose of data collection. The interviews were conducted right after the initial literature review. The primary collection of data for this research was designed to be via face-to-face interviews with the participants, however, due to the COVID-19 pandemic, the interviews were conducted via Microsoft Teams(video/audio). This research used video recording and audio recording for note taking purpose via MS Teams after requesting the interviewees' consent to record the interview.

In order to gain deep insights and perceptions towards the variables of the conceptual framework, information from experts in field of digital transformation was gathered. Furthermore, users from several domains, notably as marketing, human resources, health care, and education were assessed to understand similar requirements for the digital transformation dashboard. Therefore, the interviewees were categorized into two groups: Expert opinions (Group A) and User opinions (Group B) due to their differences in opinion. (Mooi & Sarstedt, 2014). The opinions and ideas of Group B participants who took part in the interviews are valuable because are the users who are in first stages of digital transformation. A total of 7 interviews were conducted, which falls within the range of five and thirty considered sufficient for holistic research (Creswell, 2013).

A strategic questionnaire was created to accomplish the research goals based on peer-reviewed literature and case studies from recent research, books and blogs. The key areas of the questionnaire were Interviewee background, Existing digital transformation and dashboard scenario, and open questions. This was done in order to obtain information about the context of their knowledge on digital transformation, working with tools for current decision-making processes and usage of dashboard. Each area had a main topic which further included five to seven sub-questions, added to adequately support its purpose. The identified questions for 'Group A' and 'Group B' can be found in the Appendix A and Appendix B

respectively. A set of 2 Interview scripts (indianscribes, 2016) were developed considering the topics mentioned in below table:

Question Type	Experts	Users
Background	To understand the participants working history, their background knowledge on digitalization and department they are working in.	To understand the participants working history, their background knowledge on digitalization and department they are working in.
Digital transformation	To understand company's digital transformation journey or how well verse they are with the topic of digital transformation	To understand company's digital transformation journey or how well verse they are with the topic of digital transformation
Focus Area	This is not relevant for the experts	To know if focus area is broad or specific to a particular domain including the assumptions made while goal setting in the digital transformation process
Decision Making	To understand the decisions to be made during development of dashboard.	To understand how the current decisions are being made.
Key performance Indicators	To Understand the important KPIs needed for development of monitoring & tracking in digital transformation dashboard.	Understand the important KPIs needed and currently used.
Tooling	These set of questions are framed mainly to understand the available tools for digital transformation and the issues involved.	These set of questions are framed mainly to understand the if the company is using any dashboard or other kind of tools for the monitoring process.
Open Questions	To understand the importance of dashboard in the digital transformation process	

Table 7 Interview Question Category

4.2.1 Data Collection Results

The results of the conducted interviews are presented in this section. Based on the data collected, data analysis and relevancy the findings from the interviews were divided into 3 categories which are explained in following sub-sections. Detailed information of the interviews can be found in Appendix C. Moreover, the overview list of companies and the role

of interviewees are provided in the Appendix D which briefly describes the focus area, challenges faced by each user.

4.2.1.1 Digital transformation Background

The answers to this set of questions gave an understanding of users' knowledge on tracking digital transformation success as most of them were well-versed with the concepts of digitization. Some users still prefer working the old-fashioned way, others have adapted to the digitalized era. The user from HR domain explained the importance of Employee training for success of digital transformation. The experts interviewed have worked in this field for almost a decade. The experts spoke about the digital transformation focus areas. While one expert listed and briefly explained 4 key areas: Data & Business process, Technology, Customer Satisfaction & Knowledge management & HR systems, Another Expert said financial factor is also important when tracking the digital transformation processes. The findings from this set of questions are used in making the base of the framework.

4.2.1.2 Decision-Making

The current decision-making process is mainly done based spreadsheets for most users. 3 out of 4 users are currently using multiple systems. Several participants agreed on making decisions on the fly just by looking into the systems as shown in figure 5. Dashboard used is The KPIs relevant for decision making are briefly discussed in chapter 4. Ongoing process and decisions are made continuously by people involved.

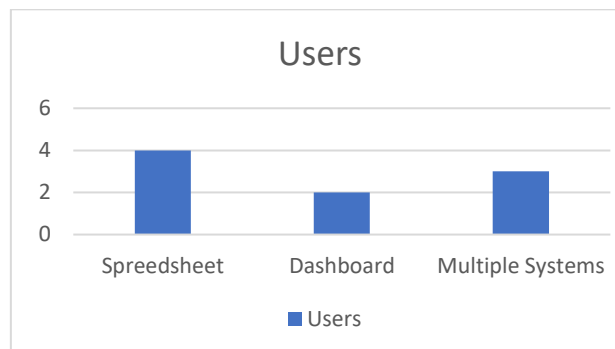


Figure 6 Current Decision-Making process

The primary focus for the marketing firm were customer satisfaction. The experts talk about decision almost never happen only in a financial area but often how often is it based on what team has made. The users from these organizations do not have one dedicated person for the monitoring or tracking. The users would like know if they have the right starting question? What needs to do next? What is the path from A to B? And lastly, help them to prioritize the tasks and make better decisions.

4.2.1.3 Dashboard-Design & Data structure

One of the Experts say 90% of dashboard are like Microsoft software packet where you use only 5 % of data and best dashboard will give just enough information of what the user is looking for. Current issues with dashboards can either be sure to complex design, too many KPI, data quality, just plain screen same as spreadsheet. Some tools used by users have a learning curve. Therefore, one of the features that all experts agreed upon is to have an

exploratory dashboard or a combination of both. This means the user should be able to drill down from one KPI to another. Secondly, it needs to be customizable. And final factor is the dashboard should be simple and easy to understand.

4.3 Artifact Design Summary

To summarize, the interview findings show current decision-making processes, challenges involved, and the scope of dashboard in their digital transformation journey. All the experts emphasize the increasing importance of digital transformation for their companies to address the competition and evolving customer needs, as customers are becoming more and more digital-oriented. Based on results from literature review, Interviews and additional research on blogs, a total of 105 KPIs were identified can be helpful for monitoring the Digital transformation. This list is mentioned in Appendix E. These are standard list of key performance indicators which can create value and act as measure for the success of digitalization of an organization. The data Structure to be used is mentioned in figure 6.

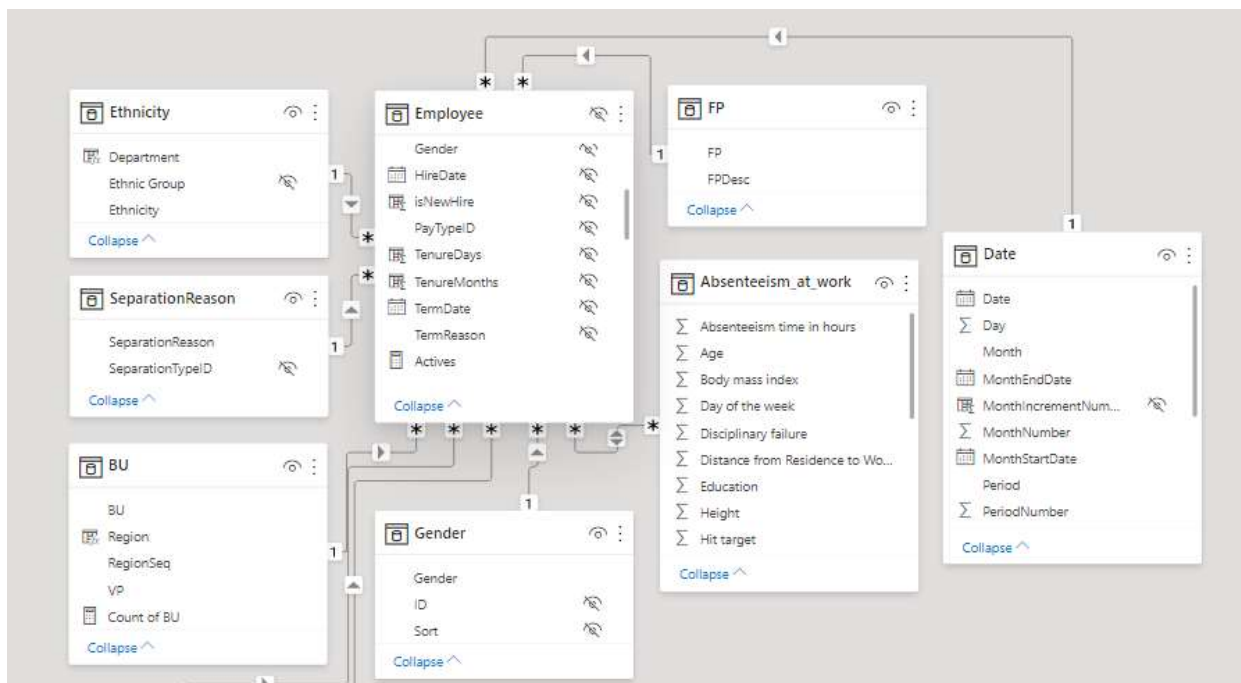


Figure 7 Data architecture

As mentioned in earlier sections, the interviews were conducted for 4 areas of digital transformation. Hence, these KPIs are further divided into groups depending on the focus area and the balanced scorecard mentioned in section 4.1. The Balanced Scorecard (BSC) helps you break down the key areas of your business (perspectives) where activities need to be monitored are Financial Perspective, Customer Perspective, Internal Business Process Perspective, Learning and Growth Perspective. These four key areas of your business are intertwined and all must be aligned. When one is impacted, there is impact on another, in other words, there will be a trade-off. Considering the BSC, and mapping each KPI against the BSC criteria, there were a total of 8 groups defined. However, after prioritization of each KPIs, the

finally groups were shortlisted to 5. This was after considering the scope and feasibility of project and finalized list is shown in table 5.

