UNIVERSITY OF LJUBLJANA
SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

IDENTIFICATION OF USER ACCEPTANCE FACTORS OF A NEW REPORTING SOLUTION AT HILTI

Ljubljana, June 2023 TILEN BURGAR

AUTHORSHIP STATEMENT

The undersigned Tilen Burgar, a student at the University of Ljubljana, School of Economics and Business, (hereafter: SEB LU), author of this written final work of studies with the title Identification of user acceptance factors of a new reporting solution at Hilti, prepared under supervision of Anton Manfreda, PhD.

D E C L A R E

1. this written final work of studies to be based on the results of my own research;

2. the printed form of this written final work of studies to be identical to its electronic form;

3. the text of this written final work of studies to be language-edited and technically in adherence with the SEB LU's Technical Guidelines for Written Works, which means that I cited and / or quoted works and opinions of other authors in this written final work of studies in accordance with the SEB LU's Technical Guidelines for Written Works;

4. to be aware of the fact that plagiarism (in written or graphical form) is a criminal offence and can be prosecuted in accordance with the Criminal Code of the Republic of Slovenia;

5. to be aware of the consequences a proven plagiarism charge based on the this written final work could have for my status at the SEB LU in accordance with the relevant SEB LU Rules;

6. to have obtained all the necessary permits to use the data and works of other authors which are (in written or graphical form) referred to in this written final work of studies and to have clearly marked them;

7. to have acted in accordance with ethical principles during the preparation of this written final work of studies and to have, where necessary, obtained permission of the Ethics Committee;

8. my consent to use the electronic form of this written final work of studies for the detection of content similarity with other written works, using similarity detection software that is connected with the SEB LU Study Information System;

9. to transfer to the University of Ljubljana free of charge, non-exclusively, geographically and time-wise unlimited the right of saving this written final work of studies in the electronic form, the right of its reproduction, as well as the right of making this written final work of studies available to the public on the World Wide Web via the Repository of the University of Ljubljana;

10. my consent to publication of my personal data that are included in this written final work of studies and in this declaration, when this written final work of studies is published.

Ljubljana, _____ Author's signature: _____

(Month in words / Day / Year,
e. g. June 1st, 2012

TABLE OF CONTENTS

INTRODUCTION **1**

1 BUSINESS INTELLIGENCE **3**

1.1 Business intelligence definition **3**

1.2 Business intelligence software **5**

1.2.1 Microsoft Power BI 6

1.2.2 SAP Analytics Cloud 7

2 USER ACCEPTANCE **9**

2.1 User acceptance of information systems **10**

2.2 User acceptance of reporting and BI solutions **14**

3 CHANGE MANAGEMENT **16**

4 SHOP FLOOR MANAGEMENT **19**

4.1 Main components of shop floor management **20**

4.2 Digital transformation of SFM **21**

4.3 Reporting solutions as part of digital SFM **23**

5 RESEARCH METHODOLOGY **24**

5.1 Research method **24**

5.2 Research process **25**

6 SHOP FLOOR MANAGEMENT IN HILTI'S PLANT 1 ..... **26**

6.1 Company and plant presentation **26**

6.2 SFM process in Plant 1 ..... **27**

6.3 Digitalisation of SFM in Plant 1 ..... **29**

7 IMPLEMENTATION AND USER ACCEPTANCE OF DSF 2.0 ..... **34**

7.1 DSF 2.0 presentation **34**

7.1.1 BI software 35

7.1.2 Back-end structure 36

7.1.3 Front-end structure 37

7.1.4 Impact on shop floor meetings 40

7.2 User acceptance factors for DSF 2.0 ..... **42**

7.2.1 Developers 42
7.2.2 Plant leadership 43
7.2.3 Coaches 44
7.2.4 Production staff 45
7.3 User acceptance initiatives for DSF 2.0 46
7.3.1 Roll out approach 47
7.3.2 User participation 48
7.3.3 Communication strategy 48
7.3.4 User training 49
8 FINDINGS AND RECOMMENDATIONS 49
8.1 Findings 49
8.2 Recommendations 51
8.3 Limitations 53
CONCLUSION 53
REFERENCE LIST 54
APPENDICES 62

LIST OF FIGURES

Figure 1: Gartner's Magic Quadrant for Analytics and Business Intelligence Solutions 5
Figure 2: Process from data source to visualization with Power BI 6
Figure 3: Process from data source to visualization with SAC 8
Figure 4: Technology acceptance model (TAM) 10
Figure 5: Darmstadt Shop Floor Management model 20
Figure 6: SFM cascade in Plant 1 28
Figure 7: Sketch of the shop floor board before implementation of DSF 1.0 30
Figure 8: Photo of the shop floor board after implementation of DSF 1.0 31
Figure 9: Screenshot of the DSF 1.0 dashboard for Level 3 32
Figure 10: Depiction of DSF 1.0 report depth based on users' information needs 33
Figure 11: Back-end structure from source to the output of DSF 2.0 37
Figure 12: Screenshot of the DSF 2.0 dashboard for Level 3 38
Figure 13: Standardized layout of DSF 2.0 reports 39

LIST OF TABLES

Table 1: Comparison of SAC and Power BI features 9
Table 2: Determinants of perceived usefulness and perceived ease of use 11
Table 3: Information system user acceptance factors proposed by UTAUT 12
Table 4: Innovation user acceptance factors proposed by DIT 13
Table 5: Determinants of TAM3 user acceptance factors in the BIS context 15
Table 6: Rogers' Digital Transformation Playbook 17
Table 7: Change management activities included in selected models 18
Table 8: Value added by digitalization to different components of SFM 22
Table 9: List of interviewees 25
Table 10: Comparison of DSF 1.0 and DSF 2.0 41
Table 11: Summary of user acceptance factors deemed important by each user group 46
Table 12: Proposed user acceptance initiatives for DSF 2.0 52

LIST OF APPENDICES

Appendix 1: Summary in Slovene language (Povzetek v slovenščini) 1
Appendix 2: Interview with Interviewee 1 2
Appendix 3: Interview with Interviewee 2 9
Appendix 4: Interview with Interviewee 3 14
Appendix 5: Interview with Interviewee 4 17
Appendix 6: Interview with Interviewee 5 20
Appendix 7: Interview with Interviewee 6 25
Appendix 8: Interview with Interviewee 7 29
Appendix 9: Interview with Interviewee 8 34

LIST OF ABBREVIATIONS

BI – business intelligence

CRM – customer relationship management

DSF 1.0 – Digital Shop Floor 1.0

DSF 2.0 – Digital Shop Floor 2.0

DSS – decision support system

ERP – enterprise resource planning

IT – information technology

KPI – key performance indicator

MES – manufacturing execution system

OLAP – online analytical processing

SAC – SAP Analytics Cloud

SFM – shop floor management

TAM – Technology Acceptance Model

INTRODUCTION

Firms operating in competitive environments are increasingly turning to digital transformation to improve their work processes. Digital transformation, which is defined as "application of digital capabilities to processes, products, and assets", can help companies increase customer value, control risk, and expose new streams of revenue (Schmarzo, 2017). As part of this effort, new digital solutions are being continually developed and old ones replaced.

Implementation of a new digital solution is often associated with large resource investments, so companies want to do everything in their power to ensure they are successful. However, Forbes (2022) reported that as many as 84% of companies fail at digital transformation. Often this happens because users do not want to work with the new solution. Attaining user acceptance and avoiding user resistance is a common challenge companies face when implementing a new solution. For example, when it comes to business intelligence (BI) solutions, many factors can lead to user resistance, such as inappropriate communication, system deficiencies, and inadequate training (Popovič, 2017). Knowing which factors have an impact on user acceptance is important for managers as it gives them an indication of which areas require more resources. Moreover, it allows them to avoid focusing on areas that intuitively seem important for user acceptance, but research showed to have little effect.

One of the areas where digital transformation can bring significant improvements is reporting, defined as the "regular provision of information to decision-makers within an organisation to support them in their work" (Hill, 2008). A related concept is BI, which provides a way for companies to analyse important business data, enabling them to improve their understanding of business and the market, as well as to improve their decision-making (Chen, Chiang & Storey, 2012). User acceptance is an important consideration for any company implementing a new reporting solution.

Hilti, a large multinational company with headquarters in Liechtenstein, currently faces this challenge as it looks to replace an existing reporting solution with a new solution at its Plant 1. Day-to-day operations at the plant are reviewed at daily shop floor meetings held at each managerial level, supported by a reporting solution developed by the controlling department. The reporting solution supporting these meetings is called the Digital Shop Floor 1.0 (DSF 1.0), which consists of around 30 digital reports built in Microsoft Power BI.

DSF 1.0 replaced the previous practice of preparing reports in Microsoft Excel, printing them out, and posting them on boards around the plant ahead of the shop floor meetings. Implementing digital reports was beneficial because of features like automatic updates of reports, better transparency of key performance indicators (KPIs), the ability to perform drill-downs, and simpler tracking of day-to-day changes in KPIs. Since DSF 1.0 was a clear success in Plant 1, efforts began to implement the solution on a global scale within the

company. The decision was made to use SAP Analytics Cloud (SAC) instead of Microsoft Power BI as the reporting tool for the global project, bringing considerable differences in the user experience. The upgraded solution was called Digital Shop Floor 2.0 (DSF 2.0).

With the rollout of the new reporting solution, Plant 1 will face a unique challenge. Users in the plant are already accustomed to working with the existing solution in their daily routine, meaning that the transition to a new solution needs to be approached carefully. It is important to consider that replacing a solution that users like and are accustomed to is likely to be more challenging than implementing a completely new solution. Therefore, this thesis aims to identify the most important factors of user acceptance a company should consider when implementing a new digital solution and apply the findings to the case of Hilti's Plant 1.

The purpose of the thesis is to provide specific and relevant insights to decision-makers at Hilti's Plant 1 on how to achieve high user acceptance of DSF 2.0. The thesis will investigate which user acceptance factors are the most important for the successful implementation of a new information system. Moreover, by applying findings from existing academic research to the current situation at Plant 1, the thesis aims to develop recommendations for improvement. Specifically, plant management should get insights on how to best promote user acceptance and avoid user resistance. The thesis aims to provide findings and recommendations that are applicable also in a wider context than Hilti's internal use. Most academic literature on user acceptance deals with the first implementations of new solutions. On the other hand, the thesis investigates user acceptance of a new version of an existing solution, where the users are highly accustomed to working with the current version. Therefore, the thesis will aim to fill this gap in the literature.

The thesis will set out to answer the following research questions:

- What are the most important factors for acceptance of a new information system?
- How can decision-makers at Hilti's Plant 1 foster acceptance and avoid user resistance towards the new reporting solution?

To answer the research questions, the following research goals should be achieved:

- Provide a review of the literature on user acceptance and change management, shop floor management and BI,
- Provide an overview of the current situation at Plant 1,
- Compare the existing and new solutions at Plant 1,
- Demonstrate improvements following the implementation of the new solution,
- Identify user acceptance factors aiding the transition considered by key stakeholders,
- Identify existing and planned user acceptance initiatives,
- Point out opportunities for improvement user acceptance management,
- Develop specific and relevant recommendations for Plant 1 management.

The thesis includes a theoretical and empirical part. The theoretical part provides a basis to discuss both solutions and make meaningful recommendations. It is done in the form of a literature review. A literature review "involves systematically identifying, locating, and analysing documents containing information related to the research problem" (Mills & Gay, 2019). The goals of the literature review are to define the main concepts and to provide a general overview of the existing research on the discussed topics. Moreover, it identifies the areas of dispute in existing research. The literature review does not seek to provide a comprehensive overview of all literature pertaining to each topic but rather focuses only on relevant literature to the research questions of the thesis.

Literature on concepts such as shop floor management, user acceptance, and BI is analysed and summarized. Shop floor management is related to the concepts of lean management and digital transformation. Similarly, user acceptance is discussed in the context of information systems, reporting solutions, and BI solutions. Moreover, BI is defined, and the market for BI solutions is overviewed, followed by a deeper analysis of Microsoft Power BI and SAC.

The empirical part provides an overview of the existing and new reporting solutions at Hilti's Plant 1, discusses its impacts on work-processes within the plant, and reviews how user acceptance was managed when implementing the existing solution. The purpose of this section is to better understand the current situation regarding the implementation of the new reporting solution at Plant 1. To achieve this, key groups of stakeholders to implementation were identified and interviews were conducted with representatives of each. Lastly, the findings from both the theoretical and empirical parts are summarized and recommendations for plant leadership and the project team are formulated.

1 BUSINESS INTELLIGENCE

1.1 Business intelligence definition

Business intelligence is an increasingly important field in an age where companies strive to improve their decision-making by understanding the data they collect. It is defined as the "techniques, technologies, systems, practices, methodologies, and applications that analyse critical business data to help an enterprise better understand it's business and market and make timely business decisions" (Chen, Chiang & Storey, 2012). The field comprises several older technologies such as decision support systems (DSS), online analytical processing (OLAP), and data warehouses.

BI solutions provide the user with the easy-to-use capability to prepare data, visualize it, and generate insights. In the past, BI solutions were complex and required the assistance of information technology (IT) professionals, which led to slow releases and low user acceptance. Additionally, users required a lot of training and help to get relevant information for their jobs from these solutions. The recent trend has been the increased popularity of self-

service BI solutions. This means that BI software has become user-friendly enough, that even business users could query their own data and create their own reports. An accompanying trend has been cloud-based BI software, which provided an easier way to disseminate reports across organizations and greater data processing capabilities (IBM, 2023).

Self-service BI solutions are in general easy to use and cause many more reports to be built, which means that internal data becomes much more available to employees at all levels of the organization. There are also some important drawbacks to using self-service BI solutions. Firstly, as report building becomes a decentralized activity, it is hard to keep unified measures and metrics, meaning that considerable confusion can arise. Secondly, business users have much less technical knowledge than IT professionals, causing that mistakes in the reports they build are much more common, together with the insufficient focus they put on data security. Lastly, if access to self-service solutions is given to many users within an organization, licensing costs can be considerable (Fruhlinger & Pratt, 2019).

Feldman and Himmelstein (2013) listed the applications of BI as measurement and benchmarking, analytics, reporting and data visualization, collaboration, and knowledge management. The same authors also noted that BI solutions should provide the following functionality:

- Presentation of relevant and accurate information.
- Rapid return of query results.
- Slice-and-dice query creation and modification.
- An ability for information consumers to pose questions quickly and easily and achieve rapid results.

Companies decide which BI solution to use based on different criteria. One of them is the type of solution they want to build. There are two types of BI solutions – functional and enterprise. With functional ones, the solution is limited to only one function or department within the company. Governance of such a solution is the responsibility of that business unit and data is usually stored in a specialized data mart. Functional solutions are developed by business users, so ease of use matters a lot when choosing the best provider, while more advanced features are less important. On the other hand, enterprise BI solutions serve the whole organization and are developed by the IT department within the company. As the IT department has better technical competencies than business users, ease of use is less important to them. In contrast, they put more importance on advanced functions such as augmented analytics (i.e., machine learning for data preparation and insight generation). Data used in such a solution covers the whole organization and is large in scope. It is usually stored in a data warehouse (Arnott, Lizama & Song, 2017).

1.2 Business intelligence software

The worldwide market for BI and analytics is very large and growing. It reached USD 15.2 billion in 2020 and is expected to grow to USD 18 billion by 2025 (Statista, 2022). In 2020, BI and analytics was the largest IT investment for 35.6 per cent of organizations, second only to cloud computing with 38.1 per cent (Society for Information Management, 2020). In recent times, firms in this market are no longer differentiated by data visualization capability, as all providers offer similar quality of service in this area. Instead, augmented analytics and cloud capabilities are the main differentiators in the current market (Richardson, Schlegel, Sallam, Kronz & Sun, 2021).

Figure 1: Gartner's Magic Quadrant for Analytics and Business Intelligence Solutions

Source: Richardson, Schlegel, Sallam, Kronz & Sun (2021).

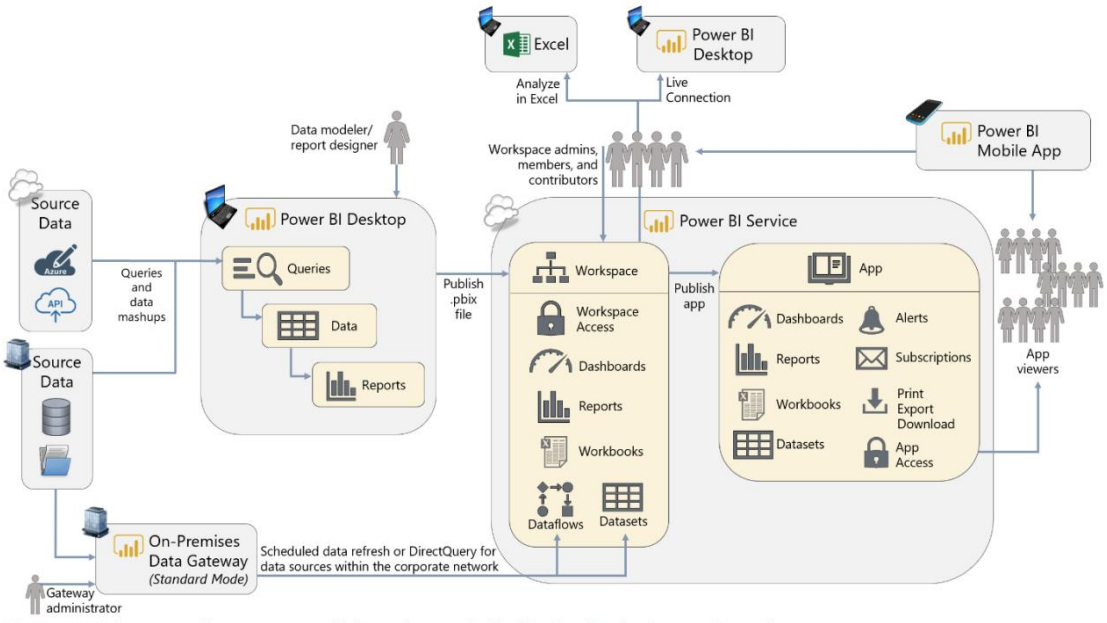
According to Gartner's Magic Quadrant (*Figure 1*), Microsoft Power BI, Tableau, and Qlik are the current market leaders (Richardson, Schlegel, Sallam, Kronz & Sun, 2021). They also note that the number of users of BI software is increasing quickly, as prices have noticeably decreased in the last decade. For example, the Microsoft Power BI desktop client is free to download and use for anyone, and the cheapest plan where a user can share their report with others costs only EUR 9.4 per user per month (Microsoft, 2022a). Gartner also noted that Microsoft Power BI is a clear market leader in terms of user adoption (Richardson, Schlegel, Sallam, Kronz & Sun, 2021). They expect this trend to continue with the increasing

integration of Power BI with other services in Microsoft's ecosystem (e.g., Teams), as well as due to the increasing prevalence of remote work. SAP Analytics Cloud is positioned as a visionary in Gartner's Magic Quadrant, which means that they are very strong in certain areas, but do not yet offer complete BI software (Richardson, Schlegel, Sallam, Kronz & Sun, 2021). This translates into lower scale and potential growth in comparison to market leaders. In the next two subchapters, Microsoft Power BI and SAC are presented in-depth, as these are the two BI software used by Hilti for DSF 1.0 and DSF 2.0.

1.2.1 Microsoft Power BI

Microsoft's Power BI platform is a combination of three different products – Power BI Desktop, Power BI Service, and Power BI Mobile. Together they make up a self-service BI software. Power BI Desktop is used by report developers to load, clean, and visualize data. It is completely free-to-use, and a subscription only needs to be purchased if a report needs to be shared with other people. Power BI Service is a cloud service to publish, share, and consume reports, dashboards, and datasets. The usual procedure is to do the data transformation, modelling, and report preparation in the desktop client and then publish it to the cloud, where it can be shared to end users. The published reports can be viewed in the browser or through an app on Windows, Android, and iOS devices. Lastly, Power BI Mobile is a mobile app available on Android and iOS where end-users can consume dashboards and reports. As is common with subscription-based services, the Power BI platform is being continuously developed and updated with new functionality monthly. (Aspin, 2016).

Figure 2: Process from data source to visualization with Power BI



Source: Coates & Webb (2020).

One of Power BI's biggest selling points is integration with other tools and services in Microsoft's ecosystem. For example, the tool enables the user to transfer all the queries and data models they built in Excel. The loaded data can then be further cleaned using Power Query functionality and set to refresh automatically on a scheduled basis. In addition, visuals from Power BI reports can be exported to Excel, if users want to dive deeper in the data, as well as to Power Point and PDF. Moreover, published reports can easily be included in Microsoft Teams channels, ensuring easy access to data, and promoting cooperation. Lastly, Power BI's integration with Microsoft's cloud service Azure enables users to get insights from big data without performance issues (Microsoft, 2022b). *Figure 2* shows the process from data source to visualization and sharing with users with Power BI.

Next to integration with other Microsoft products, Gartner outlined the affordable price and scope of product ambition as Power BI's strengths. Microsoft has led the way in lowering the price of BI software, as they offered the Power BI Desktop for free while charging low per-user fees for premium functionality. This has considerably enlarged the BI market and made Microsoft the clear leader in the space. The scope of ambition is shown with Microsoft's continued investment into areas they believe will be the future of BI, especially in machine learning.

On the other hand, Gartner also mentioned several cautions. Firstly, they mention the lacking on-premises (i.e., self-hosted) version as opposed to the cloud service. Similarly, Microsoft does not enable users to choose a different cloud host than Azure, which decreases flexibility. Lastly, content publication and governance can create significant work for business users. Management of reports and dashboards cannot be completely automatic and requires maintenance work (e.g., refreshing datasets, maintaining credentials, etc.) (Richardson, Schlegel, Sallam, Kronz & Sun, 2021).

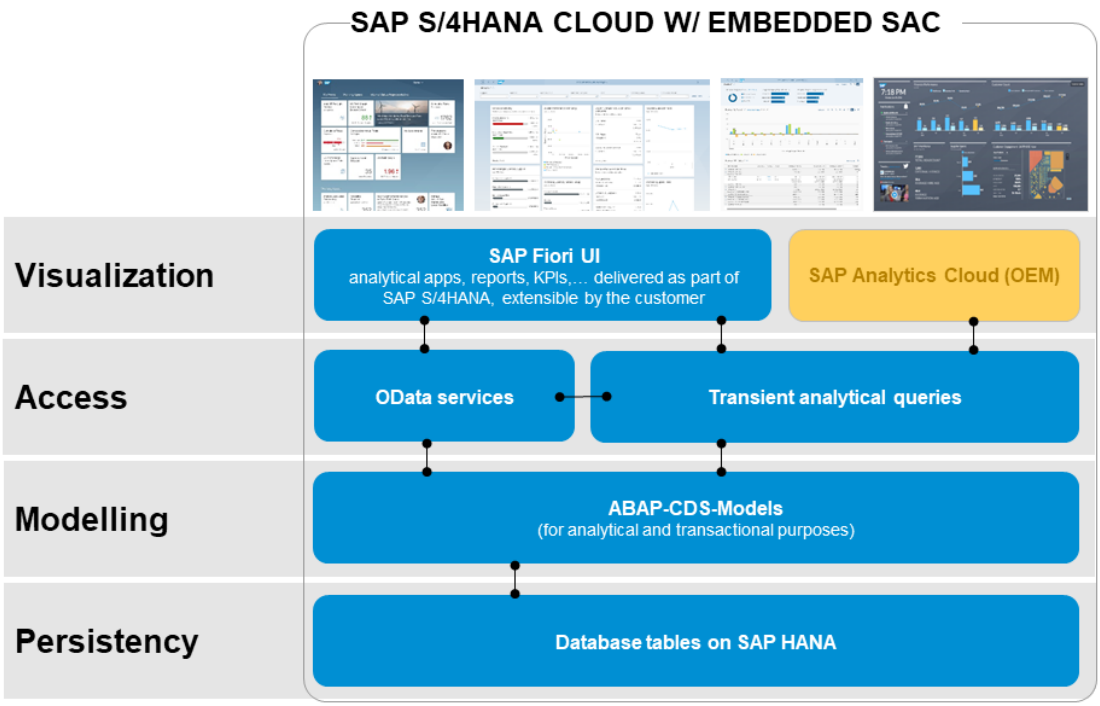
1.2.2 SAP Analytics Cloud

SAC is a self-service BI software by SAP. It was developed to merge several data analytics and visualization tools within the SAP ecosystem (Gole & Shiralkar, 2020). SAP focused on developing a complete BI software because it is a complementary product to its offering of ERP software solutions. Moreover, they realised that their clients are generating a lot of data using their products but were not using it to get insights and provide decision-making support (Hou, 2014). SAC is a completely cloud-based software, where users can load, clean, and visualize data, all from the browser. The final visualizations shown to users are called stories, which can be made both in the form of a report or a dashboard.

Perhaps the biggest selling point of SAP is the integration with SAP's existing ERP software. In essence, it acts as a frontend to the data stored in other SAP software. SAC enables developers of stories to connect directly to on-premises SAP resources, such as BusinessObjects, Business Warehouse, and HANA (Richardson, Schlegel, Sallam, Kronz & Sun, 2021). Developers can get data from these systems either by creating a live connection

or importing it, depending on the requirements of a project. SAC gives customers the option to store, model, and visualize data within one ecosystem, which avoids problems such as needing to retrieve data from many different sources, each of which has different characteristics and quality. *Figure 3* shows the process from data source to visualization and sharing with users with SAC.

Figure 3: Process from data source to visualization with SAC



Source: Sieberg (2019).

Along with integration with the existing SAP ecosystem, Gartner mentioned closed-loop capability and breadth of existing content as other strengths of SAC. Closed-loop capability means that with SAC users can complete planning, analytics, and prediction tasks, without ever having to leave the platform. This differs from Microsoft for example, where those tasks are shared by multiple tools such as Power BI and Excel. SAC also offers an extensive catalogue of existing content which users can take advantage of. For example, pre-built data models, data stories, visualizations, etc.

On the other hand, Gartner also outlined several cautions. To start, SAC does not have a large community of developers, due to having a lower market share. A large community is important because of collaboration, problem-solving, and proposing updates to the platform. Moreover, SAP's previous BI software BusinessObjects left a bad user perception, as a very report-oriented and outdated platform, which makes offering SAC to these users more difficult. Lastly, SAC is a cloud-only platform and cannot be run in a strictly on-premise arrangement, even though on-premise data can be queried (Richardson, Schlegel, Sallam,

Kronz & Sun, 2021). *Table 1* shows a comparison and evaluation of features present in SAC and Power BI.

Table 1: Comparison of SAC and Power BI features

Feature	**SAC**	**Power BI**
SAP connectivity	Very good	Good
Non-SAP connectivity (e.g., SQL, Oracle, Excel)	Good	Very good
Self-service data preparation (transforming and modelling data)	Limited	Very good
Variance analysis (actual vs. budgeted vs. forecast)	Very good	Good
Self-service data visualization and user-friendliness	Good	Very good
Mobile support	iOS	iOS, Android
Planning and budgeting	Good	Not supported
ML and AI features	Similar	Similar
Security and administration	Similar	Similar
Authorization inheritance out of DW	Very good	Limited

Source: Hilti (2021).

2 USER ACCEPTANCE

To start, it is important to make a distinction between information system acceptance and adoption, even though some researchers and practitioners use the terms interchangeably. Technology acceptance is defined as an "attitude towards technology". It is a preceding step before technology adoption, defined as "a process starting with the user becoming aware of the technology, and ending with the user embracing the technology" (Renaud & van Biljon, 2008). There is a multitude of models attempting to explain user acceptance through different factors that affect it (Venkatesh, Morris, Davis & Davis, 2003). Most models analyse both *intention to use* (i.e., acceptance) as well as *use* (i.e., adoption). As this master's thesis is focused on user acceptance of an information system, it will consider only intention to use. Further, intention to use provides the best explanation of actual use when the use of a solution is voluntary (Fishbein & Ajzen, 2010), which is usually the case for BI and reporting solutions (Grublješič & Jaklič, 2015). There have also been some attempts to provide specialized models for reporting and BI solutions, which are summarized later in the section.

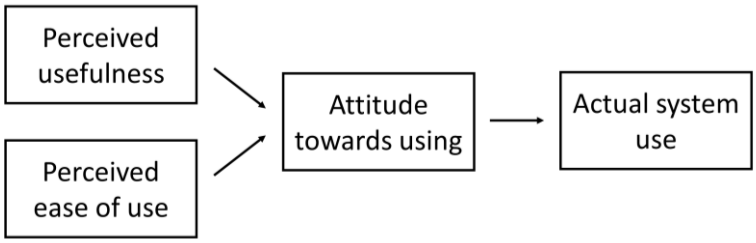
2.1 User acceptance of information systems

Information systems are a crucial part of any organisation. Their implementation promises to bring efficiency improvements leading to higher productivity and firm performance, but as noted by Venkatesh and Bala (2008), the opposite often happens. On a macro-level, this phenomenon is called the productivity paradox, which is the "discrepancy between measures of investment in IT and measures of output at the national level" (Turban, Leidner, McLean & Wetherbe, 2008). Venkatesh and Bala (2008) proposed underutilization and low adoption as two of the main sources of the productivity paradox. Therefore, information system acceptance is a necessary precondition before it will bring the promised benefits to the organization.

Enterprise solutions are an important sub-category of information systems. They are large-scale software packages, which help with operational and management processes within an organization (Ward, Hemingway & Daniel, 2005). Some examples include BI solutions, enterprise resource planning (ERP), and customer relationship management (CRM) solutions. Implementation of these solutions on a company-wide level involves significant challenges, often leading to failure (Kohnke, Wolf & Mueller, 2011). For example, up to 90% of all ERP solution implementations end up either over budget or late (Laukkanen, Sarpola & Hallikainen, 2007). A crucial precondition for successful implementation is convincing individuals within the organization to use the new solution.

User acceptance of information systems is one of the most widely researched areas in IS literature. To identify user acceptance factors, researchers have combined knowledge from different disciplines, such as information systems, sociology, and psychology. One of the most influential models of user acceptance is the Technology Acceptance Model (TAM) (Davis, 1989). Davis argued that acceptance is influenced mainly by perceived usefulness and perceived ease of use, as visualized in *Figure 4*. Perceived usefulness is determined by how much a user believes their performance will be enhanced by a new solution. Furthermore, perceived ease of use is determined by how much effort the user will need to put in to use the new solution. Moreover, he theorized that attitude towards using a solution (i.e., acceptance) is an important determinant of actual solution use (i.e., adoption).

Figure 4: Technology acceptance model (TAM)



Source: Davis (1989).

While TAM explained a high percentage of variance in intention to use information systems, the model was not very useful for practitioners. The only information it gave practitioners is that for a new information system to be accepted by users, it needs to be useful and easy to use, which is self-evident even without a model. Therefore, research on determinants of perceived usefulness and perceived ease of use was necessary. Venkatesh and Davis (2000) presented the TAM2, where they found that up to 60 per cent of the variance in perceived usefulness can be explained by subjective norm, image, job relevance, output quality, and result demonstrability.

Table 2: Determinants of perceived usefulness and perceived ease of use

Acceptance factor	**Determinant**	**Definition**
Perceived usefulness	Subjective norm	Degree to which a user perceives that people important to them think they should or should not use the system (Venkatesh & Davis, 2000).
	Image	Degree to which a user perceives that their social status will be improved if they use the system (Moore & Benbasat, 1991).
	Job relevance	Degree to which a user believes that the system is relevant to their job (Venkatesh & Davis, 2000).
	Output quality	Degree to which a user believes that the system performs their job tasks well (Venkatesh & Davis, 2000).
	Result demonstrability	Degree to which a user believes that the system provides observable, tangible and communicable results (Moore & Benbasat, 1991).
	Perceived ease of use	(Same as above).
Perceived ease of use	Computer self-efficacy	Degree to which a user believes they have the necessary competency to perform specific tasks using the system (Compeau & Higgins, 1995).
	Perception of external control	Degree to which a user believes that the organization possesses organizational and technical resources to support the system's use (Venkatesh, Morris, Davis & Davis, 2003).
	Computer anxiety	Degree to which a user is apprehensive or fearful when faced with the possibility of using a computer (Venkatesh, 2000).
	Computer playfulness	Degree of cognitive spontaneity a user displays when interacting with a computer (Webster & Martocchio, 1992).
	Perceived enjoyment	Degree to which a user perceives using the system as an enjoyable experience, without taking into account the effect on their job performance (Venkatesh, 2000).
	Objective usability	Degree to which a system requires more or less effort than comparable systems to perform specific tasks, without taking into account user perceptions (Venkatesh, 2000).
Subjective norm	/	(Same as above).

Adapted from Venkatesh & Bala (2008).

Additionally, TAM2 conveys that subjective norm also has a direct effect on intention to use. Further, Venkatesh (2000) proposed that determinants of perceived ease of use are split into two groups – anchors and adjustments. Anchors, which include computer self-efficacy, perceptions of external control, computer anxiety, and computer playfulness, are related to users' general beliefs and experiences with computers. On the other hand, adjustments relate to users' beliefs about the target system based on their direct experience with it. Adjustments include perceived enjoyment and objective usability.

To unify these findings in one model, Venkatesh and Bala (2008) presented the TAM3, which aimed to provide managers with effective interventions they can take to achieve user acceptance of an information system. *Table 2* shows the determinants of perceived usefulness and perceived ease of use as proposed by TAM3.

Venkatesh, Morris, Davis and Davis (2003) unified all prominent user acceptance models into the Unified Theory of Acceptance and Use of Technology (UTAUT). It combined findings from eight earlier models and explains 69 per cent of the variance in users' intention to use information systems. The factors they considered most important to intention to use include performance expectancy, effort expectancy and social influence. Moreover, they theorized that gender, age, experience, and voluntariness of use moderate how much each factor affects intention to use.

Table 3: Information system user acceptance factors proposed by UTAUT

Acceptance factor	**Definition**	**Items from earlier models making up the construct**	**Moderators**
Performance expectancy	Degree to which an individual believes that using the system will help them to improve job performance.	– Perceived usefulness – Extrinsic motivation – Job-fit – Relative advantage – Outcome expectations	– Gender – Age
Effort expectancy	Degree of ease associated with the use of the system.	– Perceived ease of use – Complexity – Ease of use	– Gender – Age – Experience
Social influence	Degree to which an individual perceives that important others believe he or she should use the new system.	– Subjective norm – Social factors – Image	– Gender – Age – Experience – Voluntariness
Facilitating conditions	Degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system.	– Perceived behavioural control – Facilitating conditions – Compatibility	– Age – Experience

Adapted from Venkatesh, Morris, Davis & Davis (2003).

Further, UTAUT2, an extension of the original model, proposes three additional user acceptance factors – hedonic motivation (i.e., the degree to which the technology is perceived to be enjoyable), price value (i.e., the cognitive trade-off between perceived benefits and monetary costs of technology usage) and habit (i.e., the passage of time from the initial technology usage) (Venkatesh, Thong & Xu, 2012). *Table 3* shows the definition of each acceptance factor proposed by the original UTAUT model, along with the items it is made up of and its moderators.

The IS user acceptance research field is dominated by TAM and its extensions and more recently by UTAUT and its extensions, but there are a few alternative models. The most influential is the Diffusion of Innovations Theory (DIT) by Rogers (2003) (first released in 1962). In contrast to previously mentioned models, which focus on how individuals accept new technologies, DIT investigates how organisations accept new technologies. The author recognized five factors that influence the acceptance of innovations – relative advantage, compatibility, complexity, observability, and trialability. Moore and Benbasat (1991) added to the findings by developing scales for each factor, which future researchers and practitioners could use. Furthermore, they split observability into result demonstrability and visibility. Lastly, they added voluntariness and image as two further factors. Agarwal and Prasad (1998) later added personal innovativeness as another acceptance factor. *Table 4* shows innovation user acceptance factors as proposed by DIT. Furthermore, DIT also specifies that innovation adoption will follow five stages – innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003).

Table 4: Innovation user acceptance factors proposed by DIT

Acceptance factor	Definition
Relative advantage	Degree to which a user perceives the system to be better than its precursor (Rogers, 2003).
Compatibility	Degree to which a user perceives the system to be consistent with their existing needs, values and past experiences (Rogers, 2003).
Ease of use	Degree to which a user believes that using the system will be effortless (Davis, 1989).
Result demonstrability	Degree to which a user believes that the system provides observable, tangible and communicable results (Moore & Benbasat, 1991).
Visibility	Degree to which a user is exposed to the system within the organisation (Moore & Benbasat, 1991).
Trialability	Degree to which a user can experiment with the system before adoption (Rogers, 2003).
Voluntariness	Degree to which a user perceives the use of the system to be voluntary (Moore & Benbasat, 1991).
Image	Degree to which a user expects their social status within their social system to increase if they use the system (Moore & Benbasat, 1991).
Personal innovativeness	Degree to which a user is willing to try out any new information technology (Agarwal & Prasad, 1998).