KPI Groups	Dashboard Screen	Stakeholders
Group 1	HR Analytics-Knowledge & Learning	COO/HR
Group 2	Employee Engagement for Digitalization	COO/HR
Group 3	Financial	CFO
Group 4	Customer Support & Service	CEO/M&S
Group 5	Technology & Innovation	CTO & I

Table 8 Dashboard Screen List

Sharing KPIs with stakeholders is one thing though even this is something that too many organizations fail to do. More than that, though, they need to be communicated in the right way. Hence, the important stakeholders that would have access to each group of screens. In the above table, 5 key performance indicator groups are defined. Metrics under each KPIs group are presented in depth in Chapter 5. High-level KPIs may focus on the overall performance of the business, while low-level KPIs may focus on processes in departments such as sales, marketing, HR, support and others.

4.4 Artifact Demonstration

To integrate the requirements of the organization's digitization success, a dashboard is designed based on the above-mentioned section. This chapter covers some of the assumptions and procedures used to create a dashboard that bridges the gap between the dashboard and the digital transformation KPI. To ensure that the dashboard is designed carefully and efficiently the paper by (Vilarinho et al.,2017) has been used as a reference. The additional information of how the dashboard is designed can be found in upcoming sections.

“A dashboard is a visual display of the most important information needed to achieve one or more objectives, consolidated so the information can be monitored at a glance. (Ganhholm, 2013)”. In this study, the decision conceptual framework is used to implement the dashboard which meets the necessary requirements of the interviewees. Moreover, according to Ganhholm’s research most of the business leaders use dashboards to improve organizational performance. These help users to identify and respond to problems. Therefore, dashboards are often designed to represent the relevant information to monitor organizational performance and to intervene when appropriate. This can be generalized to digital transformation dashboard which shows other relevant information such as the monitoring and tracking of digitalization success. The draft of the dashboard consists of 5 main pages and one overview page, defined by taking into account each perspective with various stakeholders (Vilarinho et al., 2017).

The smart dashboard is used as prototype to evaluate the decision-making process for digital transformation. A prototype is a tangible artifact, not an abstract description that requires interpretation (Ganhholm, 2013). The main reason to use a dashboard as a prototype is because it supports the product innovation process and idea improvement. In addition, it is easier to communicate with the interviewees through prototype requirement specification

for evaluating their requirements on dashboard and decision process. Consequently, better and more concrete feedback will be acquired from the interviewees. Furthermore, the other areas where the prototype can be used are to explore an idea to guide the developers during the further development and implementation. So, that user can test and verify by designing a certain prototype. In the below figure 8, the process of monitoring dashboard is illustrated. Some of the components are in Dutch as per the requirements of INPAQT.

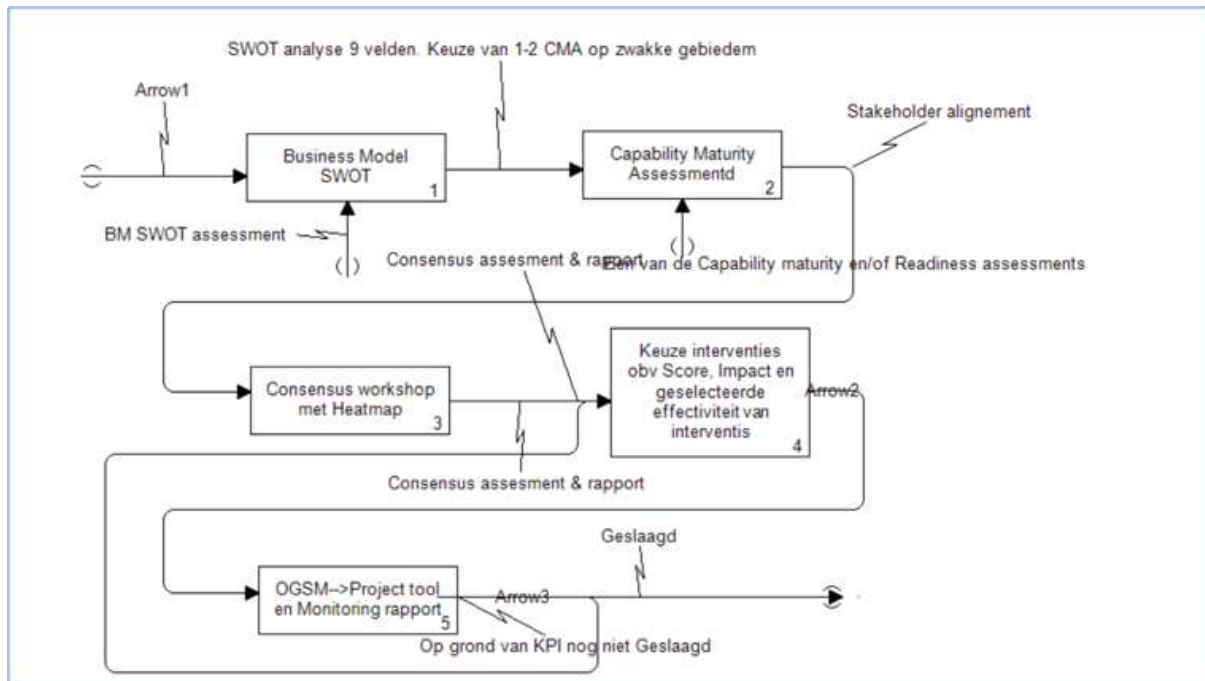


Figure 8 Digital transformation decision-making process

Finally, the Power BI tool is used to create the dashboard. It is a Business Intelligence tool that is used for cloud-based data analysis and is based on the findings of research question RQ3. For BI developers, data analysts, and business analysts, Power BI is more easy, powerful, and user pleasant than other BI solutions (such as Tabelau, Google Data Studio). It can also be used to simulate complicated concepts in a standard business environment (K. Gowthami, 2017). Dummy data linked to this dashboard has been presented in this thesis for reasons of confidentiality. In the following sub-sections, each screen is briefly explained.

4.4.1 Screen 1- HR Analytics- Knowledge & Learning

Although digital transformation is highly technology-driven, focusing solely on tech-intensive roles and departments is a failure. When it comes to digital changes, people are just as significant as technology. As a result of digital transformation, many issues arise, but HR is well-versed in how to manage them. The process of digital transformation is never-ending. HR is well-equipped to collect input and give actionable data for continual improvement. There are 3 key areas HR professionals can focus around digital transformation. The dashboard screenshot is mentioned in figure 8.

1. **Talent Management-** This set of KPIs on this screen can help the organization answer the following questions and take smart decisions business Do we have the talent we need? Are we located in the right physical locations to be able to get the talent we need to make this digital transformation happen? Do we need to build or buy that talent? And what skills do we need to build internally (such as coding) to maintain and optimize what we've turned on? These questions about talent will develop a talent acquisition plan that guarantees your company can support new technology and make the most of it. When it comes to organisational succession planning, it can be especially useful. This ratio compares the number of employees evaluated for internal promotions with the number of people hired from outside the organisation. When a large number of competent candidates apply for your available positions, you know you're doing a fantastic job of reaching out to the right people. This will also result in an increase in interviewees.
2. **Training Overview-** Human Resources can provide valuable insights. When putting together your digital transformation leadership team, HR and people operations should be taken into account. These groups will ensure that your staff obtain the necessary training and that their professional development is in accordance with the company's progress. Total Employees in digital transformation department, Digital diversity, Employee turnover rate can help the organization track their success.



Figure 9 Screen 1 HR analytics- Knowledge & Learning

3. **Employee engagement-** In today's corporate world, this is one of the most elusive and misunderstood notions. Many bosses are finding it difficult to keep up in a world where employee demands seem to be rising by the day. As is the case with digital transformation, one area where a greater emphasis should be placed is informing employees about and including them in the development of your organization's purpose. Connecting employees to your organization's purpose. KPIs force an organization not just to measure how their strategy is performing, but to decide what their strategy is in the first place. They show employees a lot about what actually matters to management in the first place. You may demonstrate to your employees the importance of their job beyond what they perform on behalf of their departments by concentrating on the important metrics that truly define corporate success. To inspire and encourage your employees to embrace digital change as a positive element for their work and careers, you must have strong leadership in place. Employee morale suffers greatly as a result of micromanagement. One of the worst effects is the stifling of employee innovation. As a result, the organization's stress level is measured by the last category of KPIs. The below table provides an overview and briefly explains screen.

The below table provides an overview and briefly explains screen 1

Category	Topic	Description	Metrics	Data source
General workforce characteristics	Digital jobs	The number of digitalised jobs compared to the number of other jobs. (Definition of digitalised job depends on organisation)	# and % of digital jobs (function and function family), quarterly/yearly per department/whole organisation	HR systems
	Specific technological functions	The presence of certain specific tech functions and departments or the absence of them.	# and % of specific tech functions (function and function family), quarterly/yearly per department/whole organisation	HR systems
Transformation	New jobs	The number of new jobs as result of the execution of a digital strategy compared to the total of new jobs.	# and % of new jobs (function and function family), quarterly/yearly per department/whole organisation. Through time: over last 3-5 yrs.	HR systems
	Disappearing jobs	The number of disappearing/superfluous jobs as result of the execution of a digital strategy compared to total disappearing jobs.	# and % of disappearing jobs (function and function family), quarterly/yearly per department/whole organisation. Through time: over last 3-5 yrs.	HR systems

Category	Topic	Description	Metrics	Data source
Recruitment for digitally strategic positions (detail of new jobs)	Who is hired for key positions	The number of key jobs that are occupied by new employees compared to the number occupied by employees from within the organisation.	# and % of new employees and % of internal promotions, quarterly/yearly per department/whole organisation. Through time: over last 1-3 years.	HR systems
	How fast vacancies are filled	The number of key jobs that remain vacant and the duration of the vacancy compared to vacancies in other areas and compared to external benchmark.	# and % of vacant key jobs (function and function family), duration of vacancy in months, quarterly/yearly per department/whole organisation. Through time, over last 1-3 years.	HR systems
	External hires	The amount of external (interim) hires for permanent key positions compared to the total number of key positions in the same area.	# and % of external hires for permanent jobs (function and function family), length of their contracts, quarterly/yearly per department/whole organisation. Through time: over last 1-3 years.	HR systems/finadmin
Training & development	Training budget allocated	The hight of the allocated training budget to execute the digital strategy compared to the total training budget and to total company investments and compared to an external benchmark	k€ and % of total training budget, Q/Y, dep/org; k€ of total company investments, Q/Y, dep/org; k€ compared to external benchmark, Q/Y, dep/org. Through time: over last 3-5 years, for the next 1-3 years.	HR systems/finadmin
	Training budget spent/used	The amount of training that has actually taken place compared to the total budget.	k€ and % spent of allocated training budget, Q/Y, dep/org. Through time: over last 3-5 years.	HR systems/finadmin
Retainment of employees	Employee turnover rate	The number of employees in digitalised jobs that leave the organisation and the duration of their employment compared to the organisations average. Same for key positions.	# and % of digital jobs, duration of employment in years, Q/Y, dep/org compared to company overall average. # and % of key jobs, duration of employment in years, Q/Y, dep/org.	HR systems

	Employee satisfaction & engagement	The satisfaction of employees in digital jobs and key jobs compared with the companies average and with external benchmark.	Rating that comes from an employee satisfaction assessment, Y. Compared with previous 3-5 years, between departments.	
Transformation power/vitality	Burnout	The number of employees in digitalised jobs and key jobs with burnout complaints compared to other jobs. The number of employees with burnout in departments/ processes that are in digital transformation compared to other departments.	# and % of digital jobs and total jobs, Q/Y, dep/org. Indicate departments that are more involved in digital transformation.	HR systems
	Illness	Same as above.	# and % of digital jobs and total jobs, Q/Y, dep/org. Indicate departments that are more involved in digital transformation.	HR systems

Table 9 Screen 1 KPI Summary

The above listed group of KPIs are summarized in below table 9.