Adapted from Rogers (2003); Moore & Benbasat (1991); Agarwal & Prasad (1998).

2.2 User acceptance of reporting and BI solutions

Most large organizations have implemented ERP and CRM solutions in recent years, which means they are gathering a lot of data. But these solutions usually cannot analyse and present the gathered data in a way that is useful for decision-making. Therefore, BI and reporting solutions are needed to accomplish this task. Some authors differentiate between reporting and BI solutions, but the terms are often interchanged in practice, as are the software used to develop solutions for each.

Most academic research relates to BI solutions, so this section will use this term. BI solutions can be described as technological solutions that provide "quality information from well-designed data stores, coupled with business-friendly software tools that provide knowledge workers with timely access, effective analysis and intuitive presentation of the right information, enabling them to take the right actions or make the right decisions" (English, 2005; Popovič, 2017). Despite the obvious benefits of BI, failure rates remain high, as between 50 and 70 per cent of BI solutions fail to meet expectations from stakeholders and fail to deliver business value (Boyton, Ayscough, Kaveri & Chiong, 2015). As with information systems in general, the problem lies in underutilization and low adoption.

BI solutions have some specifics compared to other information solutions which influence user acceptance. To start, BI solutions have a more complex user interface than the average information system, leading to a larger than expected influence of perceived ease of use on intention to use (Kohnke, Wolf & Mueller, 2011). On the other hand, users of BI solutions are on average more proficient with information systems and higher educated (Grublješič, Coelho & Jaklič, 2019; Luo, 2016), which is likely to diminish the influence of perceived ease of use on intention to use. Further, the effects of using a BI solution are usually only recognizable over the long term, so users are likely to give less importance to perceived usefulness of the solution (Grublješič & Jaklič, 2015). Lastly, use of BI solutions is most often voluntary, meaning that the effect of social influence on intention to use is likely to be lower than in other information systems (Hou, 2014).

There have been some empirical investigations into user acceptance of BI solutions. Researchers used adapted versions of the previously discussed models – TAM, UTAUT and DIT. The positive link between social influence (i.e., subjective norm) and intention to use proved to be the most conclusive (Grublješič, Coelho & Jaklič, 2019; Hou, 2014; Kohnke, Wolf & Mueller, 2011). There is also evidence of performance expectancy (i.e., perceived usefulness) having a positive influence on intention to use (Hou, 2014; Kohnke, Wolf & Mueller, 2011), even though Grublješič, Coelho and Jaklič (2019) could not confirm this. The influence of effort expectancy (i.e., perceived ease of use) on intention to use was inconclusive, with only one research finding a positive influence (Grublješič, Coelho & Jaklič, 2019; Hou, 2014; Kohnke, Wolf & Mueller, 2011). This could be because ease of use is nowadays a basic requirement of any BI solution and most users can use them without additional training, so it no longer acts as a predictor of intention to use. Besides the main

three acceptance factors featured in UTAUT, some others were also tested. Grublješič, Coelho and Jaklič (2019) found a positive influence of result demonstrability on intention to use. Moreover, Hou (2014) discovered a negative influence of computer anxiety on intention to use, while computer self-efficacy and the attitude towards using BI solutions were shown to have no influence. Therefore, one way to increase intention to use is through decreasing computer anxiety, which can be done through trainings.

Kohnke, Wolf and Mueller (2011) tested the TAM3 model in the context of BI solutions. They found that the model explains 60 per cent of the variance in intention to use. Moreover, they theorized and tested the determinants of the three user acceptance factors proposed by TAM3. This is important because it helps managers to decide which interventions to use to change user perceptions of a solution. Theorized determinants are shown in *Table 5*, along with their definitions. They found that information quality and top management support have a positive influence on subjective norm. Furthermore, the same two constructs also have a positive influence on perceived usefulness. Lastly, system performance, user information, and user training positively determine perceived ease of use. User training was not found to affect perceived usefulness, which could mean that training programmes for BI solutions put an insufficient emphasis on explaining the advantages of the solution to the organization and users' daily tasks.

Table 5: Determinants of TAM3 user acceptance factors in the BIS context

Determinant	**TAM3 factor influenced by determinant**	**Definition**
Information quality	– Subjective norm – Perceived usefulness	The accuracy, completeness, timeliness, relevance, consistency, and usefulness of the information provided by the system (Işık, Jones & Sidorova, 2013).
System performance	– Perceived ease of use	The reliability, flexibility, integration, accessibility, and speed of a system (Wixom & Todd, 2005).
User information	– Perceived ease of use	The amount, frequency, and clarity of information users get regarding system changes and improvements (Kohnke, Wolf & Mueller, 2011).
User training	– Perceived ease of use	The process of users acquiring new competencies needed to use the system (Kohnke, Wolf & Mueller, 2011).
Top management support	– Subjective norm – Perceived usefulness	Managerial beliefs and participation in the new system, and the extent to which top management advocates the use of the new system (Kulkarni, Robles-Flores & Popovič, 2017).

Adapted from Kohnke, Wolf & Mueller (2011).

Hou (2014) applied the UTAUT model to study BI user acceptance in Taiwan's electronic industry. The model explained 59 per cent of the variance in intention to use BI solutions. Additionally, gender, age, experience, and voluntariness of use were tested as moderators of user acceptance factors. Performance expectancy was found to be moderated by gender and age, with the influence on intention to use being larger for men and younger people. One

possible explanation for the difference between genders is that men are on average more task-oriented than women, so they put more importance on performance expectancy. Effort expectancy is moderated only by gender, as the effect on intention to use is stronger for women. Lastly, social influence is moderated by gender, age, experience, and voluntariness of use. The impact on intention to use is higher for women, older people, less experienced people, and in mandatory contexts (as opposed to voluntary ones). A possible reason is that those groups are on average more sensitive to peers' opinions about BI use. Further, there is less social pressure to use a BI solution in contexts where use is voluntary.

3 CHANGE MANAGEMENT

As mentioned, the majority of digital transformation initiatives in organisations fail, often because they are not accepted by users. Therefore, change management models aim to give managers the tools to ensure higher success rates for such projects. Digital transformation is a type of organizational change and is defined as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019). Rogers (2016) identified data as one of the main five domains affected by digital forces, along with customers, competition, value, and innovation. For example, data can be harnessed to create a fact-based decision-making culture, which is described as the extent to which decision-makers are encouraged to gather and analyse data to improve their decisions (Kulkarni, Robles-Flores & Popovič, 2017).

The most important organisational behaviours and values connected to fact-based decision-making culture include information integrity, formality, control, transparency, sharing, and proactiveness (Choo, Bergeron, Detlor & Heaton, 2008). All these are affected by a new reporting solution, some directly and some indirectly. For example, information transparency and sharing will improve as the reporting solution makes data more readily available within the organization. Further, information integrity and formality will improve indirectly, as the development of a reporting solution will require the organization to invest more in proper procedures for handling data. *Table 6* shows a playbook developed by Rogers (2016) to guide managers when considering digital transformation initiatives.

Rogers (2016) noted that while the technological advancement brought by digital transformation is important, the impacts on new ways of thinking and the firms' strategy are even more important. With digital transformation, the organization is likely to undergo more pronounced changes as with other types of change initiatives. This is because it involves changes that affect interconnected processes and systems within a company. Therefore, if a change is made to one part of the organization, it will affect other parts as well. Consequently, to manage these changes successfully, managers need to consider all affected parts of the organization.

Table 6: Rogers' Digital Transformation Playbook

Domains	Strategic themes	Key concepts
Customers	Harness customer networks	– Reinvented marketing funnel. – Path to purchase. – Core behaviours of customer networks.
Competition	Build platforms, not just products	– Platform business models. – (In)direct network effects. – (Dis)intermediation. – Competitive value trains[1].
Data	Turn data into assets	– Templates of data value. – Drivers of big data. – Data-driven decision making.
Innovation	Innovate by rapid experimentation	– Divergent experimentation. – Convergent experimentation. – Minimum viable prototype. – Paths to scaling up.
Value	Adapt your value proposition	– Concepts of market value. – Paths out of a declining market. – Steps to value proposition evolution.

Source: Rogers (2016).

Wade, Macaulay, Noronha and Barbier (2019) argue that the manager in this situation plays the role of an "orchestrator", someone who ensures all the instruments are in sync. One of their main tasks is aligning with other managers in the organization, whose departments are affected by the digital transformation initiative. To conclude, because digital transformations bring more pronounced changes to an organization than other types of change, as well as the managers having a specific role, findings from change management literature are an important addition to user acceptance literature.

Change management is defined as "a structured approach to facilitating a transition from a current state (where the organisation is now) to a future state (where the organisation wants to be) (Balogun, Hope Hailey & Gustafsson, 2016). However, failure rates of change initiatives are very high, as 70 to 80 per cent of them achieve substantially less than the expected value (King & Peterson, 2007). A multitude of change management models have been proposed to provide managers with a set of tools to achieve higher success rates. Bellantuono, Nuzzi, Pontrandolfo and Scozzi (2021) highlighted some of the more popular models, which are summarized in this section.

[1] The competitive value train "focuses on competition by looking at the leverage between the companies in a supply chain and their potential substitutes and by mapping how a particular product or service reaches a particular group of customers" (Rogers, 2016).

One of the first change management models was Kurt Lewin's Change Management Model. Lewin (1975) argued that organizational change has three steps. Firstly, the current state is *unfrozen* by examining the situation, promoting forces that desire change and working to decrease forces that resist change. Secondly, the organization should *move* to a new stage by taking action, participation, and involvement of the people. Lastly, the changes need to be made permanent by *refreezing* the new state by creating new standards and policies, as well as by rewarding desired outcomes (Cameron & Green, 2012). The idea behind this process is that organizations inherently avoid change – meaning that if a new equilibrium is not intentionally pursued and encouraged (i.e., refrozen), the organization will regress towards the original steady state.

Kotter (2012) developed the 8-Step Change Model by analysing his consulting experiences. According to the model, to achieve change, organizations must first emphasize a sense of urgency and then assemble an influential team to lead the change. Moreover, a clear vision for the change should be created and persistently communicated, as well as people empowered to act on it. Further, the organization should first look for and actively reward short-term wins and then look to consolidate these into longer-term progress. Lastly, the new behaviours should be institutionalized, so everyone within the organization knows how they are expected to act and old habits can be replaced.

Table 7: Change management activities included in selected models

Change management activities	**Kurt Lewin's Change Management Model**	**Kotter's 8-Step Change Model**	**GE's Change Acceleration Process**	**Prosci 3-Phase Change Management Process**
Define a strong leadership		X	X	X
Generate awareness of the need for change	X	X		X
Define a clear vision and strategy	X	X	X	X
Communicate the vision and strategy	X	X	X	X
Define a change management team		X		X
Identify short-term goals and test the change in pilot projects		X	X	
Identify and manage resistance to change	X	X	X	X
Train people				X
Monitor change			X	X
Celebrate the successes and implement corrective actions			X	X
Consolidate the change	X	X	X	

Source: Bellantuono, Nuzzi, Pontrandolfo & Scozzi (2021).

General Electric (GE) gave a team of consultants the task of analysing change management best practices. They summarized existing research and provided the Change Acceleration Process (CAP) model. One of the more important findings was that the technical suitability of a change initiative is not enough to achieve success, but the people affected by it must be considered. Moreover, they claimed that a change initiative is most likely to fail if the organization places more importance on the technical aspects of it rather than the affected people. The model states that the effectiveness of an initiative is determined by its quality and its acceptance. Finally, they defined seven steps to accelerate change: lead change, create a shared need, shape a vision, mobilize commitment, make change last, monitor the process, and change systems and structures (Bellantuono, Nuzzi, Pontrandolfo & Scozzi, 2021).

Prosci, a consultancy focused on change management, provided the 3-Phase Process model. Firstly, the organization prepares for change, where awareness of the need for change is generated, a change management team with clear responsibilities is appointed, and groups of people impacted by the change are identified. In the second phase, the change is managed by creating and executing management plans (e.g., training plan, communication plan, resistance management plan). Lastly, the third phase seeks to reinforce the change by collecting feedback, measuring how well new habits are accepted, and encouraging new behaviour by celebrating success stories. *Table 7* summarizes the activities that a change management initiative should include to be successful according to the discussed change management models (Bellantuono, Nuzzi, Pontrandolfo & Scozzi, 2021).

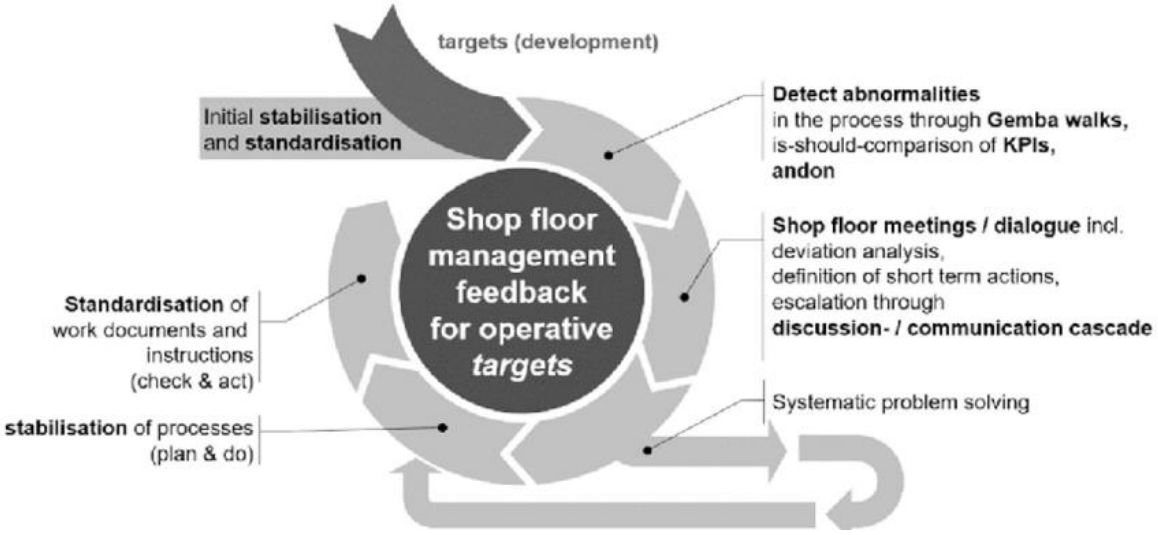
4 SHOP FLOOR MANAGEMENT

As the thesis focuses on the implementation of a new reporting system in a manufacturing setting, it is important to explain shop floor management (SFM), which is a system that many manufacturing facilities use to reduce waste and ensure optimal allocation of resources. It is defined as "an integrated managerial system that facilitates the communication, control of performance, and implementation of lean methods on the shop floor" (C. Hertle, Tisch, Kläs, Metternich & Abele, 2016). The SFM process consists of identifying deviations in production through KPIs, examining these deviations in daily shop floor meetings, starting processes to solve the problems that were found, and following up on those (Meißner, Grunert & Metternich, 2020). The SFM concepts are widely accepted by manufacturing companies, as shown by a survey of German manufacturing companies, which showed that over 80 per cent of them track KPIs (Rößler, Spiertz & Metternich, 2014). Hertle, Tisch, Kläs, Metternich and Abele (2016) summarized existing research on the objectives of SFM:

- Development of leading personnel to methodical coaches.
- Utilization of workers' complete potential.
- Sustainable support of other lean principles.
- Optimization of KPIs towards set targets.

SFM standardizes the processes and activities on the shop floor, making it a precondition to implementing lean systems (Torres, Pimentel & Duarte, 2020). Lean management encourages self-management by employees and strong vertical connections among hierarchical levels in the organization. In that sense, it serves as the opposite of more traditional tayloristic approaches, where managerial levels are separated from any operational concerns on the shop floor (Ohlig et al., 2020). Hertle, Tisch, Kläs, Metternich and Abele (2017) presented the Darmstadt Shop Floor Management model, which attempted to systematize research on SFM (*Figure 5*).

Figure 5: Darmstadt Shop Floor Management model



Source: Hertle, Tisch, Kläs, Metternich & Abele (2017).

4.1 Main components of shop floor management

There are seven main components of SFM. Visual controls are a system that aims to improve organizational performance by focusing attention on what is important (Liff & Posey, 2004). The idea is to present the current state compared to the goal to all employees, based on which corrective action can be taken. For example, KPIs should be presented clearly, visibly, and simply, so that every employee on the shop floor can understand them.

Work standardization means establishing procedures that each employee on the shop floor should follow (Torres, Pimentel & Duarte, 2020). It works by creating documentation of best practices in all job tasks to achieve maximum efficiency of production, while still taking care of other important factors such as health and safety. The documentation is later used to train employees.

Problem-solving is the process of problem evaluation, reflection, consideration of alternatives, and choosing a course of action (Liker & Meier, 2006). It is an important skill for any employee within a lean system, closely connected to the continuous improvement

mindset. Under lean, any problem is seen as an opportunity for improvement of the production process.

Continuous improvement (i.e., kaizen) is "a culture of sustained improvement targeting the elimination of waste in all systems and processes of an organization" (Bhuiyan & Baghel, 2005). The idea is that sustained small improvements to the production process can be made through a continuous effort by all employees. Continuous improvement in lean systems is most often tracked using the plan, do, check, act (PDCA) framework (Tague, 2005).

Competency development for lean manufacturing is especially important in the areas of problem-solving and continuous improvement. Having these competencies enable employees to act independently, organized, and creatively. Competency development can happen either within a formal learning framework (e.g., at training workshops) or informally during the work process (C. Hertle, Tisch, Kläs, Metternich & Abele, 2016).

The daily accountability process happens through daily shop floor meetings, where important stakeholders in an area follow a strict agenda to discuss the previous day's results (e.g., by checking KPIs on a board or screen), define actions to correct the deviations, and plan the upcoming day (Mann, 2015). They are usually conducted in a three-level cascade, where the lowest level meets first, and the highest last. This enables that all relevant information quickly travels up to the plant manager and their team.

Lastly, leader standard work includes standard activities that leaders should complete. This includes leading the daily meetings, doing Gemba walks (i.e., observing processes in action), supporting continuous improvement, coaching employees, and more (Roussel, 2020).

4.2 Digital transformation of SFM

Lean manufacturing systems strive to reduce waste in the production process to a minimum. Meißner, Grunert and Metternich (2020) assert that the traditional SFM system is wasteful due to excessive time spent on data preparation and that there is room for improvement using digitalization. The digitalization of SFM is part of a broader push for the digital transformation of manufacturing. The efforts are summed up with the term Industry 4.0 and consist of implementing information and communication technologies (ICT) within the production process (Moica, Ganzarain, Ibarra & Ferencz, 2018).

There is a consensus among researchers and practitioners that greater digitalization and interconnectivity of devices and machines on the shop floor will drastically change the organization of work (Weyer, Schmitt, Ohmer & Gorecky, 2015). For example, employees on the shop floor level will no longer just complete standardized work assignments but will play a role in driving operational performance (e.g., by optimizing and monitoring processes on the shop floor) (Davies, Coole & Smith, 2017). The new tasks that employees will take on require real-time and efficient decision support systems. This is necessary because

changes to the work environment will happen more often, so then employees will need to recognize and react to problems quickly through continuous monitoring of performance (Gröger, Stach, Mitschang & Westkämper, 2016). *Table 8* shows how digitalization adds value to individual components of SFM.

Table 8: Value added by digitalization to different components of SFM

SFM component	**Value added by digitalization**
Visual controls	• Direct integration of machine and manufacturing data. • Real-time data provision. • Automatic calculation of KPIs. • Automatic colour-coded visualization of KPIs. • Automatic notification of managers in case of deviations.
Daily accountability process	• Aggregation of KPIs for the right audience. • Categorization and classification of KPIs. • Digital board as an interactive user experience. • Task management and automatic escalation of measures. • Application guiding the shop floor meeting. • Application for planning and displaying maintenance intervals. • Application for capacity planning.
Problem-solving	• Digital board as an interactive user experience. • Tracking the problem-solving process and reminders of next steps. • Automatic feedback on decisions made in case of escalated problems. • Search function for solved problems. • Prognosis of the completion of tasks or problem-solving processes. • Development of proposed solutions for problems.
Work standardization	• Tracking of tasks and progress. • Automatic reminder of next steps.

Adapted from Meißner, Grunert & Metternich (2020).

As digitalisation adds value to so many components of SFM, it has several benefits to the SFM process. Firstly, employees on the shop floor get access to more information more quickly, meaning they correct deviations faster, resulting in higher quality work. Because of more real-time information, problems can now be discovered at their root, leading to problem-solving being proactive rather than reactive. Moreover, the need for supervision of employees is reduced, as most basic issues can now be solved by employees alone, meaning that supervisors have more time for mentoring and other activities. Another benefit is that by using near real-time and interactive digital solutions, the need for paper reporting is eliminated. Lastly, team work and cooperation on the shop floor are increased, as digital solutions provide easier communication, as well as sharing of plans, priorities, and actions (Gray, 2016).

There are also a few drawbacks of digital SFM. Firstly, maintaining large databases of data is challenging and can lead to mistakes, especially if it is not automatized and depends on manual entry by employees. Because of bad data, the KPIs shown on the shop floor can be misleading or wrong, leading to taking incorrect actions. Secondly, tracking too many KPIs

at once can cause confusion among employees and wasteful work for those who prepare them. Moreover, by automatizing the process of data collection and entry, employees might not identify with the data anymore. An automated system might also collect data incorrectly, but the mistake will go unnoticed if there is not an experienced employee overseeing the process. Further, employees might see the digital SFM as just a management monitoring tool of their work. Lastly, when implementing digital solutions for continuous improvement, employees might dislike the mandatory input of initiatives in a system, especially if it has an unfriendly design for users (Meißner, Müller, Hermann & Metternich, 2018).

4.3 Reporting solutions as part of digital SFM

The most common way of approaching the digital transformation of SFM is to introduce a digital reporting solution. A reporting solution is one type of displaying visual controls, but it is also connected to other elements of SFM. Its purpose is to achieve improvement in the production system by comparing expected and actual performance (Mann, 2015). Visual controls are presented at the daily meetings and are designed to call attention to deviations from expected performance in production. Based on the identified events, tasks are delegated to resolve them and if needed follow-ups are scheduled. Visual controls are often presented in the form of KPIs, which confirm previous decisions and ensure that progress is being made on reaching goals (Beims & Ziegenbein, 2015). However, Mann (2015) warns that visual controls need to be implemented together with strict leadership discipline, which ensures that employees on the shop floor use them as a basis for action.

Most reporting solutions include an opening screen which displays the most important information for the user in the form of KPIs, which is called a dashboard. Dashboards are defined as "intuitive and easy-to-use front-ends for monitoring, analysing, and optimizing critical business activities by enabling users on all hierarchy levels to improve their decisions" (Eckerson, 2011; Gröger, Stach, Mitschang & Westkämper, 2016). In a lean manufacturing context, dashboards are most often used to display performance on KPIs.

KPIs are "a set of quantifiable measurements used to gauge a company's overall long-term performance" (Twin, 2021). Tracking KPIs is a central part of the SFM system because it enables the detection of deviations and failures in production. Interventions can then be adopted based on the deviation found. Traditionally, KPIs were designed for and displayed to middle and top management (Ohlig et al., 2020). However, with modern SFM principles, KPIs are reviewed on all levels of the hierarchy at daily shop floor meetings. Transparency is additionally increased by displaying them directly on the shop floor (e.g., printed out on a board or on a digital screen). Increased transparency of KPIs gives employees on the shop floor the opportunity to review their work and learn from their own mistakes and successes (Lindskog, Vänje, Törnkvist & Eklund, 2016).

Employees' performance has an important effect on production efficiency. Information transparency can improve operational performance by allowing employees to learn from

their mistakes, increasing their motivation and increasing the likelihood they will participate in continuous improvement (Letmathe, Schweitzer & Zielinski, 2012). Feedback in the form of KPIs visible on the shop floor provides transparency on goal attainment and consequently higher motivation to achieve these goals. Achieving a goal can result in positive reactions and higher self-confidence in employees, leading to higher job satisfaction (Ohlig et al., 2020). Lastly, displaying information in visual form has a positive effect on decision accuracy and quality, as it enables the employees to more effectively comprehend information (Eberhard, 2021).

5 RESEARCH METHODOLOGY

The **purpose** of the master's thesis is to provide specific and relevant insights to decision-makers at Hilti's Plant 1 regarding which acceptance factors are the most important for the successful implementation of a new reporting solution. Moreover, by applying findings from existing academic research to the current situation at Plant 1, the thesis aims to develop recommendations for improvement. Specifically, plant management should get insights on how to best promote user acceptance and avoid user resistance.

5.1 Research method

The main **method** of data collection was conducting semi-structured interviews, which means that I followed a rough interview guide of questions, but the wording and order depended on the natural flow of each interview (Robson & McCartan, 2016). This method is suitable because it enabled me to ask follow-up questions to interesting responses and to gather a deeper understanding of the interviewee's motives. On the other hand, interviews are not standardized and the number of responses is too low to provide results that can be generalized to a wider population. Moreover, they are time-consuming and require both parties to speak the same language, which means it can be difficult to obtain cooperation from interviewees (Robson & McCartan, 2016). For example, I was not able to obtain any interviews from the production staff in Plant 1 because they mostly speak only German, while I do not.

I also gathered additional information by analysing archival data, such as project documentation, project presentations, organizational charts, etc. Here it was important to distinguish between the relevant and irrelevant parts of documents, because of the large amount of available information. Further, some relevant parts to the research were missing from these documents, so I supplemented them with my own experience from working on the project as well as by asking the interviewees for additional clarifications.

5.2 Research process

The main part of the research process consisted of conducing in-depth interviews with eight Plant 1 employees on different managerial levels. The interviews were semi-structured because I wanted to allow for more flexibility to ask follow-up questions to explore interesting interviewee responses, while still adhering to a rough interview structure, which enables some comparability between interviewees. Interviews were conducted in two weeks from April 13th, 2022, until April 29th, 2022.

Table 9: List of interviewees

Interviewee number[2]	Position	Connection to DSF	Stakeholder group	Length of employment at Hilti
I.1	Lean manager	Project lead (DSF 2.0)	Developer	3 years
I.2	Head of Controlling	Project lead (DSF 1.0)	Developer	11 years
I.3	Coach	User (DSF 1.0)	Coach	6 years
I.4	Unit head	User (DSF 1.0)	Plant leadership	19 years
I.5	Controller	User, Maintainer (DSF 1.0)	Plant leadership	1 year
I.6	Plant manager	User (DSF 1.0)	Plant leadership	16 years
I.7	Unit head	User (DSF 1.0)	Plant leadership	2 years
I.8	Coach	User, Developer (DSF 1.0)	Developer, Coach	6 years

Source: Own work.

One of the research goals is to identify user acceptance factors aiding the transition considered by key stakeholders. Therefore, interviewees were selected in a way that they come from different stakeholder groups. These groups were defined with the help of the DSF 2.0 project lead, and include developers, plant leadership, coaches, and workers. During the course of selecting interviewees, it became apparent that interviews with workers will not be possible because of the nature of their work not allowing for lengthy meetings, as well as the language barrier, as they mostly speak do not speak English but only German. Table 9 includes a list of interviewees, their position, how they are connected to the Digital Shop Floor project, their assigned stakeholder group, and the length of their employment at Hilti.

The interview guide was adapted slightly to each stakeholder group because they find different topics more or less relevant. For example, it makes sense to ask a developer of DSF 2.0 about the implementation plans, but it does not make sense to ask a coach who knows nothing about the topic the same question. The interview guide included from 13 to 20 questions, depending on the stakeholder group. The most important consideration when preparing the research guide was answering the research questions and fulfilling the research goals. Some questions were more general and based on my observations from working at

[2] I used this notation to refer to each interviewee in the text of the thesis.

Plant 1. The idea was to use answers from these to supplement the sections that describe the SFM process in Plant 1 and the current state of implementation of DSF 2.0.

Furthermore, other questions, especially the ones relating to user acceptance factors, were based on existing research on user acceptance of information systems and BI solutions. For example, in the question where I asked the interviewee about their opinion about the importance of different user acceptance factors, I used the factors from TAM, UTAUT and DIT. Moreover, I also had a supplementary document with the definitions and explanation of each factor if the interviewee did not know what each of them means. The order and wording of questions were adapted during each interview, according to the flow of conversation. Follow-up questions were also added. A full set of questions for I.1 and I.2 is included in the appendix, including the interviewees' responses.

The findings from the interviews were used to describe which user acceptance factors are most important for each stakeholder group. Additionally, findings were also used to present the existing and planned acceptance initiatives for DSF 2.0. Lastly, results were used also to supplement the chapters presenting DSF 1.0 and DSF 2.0, in the parts where interviewees provided more information or context than was already known through project documentation or otherwise known to me. Whenever an idea or quote by an interviewee was used in the thesis, it is denoted in the text of the thesis, to not mix-up ideas of interviewees of those of the author.

Along with interviews, analysing archival data was the other research method used in the master's thesis. The added value of using this method to supplement interviews is that I was able to include a more detailed overview of the SFM process in Plant 1 and a description of DSF 1.0 and DSF 2.0, including visual figures. Firstly, project documentation, project presentations and organizational charts were saved. Those documents which were saved only on the company intranet were downloaded and saved in PDF format. Then, the documents were reviewed and the relevant data for the thesis was highlighted. Lastly, the relevant parts of the documents were included to supplement the chapters describing DSF 1.0 and DSF 2.0 in their current state, as well as the chapter describing the SFM process in Plant 1. When a part of a document was used in the thesis it is cited in the text.

6 SHOP FLOOR MANAGEMENT IN HILTI'S PLANT 1

6.1 Company and plant presentation

Hilti supplies products and services to customers in the construction and energy industries. It is present in more than 120 countries around the world and employs more than 30 thousand people (Hilti, 2022d). The company was founded in 1941 in Schaan, Liechtenstein, where its headquarters are still located. It is privately owned by the Martin Hilti Family Trust (Hilti, 2022d). The most important product areas include anchor systems; construction chemicals;

cordless systems; cutting, sawing, and grinding; diamond coring and cutting; and direct fastening (Hilti, 2022g).

The company's mission statement, "We passionately create enthusiastic customers and build a better future," emphasizes the importance of two groups of stakeholders – customers and employees. Hilti aims to develop close and trusted relationships with customers and help them build better and faster. It seeks to value its employees and provide them with plenty of opportunities to grow and advance their careers. This is mirrored in the company values, which are integrity, courage, teamwork, and commitment (Hilti, 2022e).

Hilti uses a direct sales model, whereby the majority of employees worldwide work directly with customers. There are more than 280,000 daily interactions between Hilti employees and customers. In addition, the company runs a network of Hilti stores, where professionals from the construction industry can also buy Hilti products. The close connection with customers enables employees to innovate by constantly looking for ideas for new products and improvements to existing products. The idea is that sales representatives communicate problems encountered onsite to design labs, which then innovate and create solutions (Hilti, 2018).

The company achieved sales of about EUR 5.7 billion in 2021, which is 12.1 per cent more than in the previous year (Hilti, 2022a). It spends 6.2 per cent of sales on research and development, which shows commitment to developing new products and pursuing innovation. About 1,500 employees work on research and development in development centres located in Liechtenstein, Austria, Germany, Hungary, China, India, and the United States. In an average year, the company adds 60 new products to its product portfolio (Hilti, 2022c).

Plant 1 in Liechtenstein was Hilti's first production facility. Today it employs about 360 people and specializes in metal anchors, direct fastening elements and diamond segments. These areas make up the three production units in the plant, which has a production area of roughly 16,000 square meters (Hilti, 2022f). Besides the three production units, there are also 5 supporting units (vocational training, controlling, lean management, quality management, and technical services) in Plant 1. Other supporting functions such as human resources, health and safety, finance, IT, and facility management are shared among all the plants (Hilti, 2022b).

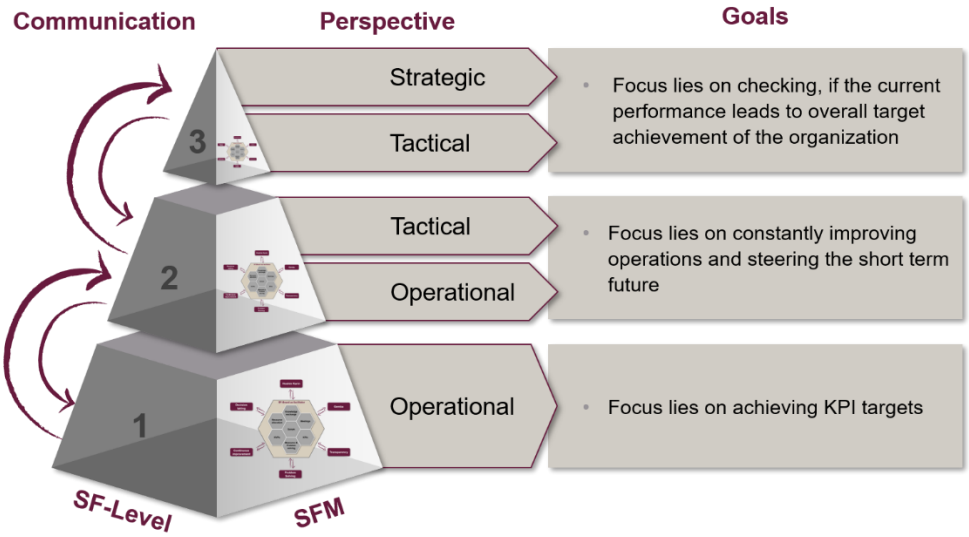
6.2 SFM process in Plant 1

The shop floor is the area within a manufacturing facility where assembly and production are carried out either by machines or people (Forcam, 2020). Effective management of the shop floor ensures that the production meets customer demands. It tries to achieve quality production output and efficient work by the workers at as low a costs as possible. To provide transparency to the SFM process, KPIs and other information are laid out on a designated

board on the shop floor, which serves as the single source of truth for people at all levels in the plant.

SFM at Plant 1 is done in a cascade from level 1 to level 3. Level 1 represents the production staff on the shop floor who work directly with machines. Their supervisors, called coaches, direct the workers to achieve maximum output while ensuring their health and safety, as well as meeting quality standards (level 2). Finally, level 3 is made up of unit managers, who coordinate efforts to provide customers with their product at the right quality, time, quantity, and level of cost. Their supervisor, the plant manager, deals with strategic issues and steers the plant in the right direction. As shown in *Figure 6*, level 1 focuses on operational issues, level 2 on operational and tactical issues, and level 3 on tactical and strategic issues.

Figure 6: SFM cascade in Plant 1



Source: Hilti (2020a).

There is a daily shop floor meeting which happens every day on each shop floor level, whose purpose is to review the previous day's result, identify abnormal events, and define corrective actions. Moreover, the meeting also ensures that relevant information makes its way up and down the shop floor cascade. As I.7 described it, "the idea is that we have a quick check-in every day to synchronize our information. We evaluate how was the last day and we take measures if necessary to make the upcoming day better." He added that KPIs are assigned to specific days, so it is always clear which KPIs will be discussed and when. Objectives of the shop floor meeting are (Hilti, 2019):

- To enable high performance of the area for the next 24 hours by mitigating risks.
- To improve area performance by eliminating root causes by deciding and executing improvement actions.
- To prioritize the focus of the area for the next 24 hours.
- To enable the area to work as a team though alignment and collaboration.

– To enable timely escalation of immediate issues.

As the meeting happens on every shop floor level, this means that each coach attends two meetings – they supervise the meeting at level 1 and participate in the meeting with their supervisor at level 2 (similar is true for unit managers). The level 1 meeting starts earliest in the morning, and the level 3 meeting latest in the morning, which ensures that all relevant information makes its way up the hierarchy quickly.

The meeting takes place in front of the shop floor board, where the KPIs and other information are posted. Each KPI is discussed once per week, so the period of discussion is usually the previous week. The supervisor and his employees identify the positive and negative trends together, and if necessary, agree on corrective actions. The meeting his highly focused and should last no longer than 15 minutes. There is a limited number of participants, a fixed agenda, and a clear action focus with fixed deadlines. When corrective measures are agreed they are followed-up at future meetings. To achieve a highly effective meeting, ground rules are set (Hilti, 2019):

– Start and finish on time.
– Come prepared.
– Ask curious questions.
– Keep the focus on the meeting.
– Accept feedback and trust its intent.
– Have fun. Enjoy the process and each other's company.