KPI Group 1- HR Analytics – Knowledge & Learning		
Overview	1	Employee turnover rate
	2	Training on digital skills
	3	Technology training & usage
Talent Management in digital transformation	4	How many employees leave the organization
	5	New Hires
	6	Hire of external expertise
	7	Internal Promotions Vs. External Hires
	8	Month-on-month (MoM) growth in hires
	9	No. of Vacancies
	10	No. of Recruitment
	11	Percentage Of Response to Open Positions
Special Roles	12	% Of tech talent in data-scientist role (early in digital journey)
	13	% Of working technical talent vs managerial talent
	14	% Of talent from tech companies or top engineering schools
	15	% Of talent holding PhDs
	16	% Of tech talent in specialist roles, e.g., cloud architect (later in journey)
Stress level / Organization	17	Burnout illness
	18	Overtime/falling behind
	19	Absenteeism

Table 10 KPI Group 1 HR Analytics – Knowledge & Learning

To summarize, when people aren't considered, digital transformations are often unsuccessful. The correct talent measures may change over time, depending on where your organization is in its digital journey. In the early stages, organizations will want to focus more on having enough senior architects and entrepreneurial builders. A narrow view that tech is the only answer without thinking of people leads to frustration and unsuccessful initiatives. Finally, in order for digital transformation activities to meet expectations and add value, everyone must understand and support initiatives. HR can save up time and increase its skills for driving an organization-wide change by embracing digital transformation first.

4.4.2 Screen 2- Financial Perspective

The financial perspective represents a set of the operating, financial investment activity goals, and strategic objectives of company financial position should also be defined. Digital transformation can help organizations grow revenue by improving the customer experience or supporting the introduction of new products and services. This section of screen can be divided in 3 categories: Revenue, Expense & Return on Investments.



Figure 10 Screen 2 Financial Perspective

1. **REVENUE-** Digital transformation can be tracked using revenue per employee, which can sum up in which direction the transformation is going. Revenue From New Digital products and services are another aspect. For example, new products or services launched on the market (percentage of revenues). Lastly, an organization should track the Percentage of revenue from Digital channels.
2. **EXPENSES-** Organizations that spend only a small proportion of their technology budgets on enabling the most strategic, bold digital initiatives are unlikely to maximize return on digital investment. The allocation of technology spend is a leading indicator CEOs can monitor to ensure that the organization is positioned to deliver digital-

backed value. It is very important to consider amount of marketing expenditure in digital channels and digital initiatives. Keep track of costs for external hires, contractual employees and organization transition to digitalization is essential for measuring the success.

3. RETURN ON INVESTMENTS - Measuring the return on digital investment is both standard and essential. Thus, digital investment is also about loss avoidance. Another way to maximize return on investment is to direct enough resources toward promoting adoption of new digital tools. An interesting predictive insight is only as useful as the response it enables. For example, data identifying the customers most at risk of buying elsewhere can retain customers only if marketing or sales associates take effective actions to keep those customers happy. The digital transformation strategic objectives achievement will allow increasing the company long-term shareholder value. Strategic objectives of customer, internal process, and organizational capacity perspective are specified by decomposition of the financial perspective goals via drivers.

The below table summarizes the above listed group of KPIs for financial perspective.

KPI Group 2- Financial Perspective		
REVENUE	1	Revenue From New Digital Services (Customer Service)- Related to products
	2	Percentage of revenue from Digital channels
	3	New products or services launched on the market (percentage of revenues)
	4	revenue per employee
EXPENSE	5	Amount of marketing expenditure in digital channels
	6	Percentage of annual technology budget spent on bold digital initiatives
	7	Operating Expenses and Contribution Margin
	8	Costs of external hiring of people
	9	Costs of illness
	10	Costs of transition and reorganization
	11	cost of user acquisition
RETURN	12	Return on Digital investments (Trainings, Products)
	14	ROI = (Net Profit)/(Invested Resources) X 100
	15	Contribution and involvement of company departments in digital initiatives

Table 11 KPI Group 2 Financial Perspective

Thus, Digital transformation has the power to radically overhaul every aspect of an organization's operations. Inevitably, the financial department is included. However, because a financial transformation has a company-wide influence, the CFO's office plays a significant role in advancing the transformation beyond its own domain. Digital transformation allows the CFO's office to reconsider current strategies and introduce improved ways to conventional, if expensive, corporate practices when done effectively. This value-added approach to innovation ultimately aids corporate firms in identifying and resolving ongoing

problems that they were initially sceptical about. CFOs seek a future based on enhanced reliability, rapid development, and timely, insightful data to assist them in making strategic decisions.

4.4.3 Screen 3- Organizational & Operational Performance

This Screen is divided into two categories. The first KPI group focuses on the organizational changes. The second group of KPIs focus on the Business processes in an organization. The process of change management involves continuous improvement and a cultural shift. It should be supported by a “culture organization” that specifically helps with change management, especially during periods of intense change. (Kaplan and Norton, 2007) show that dashboards and performance measurement are highly effective in achieving organizational change and transforming companies.

Speed, specifically the quick translation of ideas into tools that can be used on the front line, is critical in a digital organization. In a fast-changing world, delay means yielding advantage to the competition or, worse, producing a tool that is obsolete before it’s ever used. Despite this, many organizations have little idea of how they measure up in this area.

The list of KPIs for this screen are summarized in table11.

KPI Group 3- Organizational Change Capability		
Culture & Leadership	1	Contribution and involvement of company departments in digital initiatives
	2	Data-driven decision making (%)
	3	Innovative ideas being implemented and their level of success/department
Operational performance Efficiency & Quality		
Business & Products	1	Reliability (% of deliveries that are on time and within requirements)
	2	% of projects stopped on time
	3	On-time/on-budget delivery
	4	Average number of projects that are restarted after being stopped
	5	New applications, Technologies and Innovative Solutions Applied
	6	Number of systems with known vulnerabilities
	7	New business models adopted for different markets
	8	Percentage of business leaders’ incentives linked to value-creating digital builds
	9	Reduced time to market for new products
	10	Time required to build a digital application

Table 12 KPI Group 3 Organizational & Operational Performance



Figure 11 Screen 3 Organizational & Operational Performance

4.4.4 Screen 4- Customer Support & Service

For the customer perspective, customer integration involves the users in the process and making use of customer data when developing new products, as well as extensive use of customer testing of new products. In practice, end-to-end customer experience optimization, operational flexibility and innovation are key drivers and goals of digital transformation, along with the development of new revenue sources and information-powered ecosystems of value, leading to business model transformations and new forms of digital processes. There are various ways to enhance Digital Customer Service Strategy.

1. Determine which services can help you maintain long-term business resilience and success.
2. Dive deeper into the three steps to implement an effective, digital customer service strategy
3. Understand current customer journeys: Use this checklist of questions to understand typical customer journeys to help determine what customers are looking for.
4. Implement necessary technology: Explore three important technologies business leaders should consider to accomplish their CX goals.
5. Measure success: Track the right metrics to determine the effectiveness of implementing a digital customer service strategy.

The customer perspective strategic objectives are as follows:

1. User experience stands for level of usability, carefully designed authentic properties, engagement, and personalization that digital products or services possess.
2. Usability means the functionality and handiness of offered product or service that allows customer to seamlessly enjoy the usage of it Integration of customers into service creation and delivery stands for making customers actively involved into design and provision of digital product or service.
3. Customer satisfaction Customer satisfaction scores indicate satisfaction of customers with company's offerings, and include referral rates, and retention indicators.

4. Retention percentages are the ratios of customers that make return purchases of firm's products or services, measured per customer segment

The List of KPIs for this screen are summarized in below table.

KPI Group 4- Customer Support and Service	
1	Net Present Value (NPV) and Internal Rate of Return (IRR)
2	Net Promoter Score (NPS)- Before & after digital transformation
3	Customer Satisfaction (CSAT)
4	Customer Effort Score (CES)
5	User Lifetime Value
6	Number of active customers
7	New customer acquisition rate
8	New customer conversions
9	Change in customer/user behaviour
10	User satisfaction — to help continually improve the user experience of your service
11	Improved user experience
12	Increasing customer participation in digital channels
13	Integrate with power BI for customer feedback-Sentiment Analytics
14	Customer and business management focused- % numbers, graph
15	Reduced time to market for new products

Table 13 KPI Group 4 Customer Support & Service

Finally, it's important to evaluate user perception of the technology, since end-user satisfaction ultimately determines how well the technology investments translate into the desired financial and organizational improvements. Some common metrics to evaluate user satisfaction include:

Customer Effort Score (CES) Monitoring where, how, or if people are finding you and adjusting strategy and tactics based on those results will be important in this year's competitive digital market."

4.4.5 Screen 5- Technology & Innovation

The goal of digital transformation is to build a flexible organization that can adapt as technology advances. As organizations struggle to catch up, technology will always be ahead of the trend. One of the reasons why digital transformation efforts fail is a lack of adaptability. Cloud-native tools and technology can provide the agility that businesses will require in the future. "Processes should be developed end-to-end in the cloud and designed to learn from human contact to keep improving thereby establishing a baseline and monitoring targets. "It's

necessary to make sure that digital transformation and data are truly enabling businesses to recognize and take advantage of new opportunities. The List of KPIs that can be tracked during digitalization are listed in below table.

KPI Group 5- Technology & Innovation		
1	Business & technology alignment	Scale from 1 / the lowest to 5 /
2	Technology capability & flexibility	Scale from 1 / the lowest to 5 /
3	Level of integration of systems	Scale from 1 / the lowest to 5 /
4	Percent of business processes enabled by AI	% & Numbers
5	Percent of processes designed for cloud	% & Numbers
6	Cloud Application Deployments	% & Numbers
7	Data Quality	% & Numbers
8	number of licenses you purchased to the number of employees who are actually	Adoption rate of your software investment
9	Patents/R&D	ERP systems
10	Ratio Discoverers/Deliverers	ERP systems
11	Innovative ideas being implemented and their level of success	Number of ideas/years
12	number and value of successful innovations brought to market	Time to market
13	New applications, technologies and innovative solutions applied	ERP systems
14	New business models adopted for different markets	ERP systems
15	completion rate — to show which parts of the service you need to fix	ERP systems
16	Count the number of processes performed on new software	ERP systems

Table 14 KPI Group 5 Technology & Innovation

The number and value of successful ideas brought to market are indicators of success. Scaling AI capabilities such as machine learning is an essential part of many companies' digital ambitions. Keeping track of the percentage of the company's most significant business processes that are aided by AI capabilities or technologies. Companies have taken advantage of the pandemic time to do AI proofs of concept. Digital technology and innovation are increasing in importance to achieve business. Innovation capability – digital competencies of a company, including strong collaboration with internal IT department; cooperation with external partners, such as start-ups and universities; and allocation of resources, budget, and time to digital innovation.

5 Prototype Evaluation

For INPAQT, the digital transformation prototype to validate the proposed artwork was chosen as the first evaluation case. The applied evaluation technique is discussed in this chapter, as well as the proposed evaluation plan as a result of the expert evaluation interview. Once a solution has been designed, it must be validated before it can be implemented, according to the design science methodology (Wieringa, 2014). A panel of experts is gathered for this purpose, and the prototype is presented to them. The same experts are invited to take part in the questionnaire after being guided around the prototype. The questions for each set provided in the Appendix E.

5.1 Evaluation Plan

A digital transformation at INPAQT BV defines a practical environment in which the proposed prototype is implemented. In these situations, a technical action research (TAR) method is used (Wiringa, 2014). A TAR is a method of validating artifacts in the study area. As part of the assessment section, semi-structured interviews are conducted through an expert opinion process to assess the designed artifact.

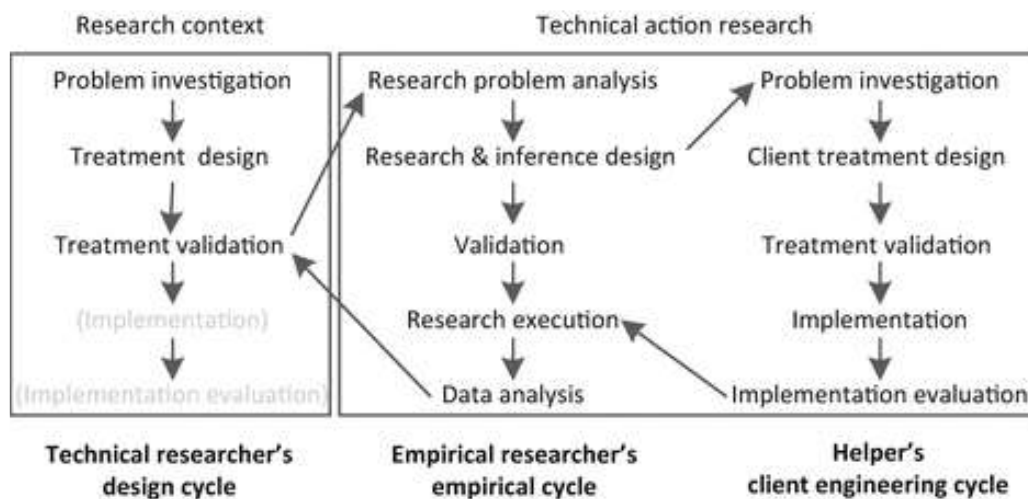


Figure 12 Three-level structure of TAR

Primarily the evaluation plan consists of the following steps:

1. Ask experts in the field of interest to validate the designed prototype.
2. Reflection on the designed artifact.

A step in the evaluation process is stakeholder analysis. The stakeholders listed are those who have an impact on the digital transformation paradigm or its outcome. They can be internal (INPAQT) or external (INPAQT) in nature (catapult24 expert). Evaluation interviews were conducted as an online video conference according to the Covid-19 measure.

5.2 Evaluation Interview

Based on the prototype and design rules, the evaluation questions were setup and this process was conducted over the video conference call. To make it easier for interviewees to evaluate and to assess in short amount of time, only the five most important questions were setup for this process. The questions were divided mainly into two sets, open and closed questions. Moreover, inclusion of both types of questions in the evaluation process helps to learn unexpected and important things (Farrell, 2016). With these types of questions, interviewees were asked to answer based on their experience how this dashboard will be useful to them.

1. Open Questions these type of questions were setup to know the usability of the dashboard and their overall impression about the information. The questions were framed like this type because it allows interviewee to give free form of answers.
2. Closed Questions these types of questions were setup to understand the usefulness of functionalities of the dashboard which have a limited set of possible answers. For instance, whether to include the functionalities (such as segmentation, elasticity etc) on the digital transformation dashboard.

For each expert, the designed innovative dashboard was provided utilizing a set of Power BI tools. This series of dashboard screens was used to illustrate the approach to each expert. The approach was explained as well as the whole development process. Following that, an open conversation conference was conducted in accordance with the interview protocol. It's worth noting that expert C was unable to participate in the interview, therefore the evaluation sessions were limited to experts A and B.

5.2.1 Expert Panel

Two experts involved during the dashboard design phase agreed to take part in the validation and evaluation

1. Expert A - Expert A knows all factors involved throughout the DT method as the company's CEO: people, organisation, technology, and the impact of the pandemic as a crucial catalyst. He is a fantastic leader and change-maker who can perform and support any type of transformation, and he plays a strategic role in rewriting procedures and establishing operational goals. The CEO must establish the duties and responsibilities of management in order to implement a successful digital transformation strategy. An ERP system can help a CEO get a bird's eye view of what's going on in the firm and identify areas where exponential value might be generated.
2. Expert B- Expert B divided his work into three categories: leadership and team development, executive and personal coaching, and corporate training and consulting. He uses INPAQT to help individuals and teams understand the change the firm wants and how to make it happen. He has a strong interest in people development, company development, and performance effect. He has a wealth of leadership development experience and has created a fantastic Team Development Program. He is currently working in the company's strategic business development department.

5.3 Evaluation Results

This section summarizes the evaluation results of the smart dashboard based on the feedback received from the interviewees. The results are divided into two sub-sections qualitative and quantitative results. The qualitative results are from open-end questions and quantitative results are from closed-end questions. This is because, in order to understand whether the dashboard will be helpful in all the perspectives of the company. Six experts relating to this field were interviewed during this phase. The results are presented down below table. The rating was given based on the interviews' outcomes.

Attributes	Description	Rate
Digitalized attributes	Designed digital transformation prototype was feasible, but not efficient enough to execute the adoption in the timespan available. This characteristic has a direct bearing on the design and implementation process. (Expert 1)	Medium
Design Efficiency	The efficiency as a performance criterion of the DT was also evaluated as one of 3 most essential elements	Medium
Decision-Making Agility	Because of the existing situation's agility, there is room for progressive improvement. However, if this procedure is continued every few months or years, a new method can be implemented, which is also beneficial to the organization (Expert 1, 2).	High
Reliability	The reliability of the performed DT in INPAQT was evaluated as not an essential element as it can be covered by the combination of the rest 3 criteria.	High
KPI Capability	The competence of INPAQT's digital transformation is a critical criterion because people must comprehend the many stages of the process. They must be familiar with the DT's tools and how they operate. (Expert 1).	High
Resilience	6. -The resilience criteria have an immense impact because there should be planning for where the organization is in three years after the DT. This is a management level change and management should always be looking in the future. it is graded.	High

Table 15 Evaluation Results

5.4 Reflection

As the final step of the evaluation process, a reflection was made using the SWOT analysis method in order to critically review the designed artifact. The results are presented in the following table:

Strengths	Weaknesses	Opportunities	Threats
Sectors covers all necessary aspects for the Digital transformation	it is a high level of description approach	the model can be used in practice by any company	Digital transformation in on-going process
the prototype can be easily transferred in other 4 sectors and KPI shortlisted is generalized			
it is based both on a practical case and supported by the theory			

Table 16 SWOT analysis

5.5 Limitations

This section reflects on the possible limitations (Peffer, 2007) of the first evaluation study. Firstly, it is acknowledged that it is a threat due to the fact this study includes only 2 practitioners. This poses a threat to generalizability of the findings and therefore it would have been much more beneficial if there had been more stakeholders. However, participants were selected because of their deep expertise of INPAQT and also because they share some commonalities, specifically:

- (1) profound knowledge of the organization,
- (2) expert knowledge of its business processes,
- (3) expert knowledge of the organization's support systems.