The key to SFM in Plant 1 is to ensure information is understandable and accessible for all. Further, KPIs need to be aligned with the goals, reported transparently, and checked regularly. Transparency makes it easier to recognize deviations from targets, recognize room for improvement, act preventively before problems occur, and visualize success to celebrate the performance of employees (Hilti, 2019).

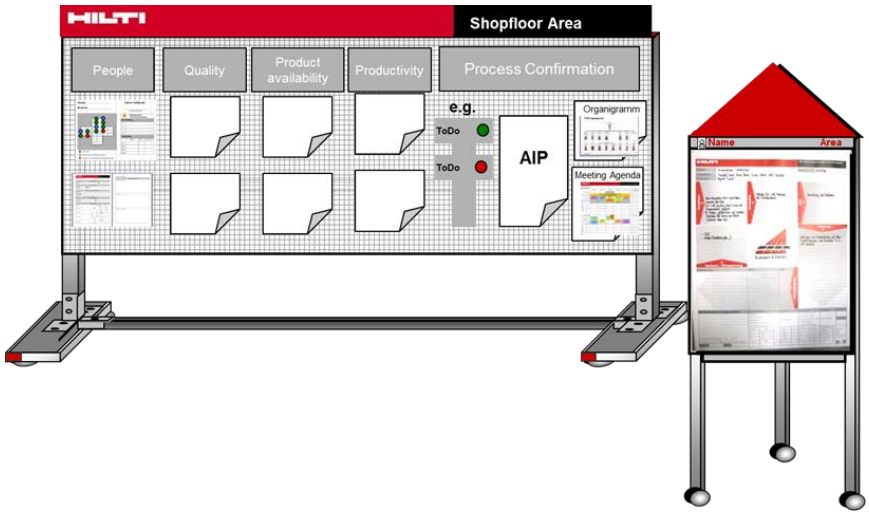
6.3 Digitalisation of SFM in Plant 1

The shop floor board is one of the key elements of SFM, as it facilitates daily meetings. During recent years, the shop floor boards in Plant 1 have undergone a lot of changes. Consequently, the steering of the plant through the SFM process has changed as well. Until 2020, all the KPIs and other information displayed on the shop floor were manually prepared, printed out, and posted on physical boards. In 2020, a digital reporting solution called the DSF 1.0, was rolled out in Plant 1, which displayed the KPIs and other information on digital boards around the shop floor. This reduced the amount of manual work and provided a lot of functionality that was previously not available.

As mentioned by I.8, preparing visual controls for the shop floor meeting was a very manual and time-consuming process before the implementation of DSF 1.0. KPIs were prepared by

the controlling department, which had to prepare them manually using SAP and Excel. Then, charts and KPIs were printed out and posted on physical boards on the shop floor. On top of that, supervisors (i.e., coaches and unit managers) additionally prepared their analyses relevant to their teams through a similar combination of SAP and Excel use. This process was wasteful both in terms of time and the environment because they had to do a lot of unnecessary printing.

Figure 7: Sketch of the shop floor board before implementation of DSF 1.0



Source: Hilti (2019).

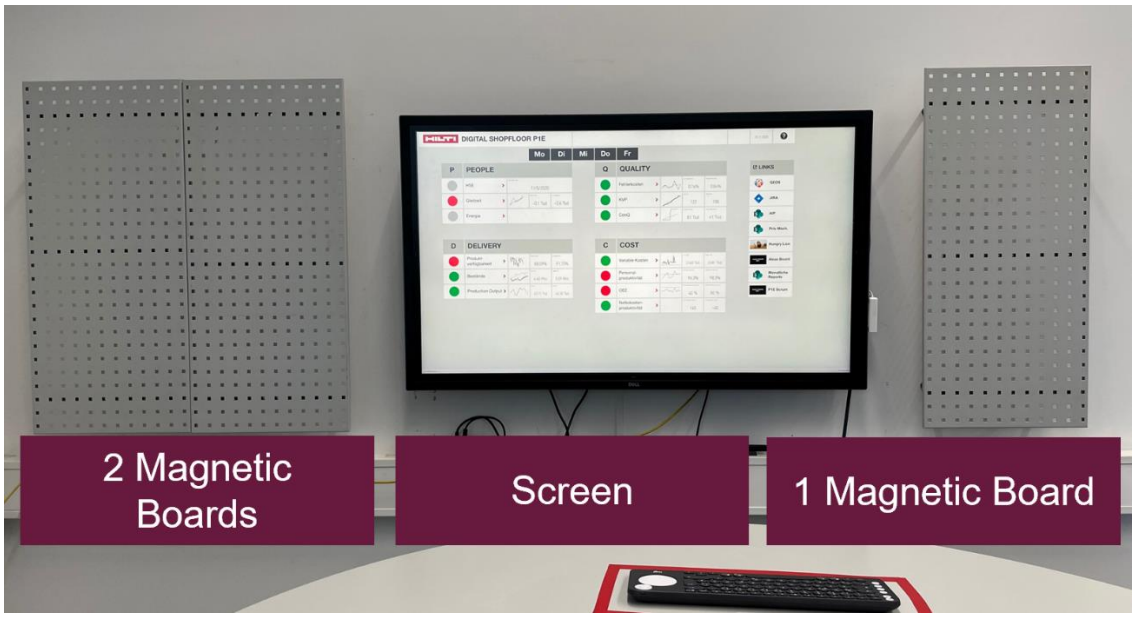
The shop floor meeting took place in front of shop floor boards, where the supervisor noted positive and negative trends with green or red magnets. Printed-out charts presented a very static view of the situation, which often led to arguments about the reasons for the identified deviations and to doubt about the correctness of the presented numbers. A paper-based shop floor board provides only limited information that does not enable users to identify the root causes behind trends. Moreover, the decision-making is done on a very small number of indicators, because the space on the shop floor board is physically limited. *Figure 7* shows a sketch of the physical shop floor board where printed charts and KPIs were posted before the implementation of DSF 1.0.

To improve on these issues, DSF 1.0 was developed, with the idea of displaying KPIs on digital screens around the plant. The goals were to improve and further standardize the shop floor routine, as well as to bring collaboration, reliability, usability, and productivity to the next level. According to I.1, “the main motivation was to generate more value for the team lead and the team. It was not our motivation to introduce an additional tool for the sake of it.” Figure 8 shows a photo of the shop floor board after the implementation of DSF 1.0.

After an evaluation of the available ready-made solutions and self-service BI software, the project team decided to develop DSF 1.0 in-house using Microsoft Power BI. There were several reasons to go with Power BI. Firstly, it offers a lot of flexibility, rich functionality,

and low cost in comparison to ready-made solutions and other BI software. Moreover, Power BI had already been adopted in various departments in Hilti, so some members of the project team already knew how to use it.

Figure 8: Photo of the shop floor board after implementation of DSF 1.0



Source: Hilti (2019).

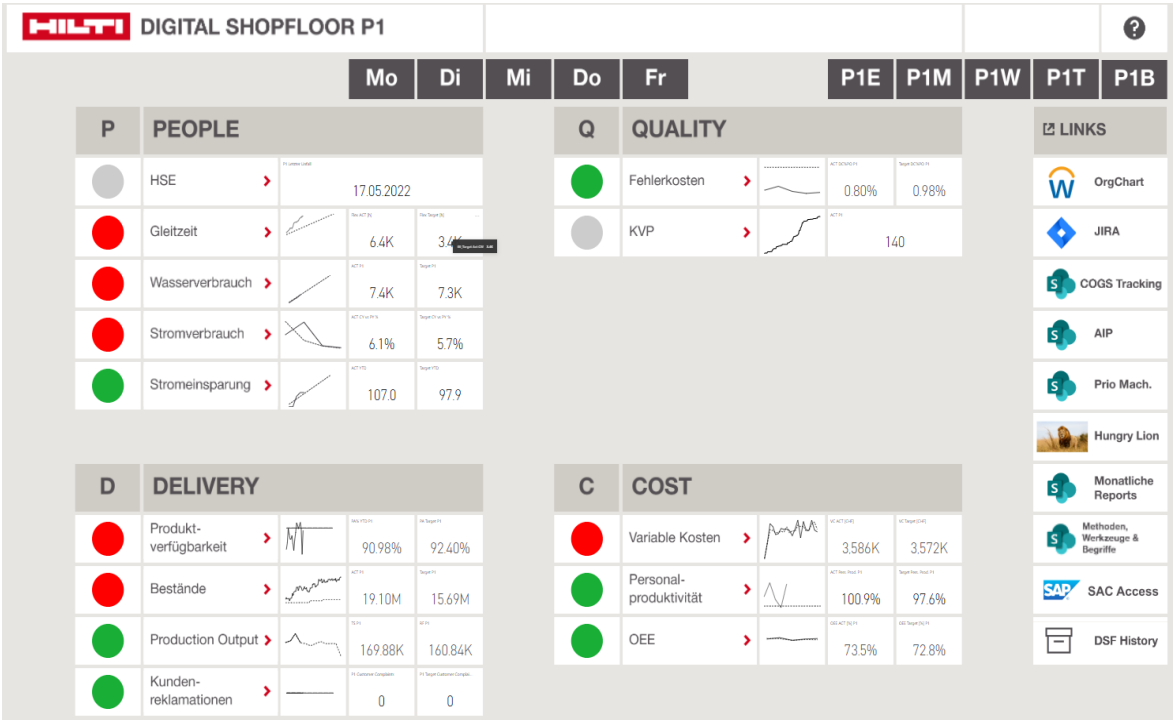
It was also already a part of the software package at Hilti, so using it did not bring any additional costs and did not require additional IT approval. Furthermore, the IT department judged Power BI to be very suitable for business users with limited technical knowledge, because of its simple Excel-like approach and easy set up. There are extensive training resources, libraries, and forums available to help report creators. Lastly, it also provided good integration possibilities with other Microsoft software already used at Hilti.

On the back-end, data presented on DSF 1.0 comes mainly from SAP, which Hilti uses as its ERP software. The process of preparing SAP data for import into DSF 1.0 is not automatic and includes manual exporting and additional calculations. Once this is done, data is loaded onto the Power BI Service, where reports are divided into workspaces according to each production unit in the plant. Workspaces allow collaboration in building reports, assignment of editing rights, bundling reports, and creating apps. Overall, the back-end structure is well thought out and provides correct data. Still, it is important to note that it was designed by a project team made up of business users and no IT professionals, so they did not manage to set up a fully automated solution.

On the front-end, the main screen of DSF 1.0 is a dashboard which shows a high-level overview of production KPIs (*Figure 9*). A green or red traffic light next to each KPI shows whether the result of the previous week was on target or not. Dashboards are structured according to the People-Quality-Delivery-Cost (PCQD) SFM framework, which provides a

holistic view od the relevant areas and accommodates a standardized meeting schedule (Velaction, 2011). Each dashboard can be filtered by the day of the week to show only the KPIs that will be discussed on that day. Further, it can also be filtered by organizational area, so each team sees only the information that is relevant to them.

Figure 9: Screenshot of the DSF 1.0 dashboard for Level 3



Source: Own work.

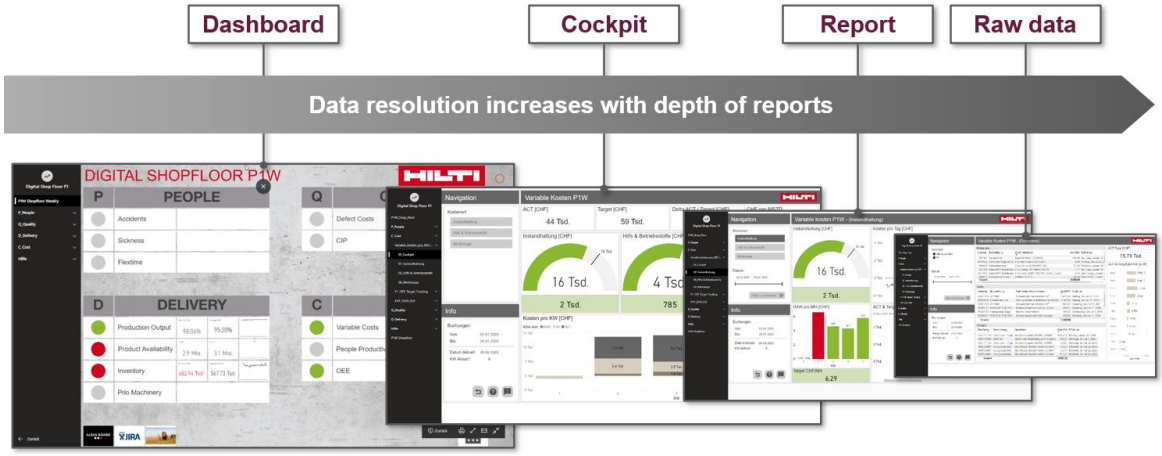
When designing the dashboard, the main goal was to make it simple so the user can easily recognize the most important information and act on it quickly. That is why the dashboard was designed with the 1-3-10 rule of visual management in mind. According to Clarity (2021), the rule says that users should:

- Understand the purpose of the board in 1 second.
- Understand the current status in 3 seconds.
- Understand the necessary measures in 10 seconds.

While the dashboard provides a high-level overview, users can also open a more detailed report for each KPI, which includes additional charts, calculations, and raw data. The reports follow a standardized layout, with the main goal being ease of use. The first page of each report includes basic charts and KPIs, but users can also drill-down to other views with more complex visualizations and raw data. The idea of the drill-down functionality is to easily investigate the root causes of a negative trend. *Figure 10* summarizes how users can drill down from high-level information on the dashboard to raw data if needed.

The implementation of DSF 1.0 had many positive impacts on the SFM process. To start, a lot of the manual work previously associated with SFM was eliminated. I.5 noted that DSF 1.0 is a big improvement over the previous practice of printing reports and posting them on physical boards. Moreover, it improved the overview of KPIs and added more frequent automatic updates of data. I.6 said that for him, the regular updates of data and having only one source of decision-making information presented the biggest positive impacts of DSF 1.0, along with the possibility of doing deep dives via drill-downs.

Figure 10: Depiction of DSF 1.0 report depth based on users' information needs



Source: Hilti (2020b).

Other positives included increased data transparency, more efficient shop floor meetings, and increased standardization of documents, data inputs, as well as the shop floor routine. I.1 mentioned that before the implementation of DSF 1.0, they "only had the final data point presented and then there was a lot of effort before and after the meeting to understand where this red-figure comes from". With DSF 1.0, there was less doubt about the correctness of numbers and the discussion in the shop floor meeting is more constructive. Moreover, the implementation of DSF 1.0 proved to be crucial during the COVID-19 pandemic, because it enabled easier remote access, preparation, and participation.

Despite the overwhelmingly positive reception in the plant, there were some negatives associated with DSF 1.0 as well. For example, I.7 mentioned that at the beginning, data was often not accurate, so they did not know what to believe anymore. Correctness of data is especially important because these KPIs are used to steer production. I.7 noted that if the numbers are incorrect, "it is dangerous because we can take the wrong decisions." Finally, there were also some technical issues such as long load times, which decreased the usability of the solution. Overall, the negatives were generally short-term and technical in nature and were quickly resolved. DSF 1.0 eventually completely replaced the paper-based process from before.

7 IMPLEMENTATION AND USER ACCEPTANCE OF DSF 2.0

7.1 DSF 2.0 presentation

DSF 2.0 is the upgraded version of the previous solution and is planned to be released during the course of 2023. It is a much bigger project than DSF 2.0 because it will be rolled out in all Hilti plants, not just Plant 1. This section aims to provide an overview of the main characteristics of DSF 2.0, which were divided into BI software, back-end structure, front-end structure, and impact on shop floor meetings.

The reason for choosing these four areas is that they impact some of the most commonly discussed user acceptance factors from academic literature (Davis, 1989; Venkatesh, Morris, Davis & Davis, 2003). For example, the BI software and the back-end structure influence the perceived ease of use of a solution. Moreover, the front-end structure and the impact on the shop floor meetings define how much the solution helps employees with their jobs (i.e., perceived usefulness).

The principles and structure of DSF 2.0 remain the same as they were for DSF 1.0, but there will be large changes on the back-end. DSF 2.0 will not be built in Power BI but in SAC, which will enable a closer and more stable connection to the source data that is mostly saved in SAP. I.1 mentioned that since Hilti uses SAP as its provider for the manufacturing execution system (MES) and ERP software, it makes sense to also use its BI software and stay within this ecosystem.

DSF 2.0 aims to build on the successes of DSF 1.0 in Plant 1 and provide this on a much wider scale. At the same time, it seeks to improve on its weaknesses, especially on the back-end structure. The project team now includes members with IT backgrounds, who will be able to provide a solution that is more automated and requires less maintenance to keep running. DSF 1.0 was built by developers without much earlier IT experience, so it includes a lot of ad hoc solutions and workarounds. These short-term solutions to problems work adequately on a one-plant basis but do not scale well on the company level.

The development approach for DSF 2.0 was outlined by I.1: “we have a big project team in the back end working on the business warehouse, getting the right data from SAP into the business warehouse, building the queries and then we work on the front-end.” The consequence will be a more stable solution, which will require minimal maintenance once set up. On the other hand, a con of this approach is that the solution will be less adaptable since any proposed change will have to be approved by the project team and aligned with all other plants.

In the initial implementation, DSF 2.0 will include less front-end functionality than DSF 1.0 currently does. This is a consequence of several factors. Firstly, all plants do not track the same indicators, so the project team looked for the common denominator of indicators that

all plants use. Secondly, SAC is a less powerful visualization tool than Power BI, meaning that all charts and indicators cannot be recreated in the same way. Lastly, the roll out will be in several stages. For plants which currently do not use DSF 1.0, this is not a problem, since having some reports ready is better than none. On the other hand, Plant 1 has a feature-rich solution (DSF 1.0) already in place, so a different roll-out approach will be taken. Until DSF 2.0 is an adequate replacement for DSF 1.0, the old solution will not be shut down, but both will run in parallel.

DSF 2.0 aims to professionalize the solution and make the maintenance as close to automatic as possible. DSF 1.0 was built and maintained by business users, often interns, who lacked technical experience and knowledge of how to build a stable and scalable solution. The solution works well in Plant 1 but requires a lot of manual work and it would be difficult to implement it in other plants. Therefore, the idea to develop an upgraded version with more IT support makes sense. Additionally, as I.5 mentioned, having the same reports in all plants with common calculation methodologies is also good for comparisons among plants: "I think having a global solution is way better than just us doing our own thing because then we will also have a level where each plant has the same report and then we can also compare results among each other."

7.1.1 BI software

The BI software used for the DSF 2.0 is SAC. It was chosen over Power BI because it enables a more direct connection to business data, which is stored in an ERP provided by SAP. Therefore, the workaround where data is first downloaded into Excel and then uploaded into Power BI can be avoided, and reports can become fully automatic. This is a big improvement versus the current solution in Plant 1, where the maintenance and updating of the DSF 1.0 takes a lot of time.

Hilti's IT team evaluated SAC's capabilities in the same four categories as for Power BI:

- Data connectivity,
- Data preparation and modelling,
- Interactivity and visualization,
- Sharing and publishing.

In terms of *data connectivity,* SAC offers the best connectivity to SAP sources out of any BI software. As Hilti's ERP solution and MES run on SAP, this is a big advantage of SAC over other business intelligence software. The connection to SAP sources is easy to establish and maintain. It also enables authorization inheritance. Further, live connections to SAP sources are supported out-of-the-box, meaning that additional steps such as setting up a data gateway are not needed. There are also connectors to many non-SAP data sources, but in comparison to other software, the options are more limited (Hilti, 2021).

SAC offers basic *data preparation and modelling* features, but trails significantly behind its competitors in this area, especially Power BI. However, improvements are on the roadmap and SAP is investing in closing the gap with competitors. This deficiency means that stronger IT support is needed for DSF 2.0, as data preparation and modelling need to be done before it can be used in the BI software. SAC is very strong in data blending capabilities on the chart level, which is a key differentiating capability over competitors. There is also a graphical modelling environment, which makes data modelling easier, but it must be noted that competitors offer this functionality as well (Hilti, 2021).

The tool offers a variety of features for *interactivity and visualization* for the most common visualization types and charts offered in BI software. The number of visuals is smaller than with Power BI and there is more limited fine-grained control over them. Moreover, the UI can be overwhelming for a beginner. Besides the common visualizations, custom JavaScript or R widgets can be included, which adds some capability, but is not a competitive advantage over Power BI, which also has support for R and Python widgets. SAC has a differentiating advantage over other software when it comes to variance charts (actual vs. budgeted vs. forecast). The report filtering and interactivity experience is solid but not better than those of competitors (Hilti, 2021).

There is a multitude of *sharing and publishing* options in SAC, with many investments by SAP in this area still ongoing. Reports can be shared with different users in the organization with different sharing rights. Data from charts and other visualizations can be exported to CSV, PDF, and Google Slides. There is also a limited integration with Microsoft Excel. In terms of mobile capabilities, there is an iOS mobile app where users can access the reports they are interested in, with an Android app being on the roadmap (Hilti, 2021).

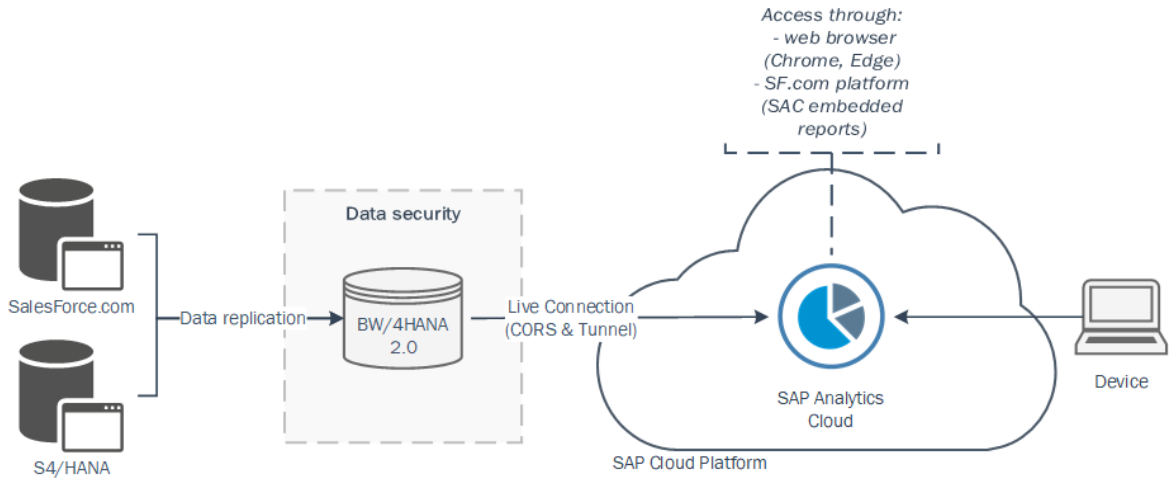
Overall, the platform is user-friendly and supports more than just the traditional BI features. A clear competitive advantage is the integration of BI, planning, and predictive functionality. For Hilti, the standout advantage is the extensive connectivity options to SAP data sources. There are a lot of online training resources, such as blogs, videos, and documentation, where users can learn to use the platform. It is suitable for business users at Hilti, but they do need training because the user interface can be overwhelming at first. Lastly, there is a smaller community of developers than for Power BI, because the product is still young, so resolving problems through public forums is less likely (Hilti, 2021).

7.1.2 Back-end structure

The back-end structure for DSF 2.0 is simpler than for DSF 1.0 because a live and direct connection to the data is possible in SAC. The main sources of data for the DSF 2.0 are Hilti's ERP and MES systems, which are both run on SAP's software solutions. Then, as noted by I.1, SAC enables a direct live connection to this data, without any intermediary steps, such as downloading it first into Excel files and uploading them to SharePoint, as was done with DSF 1.0. Finally, developers create reports and dashboards with the data from

SAP sources. These can then be accessed through the web browser of each user or shop floor boards mounted in the plants. *Figure 11* shows the process data goes through to get from the source to being shown in the reports.

Figure 11: Back-end structure from source to the output of DSF 2.0



Source: Hilti (2022e).

Besides the official sources envisioned by the project team, individual Excel files are sometimes also loaded to visualize data in SAC. This enables the developers to give business users some more flexibility to manually enter data while avoiding the complex SAP architecture. This gives some opportunity for incorrect entry of data by users, but the increased flexibility it provides outweighs the risk.

On the back-end side of SAC, different reports and dashboards are divided into folders. DSF 1.0 has a complex workspace structure in the Power BI service, but this is not needed for DSF 2.0, since SAC provides more flexibility. There is only one report for each indicator, as opposed to having duplicates of each report for each production unit, as was the practice with DSF 1.0. Reports can still be filtered to only one unit or coach area, without the technical workarounds used before. Overall, the back-end for DSF 2.0 is more robust and less prone to errors as was the case with DSF 1.0. The reason is that it is built in a more planned and consistent way by developers with more IT experience. I.1 elaborated on this point: “There are also big advantages to the robustness of the solution. I would say the SAC is more robust than Power BI ever can be in the way how we build it, to my knowledge. The connection is closer to the source data.”

7.1.3 Front-end structure

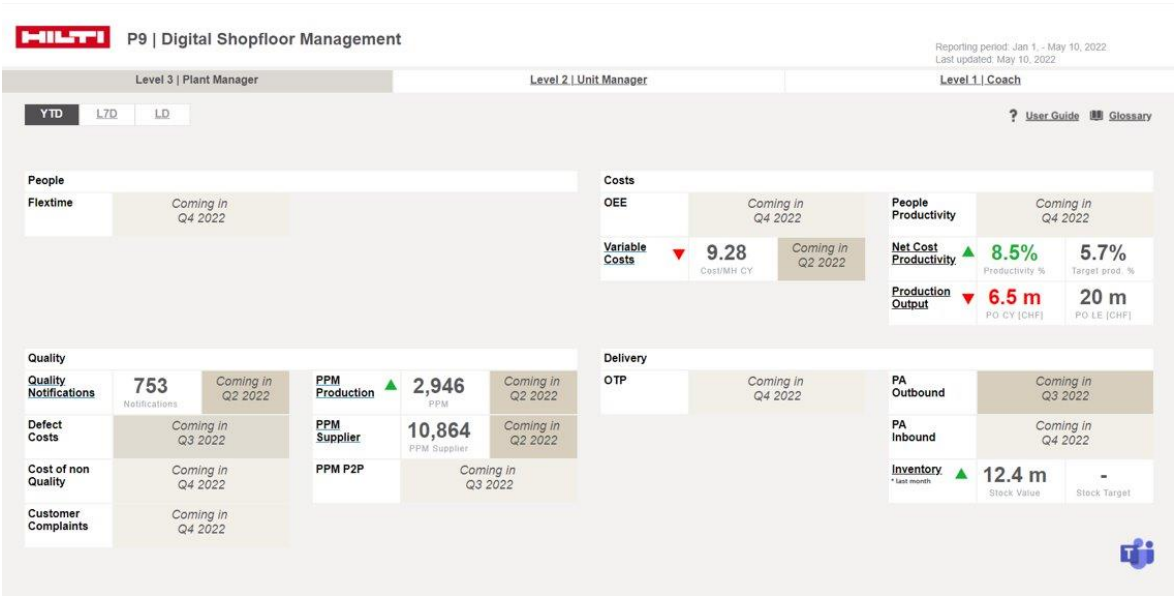
DSF 2.0 aims to be intuitive, comprehensible, and visually appealing for the user. The standardized layout of the dashboards will be similar to the one used in DSF 1.0, to enable an effortless change for the users. Therefore, the dashboards will remain structured

according to the PCQD framework presented in the previous section. The dashboards will be three levels deep, according to the SFM cascade used in all Hilti plants – level 1, level 2, and level 3.

The new solution includes some additional functionality in comparison to DSF 1.0, namely the time-filtering functionality. Users can filter the data to show the year-to-date information, only the last seven days, or only the last day. DSF 1.0 only showed the year-to-date information on the dashboard, and if users wanted to see more detailed data, they had to open individual reports. This functionality can be implemented because of the direct connection to the data that SAC enables, so all numbers can be presented on a more detailed level. Most individual reports in DSF 1.0 only enabled weekly or monthly updating of data, whereas the new solution will provide daily updating in most cases.

DSF 2.0 is currently still in the development phase, so most reports are not yet available. Therefore, the indicators for those reports are not yet shown on the dashboard. The project team are aiming to bring most reports over from DSF 1.0, although not all of them. There will also be some new reports, which are currently not available. There are some cases where reports technically cannot be developed in SAC because they depend on connections from Microsoft's ecosystem (e.g., Excel files and SharePoint lists).

Figure 12: Screenshot of the DSF 2.0 dashboard for Level 3



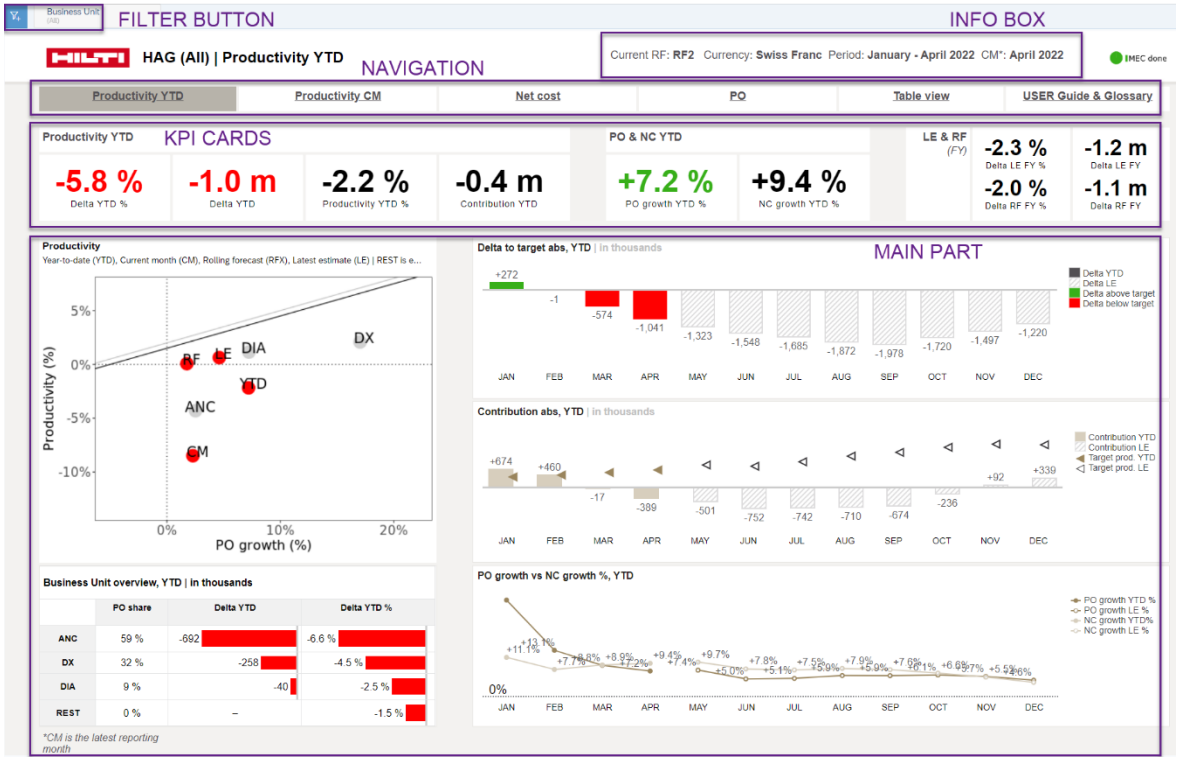
Source: Own work.

The navigation functionality of the DSF 2.0 is similar to DSF 1.0, but there are some differences as well (*Figure 12*). Users can still access individual reports by clicking on the chosen indicator. They can also access dashboards of other managerial levels, so they only see the information that is relevant to their team. For now, it is not possible to filter reports by the day of the week when they are discussed on the shop floor. Such a feature could be

added in the future if there is enough user demand. The DSF 2.0 dashboard includes two new links to the user guide and the glossary, which are meant to be the "first resort" when a user has questions about the solution, before asking the project team. Lastly, the dashboard will also provide links to other important information and tools at the bottom of the screen. Currently, there is only a link to Microsoft Teams, but more will be added in the future.

The DSF 2.0 project team strived to keep the positives from DSF 1.0. This included its simplicity in allowing users to identify the most important information quickly. That is why the new dashboard has a similar look to the one in DSF 1.0. It is again built according to the 1-3-10 rule of visual management. The concept of the traffic light was slightly adapted. There is no longer a separate visual showing a green or red traffic light, but the KPI itself is now coloured accordingly. SAC also does not provide the capability to include a small chart showing the recent trend, so this is no longer included on the dashboard. If the users want to see more granular data and identify root causes, they can still open individual reports by clicking on any indicator.

Figure 13: Standardized layout of DSF 2.0 reports



Source: Own work.

All reports in DSF 2.0 follow a standardized layout (*Figure 13*), which is different from the one in DSF 1.0. There is a filter button in the top-left corner that enables users to filter the report by time (e.g., year, month, or week), business unit, cost centre, etc. The number of available filters depends on the individual report and its underlying data. There is an information box on the top of the report, which displays relevant information, such as the

forecast period, the actual period, and the current month. The navigation is located below the info box, allowing users to switch between different sub-pages of the report. Further, the navigation also includes a link to the user guide and glossary, where users can find the technical documentation and definitions of the KPIs presented in the report.

KPI cards are displayed below the report navigation, followed by the main part of the report with charts and other visualizations. DSF 1.0 followed a loose rule that the main part should include only one or two graphs, to keep focus on the most relevant information, while other visualizations should be presented on other pages. DSF 2.0 does not follow this rule as rigorously, as there are usually four or more charts on one page. While some of the focus on the most relevant information is lost, this approach saves users' time by eliminating unnecessary page switching. The drill-down capability is more limited in comparison with DSF 1.0. For now, most KPI cards and graphs do not enable the user to drill down further to more detailed information or raw data. DSF 2.0 also includes the functionality to export data to Excel, if needed.

7.1.4 Impact on shop floor meetings

DSF 2.0 was first implemented in two pilot plants – Plant 4 and Plant 9. The solution was tested there, and users were asked to give their feedback. The initial implementation approach was similar to DSF 1.0 in Plant 1 – firstly train key users and encourage them to show how the solution works to others. After users gave their feedback, the project team worked to improve it before it gets rolled out in all plants.

The DSF 2.0 roll out plan for Plant 1 is different because they already use DSF 1.0. Therefore, DSF 2.0 will be rolled out only after it offers at least as rich functionality as the existing solution. Moreover, training will be done to make the switch easier. The change management process will also need to take into account a higher probability of user resistance in Plant 1 because users like the current solution and do not want to switch to a new one.

DSF 2.0 will primarily be used as a supporting tool for the daily shop floor meetings. Developers strived to create a similar user experience as with the old solution, so they expect a small impact on the shop floor meeting in Plant 1. Arguably, the transition from paper to digital SFM was much larger than the coming transition to a new version of the digital tool. Still, any implementation of a new information system will have some effect on how people work with it. The main impacts of implementing DSF 2.0 will relate to how people in the plant perceive the changes compared to DSF 1.0.

There are two main positive impacts for the shop floor meeting as a result of implementing DSF 2.0. Firstly, because the back end will be built by experienced IT developers, it will be simpler, more reliable, and feature a live connection to the source data. Consequently, there

will be fewer errors in the displayed data and downtimes for maintenance will be less frequent.

Therefore, the users will trust the displayed data more and there will be less doubt about the correctness of the data, which has led to disagreements in the shop floor meeting before. Secondly, the new solution will be implemented in all Hilti plants. This will enable company-level standardization of KPIs and therefore easier comparisons of data among plants. As a result, how the week-by-week performance comparisons to other plants can be included in the shop floor meetings, making them more insightful.

Table 10: Comparison of DSF 1.0 and DSF 2.0

Area of comparison	**DSF 1.0**	**DSF 2.0**
BI software	– Microsoft Power BI – Less steep learning curve and easy transition from Excel. – Extensive training resources and support communities for report creators. – Good integration with other Microsoft software.	– SAP Analytics Cloud – More difficult to use, more technical training needed. – Training resources are less readily available, the community of report creators is smaller. – Good integration with other SAP software.
Back-end structure	– Manual process to export data from SAP, transform it, and load it into Power BI. – Complex structure of workspaces for each unit. – Some reports use non-SAP sources that enable manual entry of data.	– Automated process of loading data into SAC because of a live connection to SAP. – Simple structure of one folder for each report, no division by units. – Some reports use non-SAP sources that enable manual entry of data.
Front-end structure	– Standardized dashboard structure according to the PCQD framework. – Standardized report structure with limited time-filtering and extensive drill-down capability.	– Standardized dashboard structure according to the PCQD framework. – Standardized report structure with extensive time-filtering capability and limited drill-down capability.
Impact on shop floor meetings	– Solution offers around 30 feature-rich reports with ability to add more. – There are sometimes downtimes and mistakes in data due to unreliable back-end structure.	– Solution offers only around 15 feature-rich reports, some will never be transferred over. – More reliable solution in terms of data correctness because of automation and live connection to source.