According to (Seddon and Scheepers, 2011), it is assumed that the views and perspectives of these two experts are easily comparable to those of other INPAQT practitioners with the same expertise. This is feasible because, as Seddon and Scheepers point out, identical work settings might result in similar organizational mechanisms, which can lead to similar field observations. Clearly, replicating our evaluation with additional participants would be ideal, and this would form a future study path. To conclude, this initial assessment of the proposed artifact provided strong evidence that the artifact is useful for INPAQT. The leadership team of INPAQT believes it is appropriate for their organizational requirements, and they want to use it in the component under test of their digital modernization program. This artifact is used to measure their transformation journey in INPAQT. Following the Design Science principle of iterative improvement of any proposed artifact based on repeated use in subsequent contexts within the same organization (Wierenga, 2014), the company is optimistic about the artifact's progressive improvement and potential modifications as additional knowledge and insights from its use become available. Secondly, personal bias on the part of the researcher is a prevalent concern in qualitative evaluation studies of design science objects in general. If an artifact created for one organization worked well for its original context (INPAQT), this artifact could serve as a starting point in other organizations who want to start a DT initiative and have similar goals.

6 Conclusion, Contribution and Future work

In this chapter research is concluded by presenting findings with the research objective initially defined. Furthermore, each research questions are answered based on the artifact designed and evaluated through the research process. Additionally, the limitations of this paradigm are addressed, as well as how this contributes to practice and academics. Lastly, opportunities for future research are provided and lastly, recommendations made.

6.1 Conclusion

This research successfully designed a smart KPI-Oriented dashboard for digital transformation which is called as the “Digitalization Monitoring Tool”. The development processes in this thesis followed the steps in DSRM by (Peffer, 2007). This section will explain how the study answers the research questions which are elaborated in section 1.4. The main question of this research will be answered followed by the sub-questions that are related to the answer to the main question.

Main Question: “How can organizations monitor and track their digital transformation success?”

A KPI dashboard provides you with an at-a-glance view of your business performance in real-time so you can get a better picture on how the entire organization is doing. The main question was answered in Chapter 3 and Chapter 4. The primary process of developing the framework was described in Chapter 4. However, the result of a systematic literature review in Chapter 3 provides the background information that is needed to start developing the artifact.

RQ1: What steps are followed in identifying the key performance indicators (KPI) in the digital transformation process?

KPIs generally are an essential tool for measuring the success of business and making the adjustments required to make it successful. The study answered this question in Chapter 3 and Chapter 4. According to literature review, KPIs can be identified in 2 ways: Literature based, 2-Expert-Opinions. Considering the method 2, Combining both methods, a total of 105 KPIs are shortlisted which can be used for measuring the digital transformation process.

RQ2: What are the various Decision-making approaches/methods used in an organization?

The literature review reports the SLR process of findings state-of-the-artwork related to available decision-making approaches. A total of 9-commonly used methods were identified during this stage. Later, this topic was explored during the interviews. Several participants agreed on making decisions on the fly just by looking into the systems in form of spreadsheets. Dashboard is a popular tool designed to quickly display the picture a company's performance, especially prepared for the busy leaders. Therefore, these aspects were referred in the artifact that was developed in this study.

RQ3: How can we relate an IDSS (Intelligent Decision Support System) with decision-making for the digital transformation of the organization?

Business intelligence is inclined towards management requirements and decision-making support. The purpose of a BI dashboard is to see clearly your business reality so that you can make the right decisions at the right time. Dashboard design in the business world isn't terribly exciting. Competitive organizations have implemented systems of business intelligence in order to help employees in the process of evidence-based decision-making. The dashboard is designed using the Power BI tool. It is a Business Intelligence tool-based Research question RQ3 results is used for cloud-based data analysis. Compared to other BI tools (such as Tableau, Google Data Studio) Power BI is more simple, powerful and user friendly for BI developers, data analysts and business analysts.

RQ4: How to design a smart decision support dashboard for digital transformation?

Based on the three aspects covered RQ1, RQ2, R3, a conceptual framework was designed. This was then used as a framework to design the smart decision support dashboard. By answering research question 1, a list of import metrics were shortlisted that was later incorporated in the dashboard. Research question 2 provided the decision-making method that's would help organizations to make faster decision which is a use of dashboard. The finally, the interviews helped in requirement gathering of the smart dashboard. The proposed digital transformation model consists of 4 sectors that are needed to be included for a successful digital transformation: People – HR & Employee Engagement (1), Technology - Digital Service Platform (2), Financial perspective (3), Customer perspective (4). List of key performance indicators consisting of multiple attributes as mentioned in Chapter 5 were considered that influence the digital transformation progress. It is assumed that the chosen approach of tracking a digital transformation via a smart KPI oriented dashboard clarifies how the digital transformation should be handled. Therefore, these aspects were referred in the artifact that was developed in this study. Furthermore, the outcome of this thesis demonstrates that the practitioner, in this case the researcher, may follow the majority of the procedure.

RQ5: How well does the smart digitalization dashboard perform in above context?

In order to evaluate the usefulness and the usability of the newly proposed model and to generate possible improvement options, an expert panel was used (Chapter 5). Interested readers could find the questions discussed with the experts in Appendix D and Appendix F. Whereas the opinions of the experts varied, their overall evaluation demonstrated that the prototype led the case company through the DT process and was practical, useful and usable for implementing a new system. In the perceptions of the involved experts, the prototype was found to be compatible with the organizational and technical infrastructure. As the result of the evaluation, a final transformation prototype was presented as the final artifact of this thesis. The final artifact was tested during a case study and evaluated by experts. Chapter 4 reveals how the proposed model is used in case study of INPAQT. The company case admits that the prototype is applicable for performing digital transformation in conditions of pandemic.

To summarize, as a company embarks on its digital transformation journey, it's important to have the right metrics in place to garner success as digital transformation is all about evolving for the better. The methods, frameworks, and metrics that this study brings forth can be utilized for either further research in this field or to make decisions on which methods to apply in practice based on specialized needs.

6.2 Research Contribution

The research is important from both a practitioner and a researcher's standpoint. This thesis presented two major contributions, based on the research's practical and scientific relevance, as well as the evaluation conclusions. Firstly, this thesis contributes to the body of knowledge in the Business and Information Technology discipline by offering a novel way to designing a KPI-oriented dashboard for monitoring Digital Transformation performance from a theoretical approach.

The artifact assembles the fundamental building blocks to embrace modular, agile, and evolutionary architectures based on the results of a systematic literature review and the examination of a case study in an innovative organization. Additionally, this study has conducted Technical Action Research to provide significant insights into how the proposed artifact contributes to Digital Transformation initiatives. Finally, from a practical perspective, this research has evaluated the suggested prototype and its core methodologies in a real-world Digital Transformation project. The implementation for INPAQT provided the appropriate environment to assess the usefulness of absorbed concepts from other architecture frameworks or methods that were either presented only at a theoretical level or were recently published where no real-world implementation cases existed. Therefore, this study has served as a point of reference for the validation of such approaches with their particular benefits and drawbacks in relation to practice. This is described more in detail in the next subsections.

6.2.1 Scientific Relevance

Due to its high value in conditions of crisis, several IS research schools and individual scholars were focused on providing a more effective and comprehensive prototype to organizations with different sets of essential elements for successful digital transformation. However, there has not been much progress in updating traditional approaches. This research analyses, compiles, and integrates methodologies from selected publications and proposes a new set of attributes for Digital Transformation and validates their suitability and usefulness on a case. To sum up, the thesis makes two contributions of scientific relevance: first, contribute to knowledge by proposing a framework that includes elements combined in a way that evaded so far, the attention of scholars. This new framework was evaluated by means of experts' opinions regarding its usefulness and usability. Second, contribute a case of a real-world organization and a demonstration of how the framework and the prototype actually work. This increases the realism of our proposed artifact. Of course, openly make the note that follow-up research would be needed to increase its generalizability to other similar but different contexts. This can be summarized as follows

- Conceptual framework that can be used for digitalization dashboard development.
- A list of Key performance indicators for measuring digital transformation as a whole.
- Extending the limited research on intelligent decision-support dashboard for digital Transformation mentioned in section 7.2.
- Extending the limited research on list of digitalization KPIs as digital transformation keeps evolving.

6.2.2 Practical Relevance

Industry-leading research and surveys have shown that organizations that have adopted best practices to embark on Digital Transformation initiatives are more likely to succeed than those who did not (McKinsey & Company, 2018). The digital transformation prototype and development method, as presented in this research, are meant to assist organizations to perform Digital Transformation. With the proposed prototype in this thesis, practitioners would have a map that would inform them about what to consider in their DT initiative and how to track their progress. Practitioners might adopt or adapt this map based on their own context. Clearly, the decision on how much of our proposal to adapt is contingent on the similarity of contexts between INPAQT, the company for which the prototype is originally developed, and the context of any other organization. As it is seen later in this thesis, the proposed prototype could possibly be a good candidate for adoption in any other Dutch organization that is different yet similar to INPAQT in terms of contextual settings. This can be summarized as follows

- A smart KPI-oriented Dashboard proposal for INPAQT B.V. which can be used for their clients who are in first stages of digital transformation.
- Dashboard prototype can be integrated in Innovation Management Suite of INPAQT B.V.
- Interview Scripts that can be used as part of requirement gathering for digital transformation Success

6.3 Limitations and future research directions

Despite the fact that the study has addressed the main research question and associated research objectives as well as contributing to both scientific and practitioner communities, it has several limitations. First, Digital transformation is not a project but a continuous process (Wengler et al., 2021). This limits the number of scientific publications based on which known challenges are investigated. Hence, the list of KPIs can be explored by researchers and update the current standard list. As already mentioned, the authors do note that there is future scope for work on the prioritization of key performance indicators. Second, the lack of scientific literature on guidelines and strategies for DT limits the development of the final artifact. As Chapter 4 indicates, the method was developed by combining various ideas from several sources which might possibly be limited by these sources' authors' mindset. In addition to this, our very first evaluation exercise itself has some limitations, because of the involvement of only two experts. Further improvements for our method could be discovered if the method is applied to companies from different areas and business sectors but with the same aim to perform digital transformation during a pandemic when all researched challenges are still relevant. This paper also mentions about expert based KPIs. Future research can be done on the type of questions relevant for gathering the information. Additionally, since the research was carried out by a single researcher supported by supervisors, so there are chances of bias to be formed. Lastly, the current study is more focused on the main research question, and having articles on shortlisting the baseline framework for tracking digitalization success. This requires further research to quantify the sensitivity of the scale, which could not be covered as part of this research.