Source: Own work.

On the other hand, implementing DSF 2.0 will have some negative impacts on the shop floor meeting as well. Firstly, since SAC does not support all the same functionality as Power BI, some of the reports will not be transferred from DSF 1.0 to DSF 2.0 because it is technically too complicated. In these cases, managers will have to adapt their shop floor meetings to

exclude information covered by these reports or replace it by doing their own analyses. Secondly, participants of the shop floor meetings will need to get used to the different functionality of the new solution.

For example, DSF 2.0 will offer less drill-down capability than DSF 1.0, at least at the start. As mentioned by I.3 and I.7, the team leaders in Plant 1 like the drill-down functionality so much, they want it expanded rather than scaled down, so this will be seen as a shortcoming of DSF 2.0. The new solution will still provide the functionality to easily identify the general trend in the numbers, but the identification of root causes behind the trend will be more challenging.

So, managers leading the shop floor meetings will need to prepare more in advance to explain the reasons behind the trends. If this shortcoming is not addressed, it could mean that shop floor meetings will become less constructive and more arguments about the root causes of trends will emerge. To conclude this section, *Table 10* includes a comparison of the existing and new reporting solutions based on the four discussed areas of comparison.

7.2 User acceptance factors for DSF 2.0

The change to DSF 2.0 has not been officially announced in Plant 1 yet, so employees do not know much about the solution for now. Still, most of the interviewees are aware of the future change and have at least some information on the differences versus the current solution. Plant 1 is currently the only Hilti plant with a running digital SFM solution, so it is in a unique spot. Other plants still work with paper reports. Therefore, the challenge of encouraging user acceptance in Plant 1 will be different compared to other plants. This section will focus on how different user groups consider user acceptance factors of DSF 2.0.

User acceptance factors will be considered for each user group individually because these groups have different priorities and use for the information displayed on the shop floor boards. Consequently, they also have different views on which factors are more important for user acceptance. The considered user groups are developers, plant leadership, coaches, and production staff. The information was collected by doing interviews with Plant 1 employees on different hierarchical levels.

7.2.1 Developers

Views of the developers were presented by the project leads for DSF 1.0 (I.2) and DSF 2.0 (I.1). I.2, the project lead for DSF 1.0, believes that “content fit to the users’ needs” is the most important consideration for user acceptance, which is closely aligned with perceived usefulness. She highlighted that users are more likely to accept the solution if “relevant information is found for the user to do their job”. Moreover, she said that they strived to develop DSF 1.0 in a way, where every user sees only the things that are relevant for their

team: “We gave our users exactly what they need so they do not need to click and dig through the information for the whole plant so they can find what is relevant for them.”

On the other hand, I.1 believes relative advantage to be the most important user acceptance factor. I.1 noted that because users in Plant 1 have already made the switch from paper to digital reports, they are already familiar with the benefits they bring. Therefore, he believes that it is crucial for the acceptance of DSF 2.0 to show that it is better than the existing solution. To pursue this goal, they decided not to introduce DSF 2.0 in Plant 1 until it has at least equal functionality to DSF 1.0. This is a different approach to other plants that still use paper reports, where DSF 2.0 will be introduced sooner. I.1 added that “if we develop something that is only equally good, we will not get high acceptance.”

Additionally, to relative advantage, I.1 also sees perceived usefulness as an important factor, while perceived ease of use is less important. He seemed to put more emphasis on the relevancy of information presented on the digital boards as opposed to functionality: “If we bring a new tool that is actually better in terms of functionality, but less informative … we will not get high acceptance, because users are used to having more information.” Still, he believes perceived ease of use is an important factor as well, because if users do not know how to work with a solution, then it will be difficult to get high acceptance. Similarly, I.2 also considered perceived ease of use to be less important than perceived usefulness, because it is the content that matters.

Lastly, both interviewees also discussed some other user acceptance factors. I.1 mentioned that he sees trialability as important, which is why users will be allowed to test DSF 2.0 before the official launch date to learn how to use it and suggest improvements. On the other hand, he does not see voluntariness as important, because if the users see the value of using a solution, then whether it is voluntary or not should not be important. Finally, neither interviewee sees the image as being an important factor.

7.2.2 Plant leadership

Views of the plant leadership were presented by the participants of the level 3 daily shop floor meeting (I.4, I.5, I.6, and I.7).

According to I.6, perceived ease of use and perceived usefulness are both important factors for determining user acceptance, but he believes that ease of use is a necessary prerequisite for a solution to be accepted by users. Only when a solution is easy to use, will people be motivated to try it out and use it regularly. Otherwise, the solution will only be used by a small group of tech-savvy individuals, whom he described as “nerds and geeks.” I.4 also emphasized the importance of ease of use. He said that, as someone who is not very experienced with digital things, he values solutions that are easy to navigate and understand.

On the other hand, I.5 and I.7, believe that the perceived usefulness of a solution is more important. For example, I.5 said that "having useful data is the reason for having the DSF", while "it being easy to use is a thing of perspective, which we can work on with trainings". I.7 further pointed out that if the solution has wrong or irrelevant information, it does not make sense to use it, even if it is easy to use. For him, relevancy and accuracy of information are more important than usability. Moreover, I.6 agreed that displaying correct information is very important to avoid mix-ups and wrong decisions. He also said that this was a reason why some users were resistant to accepting DSF 1.0 at first, as they doubted the correctness of the numbers, especially when they showed negative trends. Finally, I.4 also noted the importance of the correctness of the displayed data.

Several interviewees mentioned that relative advantage was an important factor for the acceptance of DSF 1.0. They said that the solution was accepted gradually and naturally because employees saw that it provides better value than the previous way of doing things. For example, I.7 said that an alternative to using DSF 1.0 would be to manually query and analyse data from SAP but said that this is a much worse experience than using DSF 1.0. This is further proved by most interviewees seeing the use of DSF 1.0 as voluntary but at the same time admitting that there is no other option but to use it. It shows that it was accepted naturally and not through an official directive by management or formalized mandatory use. Therefore, to achieve user acceptance in Plant 1, DSF 2.0 will also need a relative advantage over the current solution.

Lastly, interviewees also discussed the role of social influence and voluntariness on user acceptance. For instance, I.6 and I.7 said that in their opinion social influence does not affect user acceptance of the DSF. On the other hand, I.4 said that it might have some effect: "if people see other people using it, they are also happy about that and use it more themselves." Finally, I.4 and I.6 believe that whether a solution is mandatory of voluntary is not so important, because if people like it, it will naturally become a tool that everyone uses.

7.2.3 Coaches

Views of the coaches were presented by I.3 and I.8, who are coaches in Plant 1. Most interviewees, including I.6 and I.4, were of the opinion that coaches are the user group who gets the most value out of the DSF 1.0 because their preparation time for each shop floor meeting was greatly reduced. Therefore, the coaches' opinion on user acceptance is very important.

Both I.3 and I.8 consider relative advantage to be the most important user acceptance factor. For example, when asked about the intended switch to DSF 2.0, I.3 mentioned that as long as the new solution is comparable to the old one, he has no problem with switching. He added that he does expect some problems because of the switch, but that he does not expect an impact on user acceptance "as long as it works". Moreover, I.8 noted that an important consideration for accepting DSF 1.0 was that it was so much better than the old way of doing

things. Therefore, it follows that users in Plant 1 will have the same consideration for acceptance of DSF 2.0.

Perceived ease of use is also important to the coaches, but perhaps not as much as relative advantage. When talking about DSF 1.0 I.3 listed off a few ways ease of use could be improved (i.e., better organization, fixing formatting errors, etc.), but he characterized this as a "minor topic. I.3 further noted that if the implementation of DSF 2.0 means just a different link to access the dashboard, then users will not mind the switch, but if it brought a completely different functionality and layout, then this would be a hassle. This highlights an important distinction between implementing a completely new solution and implementing an upgrade of an existing solution. Since users are already used to working with DSF 1.0, it follows that even if the DSF 2.0 meets the criteria of being easy to use, he would find it a hassle to switch if the look and feel are different from DSF 1.0.

Lastly, I.3 also discussed his views on perceived usefulness. Here he sees the relevance of the displayed information as particularly important. He said that he does not see some of the current reports as relevant and he is not sure what useful information they get out of them. Therefore, if the information were more relevant, this would improve user acceptance. Finally, the coaches do not see social influence as an important determinant of user acceptance.

7.2.4 Production staff

I did not speak to the production staff directly, but their opinions were discussed by other interviewees. Production staff use the DSF 1.0 as part of the daily shop floor meeting, and this will continue when DSF 2.0 is implemented. Outside of the meetings, the use of the solution by this user group is more limited, according to I.3, who also said that this is because they only use it as support during the daily meeting, but they do not need to interact with it in any way. I.5 further added that workers might not have time to use DSF 1.0 outside of the shop floor meeting, as well as there being no need for them to use the solution in a different context than the shop floor meeting.

Some interviewees said that the information displayed on DSF 1.0 is simply not as relevant to the workers as it is to other user groups, which is connected to the perceived usefulness factor. For example, I.4 mentioned that the coach guides them through the shop floor meeting and that is where workers use the solution, but otherwise, it is only an additional source of information regarding their targets and KPIs. On the other hand, I.7 disagreed with the view that the information is irrelevant to workers: "My wish or my hope would be that the direct productive colleagues are just as interested in the success of their work as everybody else. And if you're interested, you need to know where you stand."

Perceived ease of use and computer anxiety are more important factors for workers on the shop floor than other user groups. Most likely this is because they have a lower average level

of digital skills. For example, I.3 said he has workers in his team who do not even know how to use email, let alone other digital solutions. He also added that the workers already do not use the current solution outside of the shop floor meeting, so he does not expect them to start with DSF 2.0. Therefore, to achieve higher user acceptance in this group, acceptance factors of perceived ease of use and computer anxiety need to be given higher priority. Finally, as the workers do not use DSF 1.0 much, relative advantage and social influence did not come up as important considerations for acceptance of DSF 2.0. To conclude, *Table 11* provides a summary of the user acceptance factors seen as important or unimportant by each user group in Plant 1.

Table 11: Summary of user acceptance factors deemed important by each user group

User group	**User acceptance factors deemed most important**[3]	**User acceptance factors deemed least important**
Developers	1. Perceived usefulness. 2. Relative advantage. 3. Trialability. 4. Perceived ease of use.	1. Image. 2. Voluntariness.
Plant leadership	1. Perceived usefulness. 2. Perceived ease of use. 3. Relative advantage.	1. Social influence. 2. Voluntariness.
Coaches	1. Relative advantage. 2. Perceived usefulness.	1. Social influence. 2. Perceived ease of use.
Production staff	1. Perceived ease of use. 2. Computer anxiety. 3. Perceived usefulness.	1. Relative advantage. 2. Social influence.

Source: Own work.

7.3 User acceptance initiatives for DSF 2.0

This section will present the user acceptance initiatives for DSF 2.0, as envisaged by the project team and key decision-makers in Plant 1. User acceptance of DSF 1.0 in Plant 1 came easily and naturally, as it was much better than the previous way of doing things. I.6 noted that there were a few employees who were a bit worried at the beginning, but they quickly came around when they saw the time-saving potential. Furthermore, the solution was implemented shortly before the COVID-19 pandemic forced everyone to work from home. This also had a positive effect on user acceptance, as having a digital solution with all the production data was very useful during these times.

On the other hand, user acceptance of DSF 2.0 will not come as easily. Users of the current solution are not excited about learning how to use a new solution and they like working with the current one. For example, I.4 said that he dislikes the constant change when it comes to

[3] Each column is ordered by strength of opinion regarding the most and least important user acceptance factors as expressed in the interviews, with the strongest opinions being listed first.

digital solutions: “That is what I do not like – if we have an established solution for two years and then we start again at zero, and we have to learn everything again. Maybe I am too old, I do not know. Sometimes the changes are too fast for me.”

Moreover, there is a fundamental difference between DSF 1.0 and DSF 2.0 – the original solution was developed strictly for Plant 1 and designed in a way to fit their needs. In contrast, the new solution is a company-wide project, which must consider the needs and wishes of users across all Hilti plants. Therefore, some users in Plant 1 are worried that the new solution will contain less relevant information. Lastly, I.6 also said that they could encounter the “not invented here syndrome”, meaning that users would like DSF 2.0 less because it was not invented in their plant and is not fit exactly to their needs.

Therefore, achieving high user acceptance of DSF 2.0 will be a considerable challenge. Interviewees discussed which acceptance initiatives were most important for DSF 1.0, and which they believe to be most important for DSF 2.0. Initiatives can be grouped into the following themes: roll-out approach, user participation, communication strategy, and user training.

7.3.1 Roll out approach

When implementing DSF 1.0, a gradual roll-out approach was used. This means that they developed and presented reports one-by-one, so the users had time to learn how to use each and give feedback that made future reports even better. I.2 said that the implementation process included users and encouraged their feedback: “We let the users participate in creating the structure, wishing for new reports, adding a traffic light that indicates when a KPI is green or red.”

In addition to presenting reports gradually, they also followed a hybrid approach, meaning that the old reporting solution (i.e., posting paper reports on the board) was kept in use for some time. This allowed users to get used to the changes at their own pace and gave the development team time to roll out new reports gradually, as they were completed.

DSF 2.0 will follow a different roll out approach. Individual reports will not be unveiled immediately as they are developed, but they will rather wait until all are developed and then unveil all at once. The idea is that DSF 2.0 should contain at least as much information as DSF 1.0 before it is presented to users. I.1 described this roll out approach as the “big bang approach”. Contrastingly, I.6 expressed some doubt in this approach, saying that it is better for user acceptance if reports are released one by one so users can learn as they go.

I.5 argued that the “big bang approach” would be most effective if DSF 1.0 was shut down at the same time. She said that there is no use in keeping two reports that are showing the same information. On the other hand, I.2 does not agree with this and supports following a hybrid approach where both solutions run in parallel for some time. She recommends making

DSF 2.0 readily available and promoting it, especially in the parts where it improves upon DSF 1.0, but not forcing anyone into using it. She argues that this is the best way to demonstrate how the new solution is better than the old one, which would in turn make users excited about using it.

7.3.2 User participation

Project leads for DSF 1.0 and DSF 2.0 (I.2 and I.1) agree that the solution should provide users with relevant information for their jobs. They both agree that allowing users to participate in the development of a digital solution is the best way to ensure that this criteria is met. For instance, I.1 noted that "a big part of how to get people motivated for this new solution is allowing them to contribute and really get them on board in the pilot plants to co-develop the tool." He added that this is how users will see the value in using the new solution, as opposed to being forced to use it.

I.2 similarly praised the participative approach, saying that they always worked to develop new features and reports based on user requests, because it was so supportive of user acceptance. She added that to achieve high acceptance the user "has to think it is cool, otherwise you have no chance". Therefore, to achieve acceptance of DSF 2.0 in Plant 1, it will need to be partly customized to local needs. I.2 noted that the best way to achieve this would be if a part of the development team was stationed in Plant 1, meaning that they could quickly implement user requests.

Further, I.2 pointed out that developers of such solutions usually try to standardize the displayed information, thinking that they best know what should be displayed. She moreover noted that this is false because it soon becomes apparent that different user groups have different information needs. Therefore, DSF 2.0 will seek to strike a balance between a standardized and a tailored solution, that allows for some adaptation according to the needs of individual plants.

7.3.3 Communication strategy

Several interviewees pointed out that they consider the communication strategy during the implementation phase of DSF 2.0 to be important for user acceptance. When DSF 1.0 was being implemented, they held enthusiastic presentations on the development progress and use cases for engineers and managers within the plant. The focus was always on showing the users the value of the new solution, especially the time-saving potential. At the same time, they also communicated that top management supports the project, considers it to be important and thinks it can lead to further innovation down the road, as discussed by I.2.

The same is planned for the promotion of the new solution. I.1 said that the first step of the communication strategy for DSF 2.0 will be to regularly update all stakeholders on the

progress of the project and to incorporate their feedback. Later, they will focus more on real-life demonstrations, where users can give even more focused feedback, ahead of the official launch in 2024. I.1 believes that explaining the advantages of DSF 2.0 and the value it brings to the user is most important for acceptance. He says that during the promotion phase, they will focus on showing users how they can use the solution to properly identify causes of deviations to make better decisions. He believes that the potential for better decision-making is the biggest motivator for user acceptance.

7.3.4 User training

Users of DSF 1.0 do not believe that training was a big contributor to user acceptance because the solution was so easy to use, none were necessary. For example, I.7 said, “it is so easy to use that any sort of training would be unnecessary.” Further, I.4 also said he was only briefly trained on how to use it, but that it was so self-explanatory that no in-depth training was needed.

Contrastingly, I.1 believes that training will be important for user acceptance of DSF 2.0. He stressed that these trainings should be focused firstly on team leads, and only later on other employees. The reason is that DSF 2.0 is a facilitating tool for efficient shop floor meetings, so user acceptance is “tremendously driven by the team lead”, as mentioned by I.1 because the team lead guides other participants through each shop floor meeting.

The idea is to first test the solution across different levels in Plant 1, together with the team leads, which will help them understand the solution better and provide good feedback. Moreover, the test period will also serve as training for key users. Later, they will combine face-to-face trainings with digital ones, along with writing detailed supporting documentation. The focus will be on letting users participate, ask questions, and provide feedback. They will then use the feedback to customize the solution to the specific needs of Plant 1.

8 FINDINGS AND RECOMMENDATIONS

The thesis aimed to answer two research questions by providing a theoretical overview of relevant literature, as well as an empirical investigation into the current state of DSF 2.0 implementation and how it relates to user acceptance.

8.1 Findings

TAM with its extensions is one of the most influential models explaining user acceptance of information systems. It proposes that perceived usefulness, perceived ease of use and subjective norm determine user acceptance of an information system (Davis, 1989; Venkatesh & Bala, 2008; Venkatesh & Davis, 2000). UTAUT also came to a similar

conclusion by proposing performance expectancy (similar to perceived usefulness), effort expectancy (similar to perceived ease of use) and social influence (similar to subjective norm) as the most important user acceptance factors.