This section provides recommendations that can be addressed by researchers who follow this thesis. The directions for future work are listed below:

- a. The current framework provides the techniques for 4 specific domains which are still limited. Other domains of digital transformation that can be explored and applied in the information conceptual framework and dashboard design.
- b. Various AI method can be implemented such as sentimental Analysis for customer feedback.
- c. The evaluation of the dashboard can be applied in companies or implement the framework in the different business sector or environment. Hence, the future study will have more insight to improve the framework based on the various challenges that might be faced by the researchers.
- d. The input from the expert might be the option for adding value to the evaluation process of the framework.

These recommendations might be considered by the researchers who are willing to improve or evaluate the process of this study.

APPENDICES

Appendix A – Interview Script for Experts

I. Background Questions

1. What is your designation and what department are working for?
 - a. Organization name, position, role
2. Have you worked in field of digital transformation?
 - a. How long have you worked in this field?
 - b. If not, what kind of knowledge do you have on Digital transformation?
3. Have you used a dashboard before?
 - a. How familiar are you working with dashboard?
 - b. If yes, then what Kind of dashboard have you used?
 - c. If not, why not? What do you used for monitoring or tracking purpose?

II. Existing Dashboard

1. Does your current/previous organization use a Dashboard? If yes,
 - a. Who created the dashboard? (Analyst?)
 - b. How was the validation done? (Subject Matter Expert?)
 - c. Who currently maintains the dashboard? (Owner?) Handle access requests? Troubleshoot? Answer questions?
 - d. Who uses this dashboard? (Viewer?) & How competent is the end-user? Is the end-user familiar with the data and business domain or are they new to the data?

III. Digital Transformation & Dashboard-

1. What do you think Users look for in a Dashboard?
 - a. How detailed does your dashboard need to be? Should the dashboard be explanatory (tells everything) or exploratory (allows users to choose)?
 - b. What would the users prefer in your opinion?
2. Do you think it is necessary to have a standard list of KPIs apart from user requirements?
 - a. Which groups of KPIs do you think would be important at this phase?
 - b. Any KPIs related to monitoring digital transformation?
 - c. Does your company measure the success of digital transformation? What are the key performance indicators that your organization keeps the track of?
3. Which decisions/actions did the previous/current dashboards inform?
 - a. What type of decision needs to be made when developing a dashboard? ☐ Is this dashboard meant to help executives understand an established process and prescribe results or to explore a new course of action? 1
 - b. What kind of assumptions are being made currently or should be taken into consideration? Are they valid, consistent? 1
4. Existing Tools? & Visualization of Data
 - a. Are there any related tools/reports/data sources that other groups may be using? 1
 - b. If you could have access to ANY data you want, what would it be?1
 - c. If you could directly track/measure anything, what would it be? 1
 - d. How does it align with the big picture goals of the team/organization? 1

5. Current Problems with Dashboard:
 - a. Can you give us examples of what you like and dislike about dashboards you have used or that this is meant to replace?
 - b. What did you always want to know but couldn't find out?
 - c. What is currently missing? hard to get? Incorrect?
 - d. What have been blockers in the past?
 - e. If this dashboard is not doing what the viewers expected it to do, is it a training issue? Design issue? Data issue?

IV. Open Questions

1. Why do you think Dashboards are important?
2. What's your final opinion or how would you summarize on monitoring digital transformation Dashboard?

Appendix B – Interview Script for User

I. Background Questions

1. What is your designation and what department are working for?
 - a. Organization name, position, role
2. Have you worked in field of digital transformation?
 - a. How long have you worked in this field?
 - b. If not, what kind of knowledge do you have on Digital transformation?
3. Have you used a dashboard before?
 - a. How familiar are you working with dashboard?
 - b. If yes, then what Kind of dashboard have you used?
 - c. Does your company use a dashboard?
 - d. If not, why not? What do you used for monitoring or tracking purpose?

CURRENT SCENARIO

Focus Area

1. What is the current primary focus area? (Focus is specific- overviewing the results of a new project / broad-measure overall performance)
2. How are you currently answering questions related to Area of Focus? Such as digital transformation? Or monitoring progress? Change management?
3. What kind of assumptions are being made currently or should be taken into consideration?

Decisions:

1. How are decisions currently made? What is the current process?
2. What type of decision are currently made? prescriptive / exploratory decisions

Tools:

1. Are there related tools/reports/data sources that other groups may be using? 1
2. Which decisions/actions did the previous/current tools inform?1

KPIs:

1. Which groups of KPIs do you focus on in the first place? 1
2. Do you think it is necessary to have a standard list of KPIs?
3. Any KPIs related to monitoring digital transformation?

Company related:

1. Does your company measure the success of digital transformation? What are the key performance indicators that your organization keeps the track of?
2. What is being measured? An example might be useful as in How does these KPIs align with the big picture goals of the team/organization? 1

Pains:

1. What have been blockers in the past?1
2. What is currently missing? hard to get? incorrect? 1

Gap Analysis (past/present pains)

1. What did you always want to know but couldn't find out?1
2. If you could directly track/measure anything, what would it be? 1
3. If you could have access to ANY data you want, what would it be?1

Target Goal

1. What do look for in a Dashboard?
2. If given a chance to use a dashboard, what kind of dashboard would you like to use? (Exploratory or explanatory?) Should the dashboard be explanatory (tells everything) or exploratory (allows users to choose)? What would u prefer?
3. How detailed does your dashboard need to be?
4. Which decisions/actions would you like the dashboard to inform?

Dashboard Issues

1. Can you give us examples of what you like and dislike about dashboards you have used or that this is meant to replace?
2. If this dashboard is not doing what the viewers expected it to do, is it a training issue? Design issue? Data issue?1

Open Questions

1. Why do you think Dashboards are important?
2. What's your final opinion or how would you summarize on monitoring digital transformation Dashboard?

Appendix C – Interview Results

Background	User	Kevin Wierda	Jeroen Mattheijer	Peter Schreurs	Yoanette den Boer
	Company	Catapult24	MEE-Vivens	Deltion College	Amstelring
	Domain	Marketing	Care/Hr	Education	Care
	Position	E-commerce specialist and project manager.	Teamleader Human Resource	Project leader	CIO
	Most relevant previous experience	Responsible for system integration and data visualization. Focusing on external and internal data analysis, email marketing and marketplace management.	Involved in developing software to replace spreadsheets, used in the merger between ABN AMRO and Fortis.		Responsible IT, innovation and data - strategic advisor to the Executive Board Small team in technical innovation
		It is both Broad & Specific 1. Overall performance, specific projects & some other dashboard 2. Main goal is to keep on track and invest the profit we make to increase the traffic and revenue to make year after more.	Main Human Resource processes: 1. Recruitment of new employees 2. Workforce management i.e., how many and what type of professionals need to be on our payroll and how large should our flex shell be. 3. Personnel information (contract, performance) 4. Personnel development	1. Improve decision-making. Track the applications and hardware used by teachers. Sometimes they use more than they need. This enables to have discussion with them	1. Care for elderly digitally increase and less people take care of them. 2. Being data driven 3. Optimize the technology solution and try to make it easier and less work for careers 4. Member in digitalization in Netherlands

		<p>3. On broad sustain the growth of the company</p> <p>4. Focus on Profit & Revenue in magento/ERP dashboard</p> <p>5. Misc. project SEO – google ads in google data studio</p> <p>6. Customer Satisfaction - Customer service as most imp part of the company</p>		Availability of the room	
Focus Area	Current Tracking		<p>Website, Exact (Business Information System). Overviews and reports about vacancies were made manually. Very time consuming. Current situation Automated integration of website & back-office system (Exact). Now all information about vacancies is automatically transferred to our ERP system. Getting the information out in relevant reports. Near future Making a dashboard in the ERP</p>	Work overload. Workforce management.	

			system that shows the reports we need.		
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		<p>1. Company uses multiple dashboards for tracking and decision making.</p> <p>2. Revenue and profit analysis tools in ERP software of dozon(parent company) and in magento as well for some KPIs</p> <p>3. A lot of google advertising as it is way largest in this field</p>	<p>Exact BIS, the heads of the managers. Overviews are made manually by different stakeholders (probably in spreadsheets, not exactly clear in detail) Stakeholders have a different & partial view of the situation. How can one data source serve all stakeholders? This is currently being looked at together with external company. Future situation One system to support</p> <p>a. Managers to have enough qualified people at the right time;</p> <p>b. Finance department in their budgeting process;</p> <p>3. HR to gain insight in the future movement of contracts and employees. Stakeholders have their own dashboards with relevant information. These dashboards still have to be designed.</p>	<p>1. operational stop because of processes a different process which involves people that now do not look at the same dashboard</p> <p>2. Top desk for working and prioritizing</p>	<p>1. Track all the individual innovations and other projects Monitoring is in line with project management</p> <p>2. Sensor Data show how care is going as it gives Process information</p> <p>2. Sensor data gives advice</p>
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Decision Making	Operational Level	<p>1. Ongoing process and decisions are made continuously by people involved. Everyday Basis, Check prices with Competitors, Decisions are made on the fly.</p> <p>2. Actively help customers in needs with customer service needs with our power tools we sell. (Tracked in helpdesk)</p>	<p>Current situation Exact Business Information System The system is not designed to support operational HR-processes, nor facilitate HR in mergers. How to move HR information into a different system? This is the question that is currently being asked.</p> <p>There is an ongoing discussion about working with a separate HR system - or not. Future situation Unknown Unknown</p>	NA	<p>1. Started with training people with technical innovations</p> <p>2. People came with problems with feedback and leave review</p> <p>3. Transform the mindset</p> <p>4. Based on this support in using technologies</p> <p>5. Show data bank and data is validated by dept and other people can make their standard kips and reporting for decision making</p>
	Strategic Level	<p>1. 5 yearly plan having sub plans</p> <p>2. Find new project to continue to build on and also monitor website performance and check if targets and profits are met</p> <p>3. Turn on notifications to meet revenue goals</p>	NA	NA	learning process using the E-Learning

	Assumptions	If conversion rate drops in GA then we know something is going on and we should dive into specific website learning pages	NA	NA	Elderly have a care plan which is promised in the care plan to the clients or the family that gives an external equality
	Previous Tools	Google Analytics, Magento. Still in use		Spreadsheets and Central Database, Top Desk	Exocube. Sponsored by Microsoft but not developing anymore coz of powerbi - old fashioned management reporting
Tools	Current Tools	Google analytics, KPIs Google data studio, not focused on dashboard	NA	Multiple system Data--> Central database. All info is provided from same place	Tableau. Still in Transition Used in combination with python and ai solution'
	Current Tools Main KPIS	Trustpilot for review Score	NA	NA	
		Return on investment, return on expense,	NA	NA	Normal KPIs on results sickness cost profit
KPIS	Main KPIS Pain	Most of KPIs are available for dashboard but we have so much data that we can find a lot of KPI	NA	NA	No target, but trends, insights. Need to translate into KPIs

		Every now and then, we put in excel sheet manually and it's not tracked else or automated	NA	Communication gap. As everyone had a different report.	Upscaling is the problem
Pain What would they like to monitor		Delivery Time- A lot of suppliers and info comes from them about delivery time which we need to give our customers	NA	NA	old alarms for falling apart. Technical innovation tracking
				NA	Different processes in still digitalization
		Review score not in dashboard Trustpilot, google try to get happiest customer in market by providing customer service	NA	NA	a digital transformation that people always want to keep their data for themselves internally no way
		We should do data analysis to look KPIs we can use in future to extend our list from 5 to 30	I would like to know: Did we have the right starting question? What do we need to do next? What is the path from A to B? The dashboard needs to keep us on track.	Need dashboard for the security system data	1. Medications is all digitalized but would like to track upscaling 2. Upscale is digital contact

Target Goal	What would they like to monitor	Monitor the fluctuations of how happy our customers are	I would also like to measure the effects or results of the digitalization on our care professionals: It should empower them. They now feel like they are serving the system, while the system should serve them. A lot of care professionals have no or limited IT experience, they need guidance.	1. Prioritize what is happening 2. Know what is changing 3. Report to Managers. And what can be secured in the business	Dashboard with KPIs of upscaling and integrate with concern report so everyone can measure the success of digital transformation
				All the processes available in institution such as catering, buildings etc.]	how to make them familiar with using digital means
		The dashboard needs to keep us on track.		Detailed dashboard: high level. Gives the urgency & priorities to able to work. highest-level address things like people not working. Able to drill down things	New way of working to make a different kind of transformation. What we did this year is to have again all kind of digital transformation to make people more digital we already did that a few years

Table 17 Detailed Interview Results

				if there is a mistake	
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Appendix D – Key Performance Indicator List

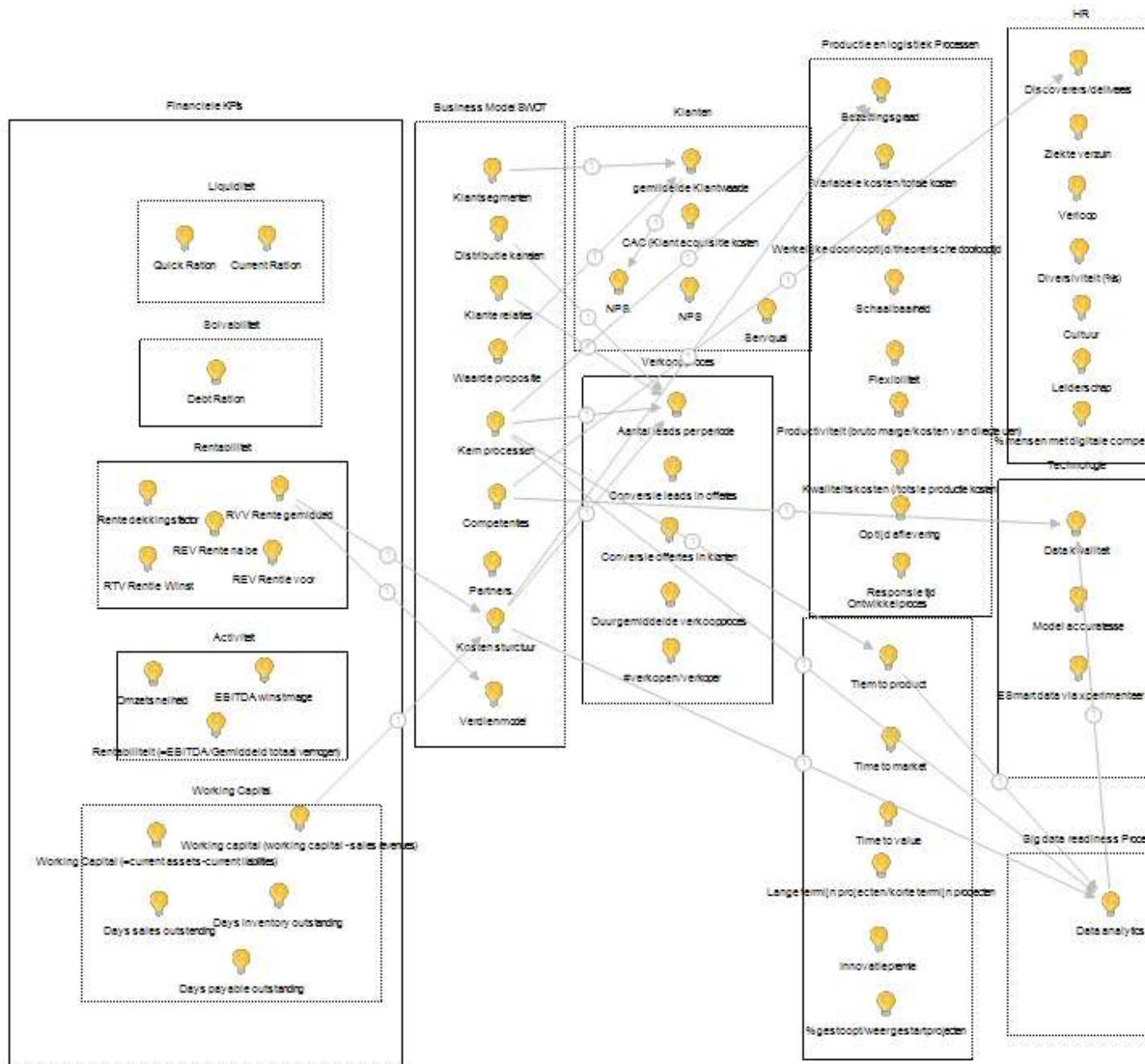
Sr. No.	Key Performance Indicators
1	% of working tech talent vs managerial talent
2	% of digital sales
3	% of projects stopped on time
4	% of talent from tech companies or top engineering schools
5	% of talent holding PhDs
6	% of tech talent in data-scientist role (early in digital journey)
7	% of tech talent in specialist roles, eg, cloud architect (later in journey)
8	Absenteeism (ziekteverzuim)
9	Additional revenue from digital channels
10	Amount of marketing expenditure in digital channels
11	Application Management
12	Average number of projects that are restarted after being stopped
13	Big Data Readiness
14	Burnout illness
15	Business & technology alignment
16	Change in customer/user behaviour
17	Cloud Application Deployments
18	Collaboration
19	Completion rate — to show which parts of the service need to fix
20	Contribution and involvement of company departments in digital initiatives

21	Contribution and involvement of company departments in digital initiatives
22	Control Model
23	cost of user acquisition
24	cost per transaction — to make your service more cost efficient
25	Costs of external hiring of people
26	Costs of illness
27	Costs of transition and reorganization
28	Count the number of processes performed on new software
29	Customer and business management focused
30	Customer Effort Score (CES)
31	Customer Satisfaction (CSAT)
32	Data & Processes
33	Data Quality
34	Data-driven decision making (%)
35	Digital orientation of employees
36	Employee turnover rate
37	Flexibility (Transfer time as % of actual lead time (Gov)
38	Hire of external expertise
39	Hours Saved
40	How many employees leave the organization (verloop)
41	Improved user experience
42	Increased availability
43	Increasing customer participation in digital channels
44	Infrastructure
45	Innovation Culture
46	Innovative ideas being implemented and their level of success
47	Innovative ideas being implemented and their level of success/department
48	Innovative methodologies and adaptation to new situations or markets
49	Integrate with power BI for customer feedback
50	Internal Promotions Vs. External Hires
51	Level of digital maturity, training and experience of partners, employees and management
52	Level of integration of systems

53	Level of participation and positioning of the organization in the market
54	Maintenance Cost
55	Management mindset towards digitalization
56	Month-on-month (MoM) growth in hires
57	Net Present Value (NPV) and Internal Rate of Return (IRR)
58	Net Promoter Score (NPS)
59	New applications, technologies and innovative solutions applied
60	New applications, Technologies and Innovative Solutions Applied
61	New business models adopted for different markets
62	New business models adopted for different markets
63	New customer acquisition rate
64	New customer conversions
65	New Hires
66	New products or services launched on the market (percentage of revenues)
67	No. of Vacancies
68	No. Of Recruitment
69	number and value of successful innovations brought to market
70	Number of active customers
71	number of licenses you purchased to the number of employees who are actually utilizing the software
72	Number of systems with known vulnerabilities
73	On-time/on-budget delivery
74	Operating Expenses and Contribution Margin
75	overtime/falling behind
76	patents/R&D
77	Percent downtime
78	Percent of business processes enabled by AI
79	Percent of processes designed for cloud
80	Percent of reactive work
81	Percentage of annual technology budget spent on bold digital initiatives
82	Percentage of business leaders' incentives linked to value-creating digital builds
83	Percentage Of Response To Open Positions
84	Percentage of revenue from Digital channels

85	Privacy & Security
86	Processes optimization and flexibility
87	Product Innovation
88	Product-aligned agile delivery
89	Rate Of Innovation
90	Ratio Discoverers/Deliverers
91	Reduced time to market for new products
92	Reduced time to market for new products
93	Reliability (% of deliveries that are on time and within requirements)
94	Return on Digital investments (Trainings, Products)
95	Return on investment
96	Revenue From New Digital Services (Customer Service) -- Relate to products
97	revenue per employee
98	$ROI = (Net\ Profit)/(Invested\ Resources) \times 100$
99	Strategic innovation
100	Technology capability & flexibility
101	Technology training & usage
102	Time required to build a digital application
103	Training on digital skills
104	User Lifetime Value
105	User satisfaction — to help continually improve the user experience of your service

Table 18 Digital transformation KPI List



Appendix E – Evaluation Questions

1. How successfully was the DT managed/served by the design?
2. In the short, medium, and term period, did the design meet the expected DT results/stated objectives?
3. What is the design's positive and bad aspects?
4. To what extent can the design be criticized for the changes?
5. What elements of the design and setting made the biggest difference?

Appendix F – Literature Review Data Extraction

ID	Title	Authors	Year	Keywords	Domain
1	Improving business decision making based on KPI management system	Paulo Roberto Martins de Andrade, Dr. Samira Sadaou	2017	E-business, Decision Support Systems, KPI Management, Software Development, Business Metrics.	Organization
2	Selection and Optimization Model of Key Performance Indicators	Nyamsuren Purevsuren*, Zolzaya Dashdorj**, Tamir Khujuu***, Erdenekhuu Norinpel****	2020	KPIs, performance, metrics, strategy, decision making	Education
3	A Group Decision Making Approach for Evaluation of ERP Critical Success Factors Using Fuzzy AHP	MS. Amalnick1, A. Ansarinejad 1, S.ansarinejad1, L. Hatami-Shirkouhi21	2010	Enterprise resource planning; Critical success factors; fuzzy AHP	Organization
4	Decision theory on key-performance-indicator-based process monitoring and fault diagnosis approaches	Hao Zhou; Hengbo Ma; Xinrui Shen	2017	Key performance indicators, Process monitoring, Decision theory, Multivariate statistics, Fault detection	Generic
5	An AI based Decision Support System for preventive maintenance and production optimization in energy intensive manufacturing plants.	Matteo Confalonieri, Andrea Barni, Anna Valente, Marco Cinus, Paolo Pedrazzoli	2015	Decision support system, preventive maintenance, optimization.	Manufacturing

6	Using Key Performance Indicators as Knowledge-Management Tools at a Regional Health-Care Authority Level	Alexander Berler, Sotiris Pavlopoulos, and Dimitris Koutsouris	2005	Balanced scorecard (BSC), business intelligence, health-care system key performance indicators (KPIs), knowledge management (KM), regional health-care authority.	Healthcare
7	Design of Dashboard for University Examination	Mr. Santosh B Akki1, Dr. Vijayalakshmi M. N	2008	Dashboard, e-Governance, Result Process,EMS	Education
8	Design a Balanced Scorecard-Based Model for Human Resource Measurement System	Yan PENG	2009	Performance management, Balanced scorecard, Human resource, measure	HR system
9	Performance dashboard: Cutting-edge business intelligence and data visualization	S M Kumar; Meena Belwal	2018	Performance Dashboard,KPI,Data Visualization,Business analytics,Business Intelligence,REST web services,Single Sign On,SAML,Pentaho ,Bootstrap,REST framework,MVC,RBAC	Healthcare
10	Critical success factors assessment in software projects	Rabia Hashim, Dr. Muhammad Abbas, Muhhammad Hashim	2013	Risk factors; risk estimate; risk uncertainty; project failure	Software Engineering

11	A Holistic Approach for Selecting Appropriate Manufacturing Shop Floor KPIs	A. R. Khan Mohammed; B. Ahmad; R. Harrison	2020	key performance indicators;KPIs;manufacturing industries;shop floor;holistic model	Manufacturing
12	A Survey Paper on Identifying Key Performance Indicators for Optimizing Inventory Management System and Exploring Different Visualization Tools	P. Singh; S. Ghosh; M. Saraf; R. Nayak	2020	KPIs;Dashboard;Supply chain management;Hadoop;HDFS;Machine learning;Spark	Manufacturing
13	Adaptive resource modeling to redirect stakeholder perception of bottlenecks	C. Mouradian; M. E. Doerfler; S. Norouzzadeh; N. Riebling	2017		HR system
14	Dashboard to Monitor Performance of an Hotel in the Financial Perspective	A. M. Santos Lavrador; R. M. S. Laureano	2019	Performance;Dashboard;Report;Excel;Hotel	Finance
15	Decision making to calculate economic sustainability index: A case study	S. Yasser; N. Sameh; S. Kassem; Y. Emad; O. Tariq; I. Fahim	2020	UML;Object-oriented modelling;Economic Sustainability;Economic Sustainability Index;;AHP	Finance

16	Development of a Decision Support Framework, based on Critical Success Factors, to obtain and analyze the level of entrepreneurship at the University	L. F. M. Tusnski; L. M. Ribeiro; D. B. Espindola	2019	Entrepreneurship; Critical Success Factors; Indicators	Education
17	Development of a Decision Support Tool for Intelligent Manufacturing using Classification and Correlation Analysis	D. KrÅ³; J. SkowroÅ„ski; M. Zareba; K. Bartecki	2019	NA	Manufacturing
18	Development of an Interactive System to Enhance Strategic Planning Process and Quality of Aviation Operations Using Balanced Scorecard: A UAE Case study	M. Alloghani; A. Hussain; D. Al-Jumeily; A. Aljaaf; N. AlShamsi	2017	ICT; BSC; MOI; QA; KPI; CRM; ERP; SME; BI; MVC; SQL; JQuery; XML	Case Study
19	Identification of key success factors and challenges for ERP systems – A systematic literature review	S. F. Wijaya; H. Prabowo; Meyliana; R. Kosala	2017	Critical success factors; Challenges; ERP systems; Systematic literature review	ERP
20	University dashboard: An implementation of executive dashboard to university	Meyliana; H. A. E. Widjaja; S. W. Santoso	2014	executive dashboard; data warehouse; key performance indicators (KPI); university dashboard	Education

21	A balanced scorecard for holistic monitoring of shared services for corporate data protection	Weissgerber F., Lazar E., Tafreschi O.	2019	Balanced Scorecard; Data Protection Services; Shared Service Center	Organization
22	Digital transformation in sales as an evolving process	Wengler S., Hildmann G., Vossebein U.	2021	Business type; Capacity building; Data; Digital technologies; Digital transformation; Key performance indicators (KPI); Market intelligence (MI); Market-oriented transformation model (MTM); People; Process; Sales	Marketing
23	Digital transformation in the public sector: Identifying critical success factors	Jonathan G.M.	2020	Critical success factors; Digital transformation; Digitalisation; Digitisation; Public organisations	Government
24	Digital Transformation of Centru Region - Romania. Needs Assessment	Claudia O., Mihaela H.	2020	(digital) competitiveness; (digital) innovation; Centru Region-Romania; digital transformation; innovation performance	Weather

25	Digital workplace management: Exploring aspects related to culture, innovation, and leadership	Haddud A., McAllen D.	2018		Organization
26	Drivers for digitalization in retail and service industries	Strønen F.	2020	Digitalization; Traditional industries; Value creation	Organization
27	Governance lessons from Denmark's digital transformation	Nielsen M.M.	2019	Benefit realization; EGovernment; Governance; Key performance indicators; Strategy	Government
28	Integrating strategic and operational decision making using data-driven dashboards: The case of St. Joseph mercy Oakland hospital	Weiner J., Balijepally V., Tanniru M.	2015	NA	Healthcare
30	A data-driven analytics approach in the study of pneumonia's fatalities	M. Y. Santos; A. Carvalheira; A. Teles de Araujo	2015	data-driven analytics;pneumonia;dashboards;data exploration;data analysis	Healthcare
31	A framework of Thailand higher education dashboard system	N. Denwattana; A. Saengsai	2016	Dashboard;analytic data-driven tool;decision support;framework;higher education;information systems	Education

32	Analytic Information Systems in the Context of Higher Education: Expectations, Reality and Trends	I. Guitart; J. Conesa	2015	business intelligence;analytics;virtual learning environment;teacher tools;quality	Education
33	Business-intelligence framework for visualization and its associate text narration	C. Wutthikhet; N. Phisanbut; P. Piamsa-nga	2020	narrative visualization;business intelligence;dashboard design;human-computer interaction	NA
34	Decision Support Systems for Improving the Quality of Medical Care	B. Ghosh	2008	NA	Medical
35	Design of Dashboard for University Examination Result Analysis System	S. B. Akki; M. N. Vijayalakshmi	2018	Dashboard;e-Governance;Result Process;EMS.	Education
36	Development of a Health Dashboard for an Electronic Health Record System	I. B. Filho; S. C. Sampaio; J. C. A. Tenório; E. V. de C. Filho; M. E. de C. Pessoa; R. S. Malaquias; P. A. Fernades	2020	Electronic Health Record;Dashboard;Computational Platform;School Services in Health	Healthcare
37	Enhancing performance of an ERP systems with a dashboard system	S. F. Wijaya	2016	Enterprise Resource Planning (ERP) systems;Dashboard system	Generic

38	Integrated Architecture of Data Warehouse with Business Intelligence Technologies	C. A. Ul Hassan; R. Irfan; M. A. Shah	2018	Data warehousing; Business Intelligence; Data Analysis; Architecture	Generic
39	Model-view-controller pattern in BI dashboards: Designing best practices	P. P. Churi; S. Wagh; D. Kalelkar; M. Kalelkar	2016	BI; Business intelligence; Controller; Model; MVC; View	Generic
40	Real-time Performance Monitoring for an Enterprise Information Management System	T. C. Chieu; L. Zeng	2008	Business Performance Management; Real-Time Dashboard; Key Performance Indicator; Extract Transform Load; Data Warehouse	Organization
41	MedThaiVis: An approach for thai biomedical data visualization	J. Mitrpanont; N. Janekitiworapong; S. Ongsritrakul; S. Varasai	2017	NA	Organization

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