Different user groups in Plant 1 do not have a uniform view of which TAM and UTAUT factors are most important for user acceptance. For example, developers and plant leadership stressed the importance of perceived usefulness. They believe it is most important that DSF 2.0 provides relevant information to the users, so they can perform better at their jobs. Similarly, coaches also found perceived usefulness to be the most important factor. Research mostly confirmed the positive influence of perceived usefulness on user acceptance in regard to BI solutions (Hou, 2014; Kohnke, Wolf & Mueller, 2011).

The opinion of user groups about the importance of perceived ease of use is more mixed. Developers and coaches believe that this factor is secondary to perceived usefulness. It was even described as a "minor topic" by I.3. On the other hand, the interviewees believe that perceived ease of use is more important than perceived usefulness for the production staff, because they have on average fewer digital skills than other users groups, so they are unlikely to use a complicated digital solution.

This view is confirmed by Kohnke, Wolf and Mueller (2011) who theorized that perceived ease of use is especially important for more complex solutions. Empirical research has failed to prove that perceived ease of use influences user acceptance in the context of BI solutions (Hou, 2014; Kohnke, Wolf & Mueller, 2011). Possibly this is because modern BI solutions strive for ease of use by default, so their users do not consider this to be an important determinant of user acceptance.

Interestingly, all user groups consider subjective norm to have the least effect on user acceptance of DSF 2.0. This directly contradicts empirical findings, where this factor had the most conclusive positive influence on user acceptance (Grublješič, Coelho & Jaklič, 2019; Hou, 2014; Kohnke, Wolf & Mueller, 2011). This could be because the use of DSF 2.0 is voluntary, so users do not see pressure from others in the organization as an important determinant of user acceptance. This effect was previously confirmed by Hou (2014) who found that subjective norm has a higher impact on user acceptance in mandatory contexts.

Besides TAM and UTAUT, DIT is another commonly used user acceptance model. It proposes eight user acceptance factors – relative advantage, compatibility, ease of use, result demonstrability, visibility, trialability, voluntariness, image, and personal innovativeness (Agarwal & Prasad, 1998; Moore & Benbasat, 1991; Rogers, 2003). Interviewees from all stakeholder groups agreed that relative advantage is the most important DIT user acceptance factor. They see this factor as the most important because users in Plant 1 are already accustomed to working with DSF 1.0. Therefore, they claim that DSF 2.0 will need to be better than DSF 1.0 in terms of functionality as well as the information it provides to users to achieve high user acceptance. This link was not empirically confirmed by either of the

three researchers that studied user acceptance factors in the context of BI solutions (Grublješič, Coelho & Jaklič, 2019; Hou, 2014; Kohnke, Wolf & Mueller, 2011).

8.2 Recommendations

This section will provide a set of initiatives that should be followed to ensure high user acceptance of DSF 2.0 in Plant 1. Some of these were mentioned by interviewees, while others stem from findings in academic literature. *Table 12* includes a summary of these proposed initiatives.

DSF 2.0 should be rolled out gradually in Plant 1. This means that each report should be added to the solution immediately when it is ready, so users can get used to it, ask questions, and recommend improvements. In the meantime, DSF 1.0 should remain active, which will give users access to all the old reports, so they do not feel like they are losing any functionality with the launch of DSF 2.0. Eventually, as the new solution provides as much information as DSF 1.0, the old solution should be removed. Without this intermediary period, turning off DSF 1.0 could lead to annoyance and disillusionment, since the users will not be sufficiently competent in using the new solution yet.

It will be crucial for user acceptance to show users how DSF 2.0 is better than DSF 1.0, both in terms of the information it provides to users, as well as its ease of use. Rogers (2003) noted that it is most important to decrease an individual's uncertainty about the relative advantage of a new solution. He also pointed out several factors that affect relative advantage, such as low initial cost, a decrease in discomfort, savings in time and effort, and the immediacy of the reward.

Therefore, the project team should communicate how using DSF 2.0 will save users time and provide them with more relevant information to make their jobs easier. The project team should also focus on the similarities between the two solutions and show users that switching will not require a large investment of time or effort.

As noted, all user groups consider subjective norm and social influence to be the least important factor, which directly contradicts empirical research on user acceptance of BI solutions. Kohnke, Wolf and Mueller (2011) found that if a solution provides quality information, it will generate positive feedback from influential people, which will influence others to accept the solution.

Therefore, the project team should focus more on how social influence affects user acceptance of DSF 2.0. To start, they should identify key users who have the most influence on others within the plant. These users should be the first ones who get to try out the new solution and give their feedback. If they are excited about the solution, they can have a large positive impact on user acceptance in their teams.

Table 12: Proposed user acceptance initiatives for DSF 2.0

User acceptance initiative	**Description**
Gradual roll-out approach.	– DSF 2.0 should be rolled out gradually in Plant 1, meaning that reports should be added one by one as soon as they are ready. – Supports user acceptance by letting users get to know reports one by one, so they are not overwhelmed. At the same time, they can make better recommendations for improvements if the amount of information is not too large.
Run both solutions in parallel.	– There should be a period where both solutions run at the same time even if they contain the same information. – Supports user acceptance by reducing their anxiety about the correctness of information, since they can compare that both solutions provide the same numbers. Additionally, this will reduce initial user resistance because users will not feel like they are losing access to any information.
Participative development.	– Before launch, present the solution to users and ask for their feedback. Based on this feedback, changes should be made to the solution. – Supports user acceptance because users feel like they have a voice and the information will be more relevant to their needs.
Customization to local needs.	– According to the specific needs of each production location, the project team will allow for some customization of DSF 2.0. – Supports user acceptance by providing information that is more relevant to users' needs.
Regular presentations on progress.	– Stakeholders in the plant should be updated on the progress of the project regularly through enthusiastic presentations. – Supports user acceptance by showing users the value of the solution, such as the time-saving potential for their jobs and easier decision-making due to better information.
Communicate top management support.	– Regularly communicate that the top management supports the project and thinks it is important. – Supports user acceptance because top management has an influence on the opinions of subordinates, as well as the perception of the project.
Communicate similarities between DSF 1.0 and DSF 2.0.	– When promoting DSF 2.0 similarities to DSF 1.0 in terms of functionality and information provided should always be stressed. – Supports user acceptance by decreasing the anxiety of users who are resistant to using a new digital solution by showing them that the use is similar to the existing solution.
The training focused on team leads.	– Team leads will lead the participants through the daily shop floor meeting using DSF 2.0, so they should be the focus of the training. – Supports user acceptance by making key users excited about the value of the solution, who can then pass it on to other users in the plant.
Additional training for users with poor digital skills.	– Users with poor digital skills should receive additional training on how to use DSF 2.0, especially in the production staff user group. – Supports user acceptance by reducing computer anxiety, which is an important factor for users with poor digital skills.
Make information more relevant to production staff.	– The project team should work with the production staff to make the information on DSF 2.0 more relevant to them – e.g., including data on the performance of individual machines, not only high-level overviews. – Supports user acceptance by increasing perceived usefulness for the user group which currently has the lowest acceptance rates.

Source: Own work.

Moreover, Kohnke, Wolf and Mueller (2011) also found that top management support has a positive influence on subjective norm. Top management sets the tone for how users within an organisation perceive change. If they communicate that a certain project has their full support and that they consider it important, this can also influence the opinions of their subordinates. Consequently, top management should be vocal about the importance of DSF 2.0 for the plant and that they fully support the new solution.

The production staff currently only uses DSF 1.0 as part of the daily shop floor meeting, but not much outside of it, because the information that is displayed is not relevant to them. Moreover, it was pointed out that many of them have a low level of digital skills, so they are unlikely to use a digital solution. DSF 2.0 should be more ambitious in pursuing user acceptance of the production staff because they should also know the production KPIs, so they can work to improve the numbers and gain a better understanding of their superiors' decisions. The project team should work with representatives of the production staff to include information that is more relevant to them. One example would be to include more granular information about the performance of a specific machine. Lastly, additional training should be organized for those who do not have sufficient digital skills.

8.3 Limitations

The master's thesis has a few limitations. Firstly, since the empirical part used interviews from only once company, findings have limited generalisability, because they may not be representative of a broader set of companies. Future research could investigate whether findings hold true for a larger number of companies or only for the one analysed in this thesis.

Furthermore, another limitation of using interviews is that they are subject to bias from both the interviewee and the interviewer, which is difficult to avoid. Further research could test the findings of the master thesis while avoiding bias by using a quantitative research method. Lastly, I was not able to obtain any interviews with representatives of the production staff group because of the language barrier, so their opinions are summarized from interviews with other employees in the plant, who were once production staff but were later promoted to higher positions.

CONCLUSION

To provide insights on how to achieve high user acceptance of DSF 2.0, this thesis aimed to identify the most important user acceptance factors for the new reporting system. Based on a literature review and qualitative research into the current state of DSF 2.0 implementation, it concluded that stakeholders consider perceived usefulness and relative advantage to be the most important factors of user acceptance. Further, even though empirical results confirmed a strong effect of social influence on user acceptance (Grublješič, Coelho & Jaklič, 2019;

Hou, 2014; Kohnke, Wolf & Mueller, 2011), the stakeholders in Plant 1 do not see this factor as important at all.

Moreover, the thesis provided a set of ten recommendations on how decision-makers at Hilti's Plant 1 can foster user acceptance of the new solution. The most important areas include a gradual roll out approach, explaining the value of the new solution, decreasing user anxiety about the switch, and focusing more on increasing user acceptance among the production staff.

The main method used was conducting interviews because they provided in-depth information on user acceptance of DSF 2.0 in Plant 1, including the experiences and attitudes of the participants. Furthermore, interviews enabled me to tailor the questions to each user group, because they find different things relevant regarding user acceptance of DSF 2.0. The findings from interviews largely aligned with existing research, especially by stressing the importance of perceived usefulness and relative advantage. Further empirical research is needed to determine if some findings hold only for the limited sample of interviewees or also the general population. For example, researchers could test the influence of subjective norm on user acceptance of information systems in production facilities, since the thesis found a disconnect between the interviewees' statements and existing research.

The thesis provides new insight into user acceptance of a reporting solution at a manufacturing facility. It considers the differing perspectives of user groups and derives actionable recommendations. Despite the recommendations being directed at decision-makers at Hilti's Plant, I believe the findings and recommendations can be generalized to other similar production facilities and even companies in other industries that are undergoing the implementation of a new information system. Further, since most literature focuses on implementations of new information systems, the thesis contributes to the less researched field of user acceptance of new versions of existing information systems.

REFERENCE LIST

1. Agarwal, R. & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research, 9*(2), 204–215. https://doi.org/10.1287/isre.9.2.204
2. Arnott, D., Lizama, F. & Song, Y. (2017). Patterns of business intelligence systems use in organizations. *Decision Support Systems*, *97*, 58–68. https://doi.org/10.1016/j.dss.2017.03.005
3. Aspin, A. (2016). *Pro Power BI desktop*. Staffordshire: Apress.
4. Balogun, J., Hope Hailey, V. & Gustafsson, S. (2016). *Exploring strategic change* (4th ed). Harlow, United Kingdom: Pearson Education.
5. Beims, M. & Ziegenbein, M. (2015). *IT-Service-Management in der Praxis mit ITIL®* (4., überarbeitete und erweiterte Auflage). München: Hanser.

6. Bellantuono, N., Nuzzi, A., Pontrandolfo, P. & Scozzi, B. (2021). Digital transformation models for the I4.0 transition: Lessons from the change management literature. *Sustainability*, *13*(23), 12941. https://doi.org/10.3390/su132312941
7. Bhuiyan, N. & Baghel, A. (2005). An overview of continuous improvement: From the past to the present. *Management Decision*, *43*(5), 761–771. https://doi.org/10.1108/00251740510597761
8. Boyton, J., Ayscough, P., Kaveri, D. & Chiong, R. (2015). Suboptimal business intelligence implementations: Understanding and addressing the problems. *Journal of Systems and Information Technology*, *17*(3), 307–320. https://doi.org/10.1108/JSIT-03-2015-0023
9. Cameron, E. & Green, M. (2012). *Making sense of change management: A complete guide to the models, tools, and techniques of organizational change* (3rd ed). London ; Philadelphia: Kogan Page.
10. Chen, Chiang, & Storey. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly*, *36*(4), 1165–1188. https://doi.org/10.2307/41703503
11. Choo, C. W., Bergeron, P., Detlor, B. & Heaton, L. (2008). Information culture and information use: An exploratory study of three organizations. *Journal of the American Society for Information Science and Technology*, *59*(5), 792–804. https://doi.org/10.1002/asi.20797
12. Clarity. (2021, April 13). The 1-3-10 Rule and Visual Management. Retrieved 3 June 2022, from https://www.clarityvisualmanagement.com/2021/04/13/1-3-10-rule/
13. Coates, M. & Webb, C. (2020). *Planning a Power BI Enterprise Deployment* (p. 259) [Whitepaper]. Microsoft. Retrieved from Microsoft website: https://aka.ms/PBIEnterpriseDeploymentWP
14. Compeau, D. R. & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, *19*(2), 189. https://doi.org/10.2307/249688
15. Davies, R., Coole, T. & Smith, A. (2017). Review of socio-technical considerations to ensure successful implementation of Industry 4.0. *Procedia Manufacturing*, *11*, 1288–1295. https://doi.org/10.1016/j.promfg.2017.07.256
16. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008
17. Eberhard, K. (2021). The effects of visualization on judgment and decision-making: A systematic literature review. *Management Review Quarterly*. https://doi.org/10.1007/s11301-021-00235-8
18. Eckerson, W. W. (2011). *Performance dashboards: Measuring, monitoring, and managing your business* (2nd ed). New York: Wiley.
19. English, L. (2005, July 6). Business intelligence defined. Retrieved 26 December 2021, from BeyeNetwork website: http://web.archive.org/web/20130509224449/http://www.b-eye-network.com/view/1119
20. Feldman, D. & Himmelstein. (2013). *Developing business intelligence apps for sharepoint*. Beijing: O'Reilly.

21. Fishbein, M. & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. New York: Psychology Press.
22. Forbes. (2022, January 6). Why 84% Of Companies Fail At Digital Transformation. Retrieved 9 January 2023, from https://www.forbes.com/sites/brucerogers/2016/01/07/why-84-of-companies-fail-at-digital-transformation/?sh=5bf4f1ad397b
23. Forcam. (2020, August 31). What is Shop Floor Management & Why is it Important? Retrieved 3 June 2022, from https://forcam.com/en/shop-floor-management/
24. Fruhlinger, J. & Pratt, M. K. (2019, October 16). What is business intelligence? Transforming data into business insights. Retrieved 5 April 2022, from CIO website: https://www.cio.com/article/272364/business-intelligence-definition-and-solutions.html
25. Gole, V. & Shiralkar, S. (2020). *Empower decision makers with SAP analytics cloud: Modernize BI with SAP's single platform for analytics*. Retrieved from https://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=2637065
26. Gray, J. (2016, June 20). The benefits of a digital shopfloor. Retrieved 3 April 2022, from Aerospace Manufacturing website: https://www.aero-mag.com/benefits-digital-shopfloor
27. Gröger, C., Stach, C., Mitschang, B. & Westkämper, E. (2016). A mobile dashboard for analytics-based information provisioning on the shop floor. *International Journal of Computer Integrated Manufacturing*, *29*(12), 1335–1354. https://doi.org/10.1080/0951192X.2016.1187292
28. Grublješič, T., Coelho, P. S. & Jaklič, J. (2019). The shift to socio-organizational drivers of business intelligence and analytics acceptance. *Journal of Organizational and End User Computing*, *31*(2), 37–64. https://doi.org/10.4018/JOEUC.2019040103
29. Grublješič, T. & Jaklič, J. (2015). Business intelligence acceptance: The prominence of organizational factors. *Information Systems Management*, *32*(4), 299–315. https://doi.org/10.1080/10580530.2015.1080000
30. Hertle, C., Tisch, M., Kläs, H., Metternich, J. & Abele, E. (2016). Recording shop floor management competencies – A guideline for a systematic competency gap analysis. *Procedia CIRP*, *57*, 625–630. https://doi.org/10.1016/j.procir.2016.11.108
31. Hertle, Christian, Tisch, M., Metternich, J. & Abele, E. (2017). Das Darmstädter Shopfloor Management-Modell. *Zeitschrift Für Wirtschaftlichen Fabrikbetrieb*, *112*(3), 118–121. https://doi.org/10.3139/104.111675
32. Hill, G. (2008). Definition: What is enterprise reporting? Retrieved 10 February 2022, from A guide to enterprise reporting website: http://ghill.customer.netspace.net.au/reporting/definition.html
33. Hilti. (2018). *Business Model*. REDi - Hilti Intranet.
34. Hilti. (2019). *Digital Shop Floor Presentation—Follow Up*. Internal Hilti Document.
35. Hilti. (2020a). *The Evolution of Digital Shop Floor Management*. Internal Hilti Document.
36. Hilti. (2020b). *The Next Level of Shop Floor Management*. Internal Hilti Document.

37. Hilti. (2021). *SAP Analytics Cloud (SAC) vs Power BI*. Internal Hilti Wiki.
38. Hilti. (2022a). *2021 Business Results*. REDi - Hilti Intranet.
39. Hilti. (2022b). *2021 Plant 1 Presentation*. Internal Hilti Document.
40. Hilti. (2022c). *2022 Company Presentation*. REDi - Hilti Intranet.
41. Hilti. (2022d). Company profile. Retrieved 13 January 2022, from https://www.hilti.group/content/hilti/CP/XX/en/company/corporate-information/company-profile/company-profile.html#nav/close
42. Hilti. (2022e). Core purpose and values. Retrieved 13 January 2022, from https://www.hilti.group/content/hilti/CP/XX/en/company/corporate-information/Strategy/core-purpose-and-values.html
43. Hilti. (2022f). Our production locations. Retrieved 13 January 2022, from https://www.hilti.group/content/hilti/CP/XX/en/company/corporate-information/production-locations.html
44. Hilti. (2022g). Product Overview. Retrieved 23 March 2022, from https://www.hilti.group/content/hilti/CP/XX/en/products/product-overview/product-overview.html#nav/nav-products
45. Hilti. (2022h). *SAP Analytics Cloud*. Internal Hilti Wiki.
46. Hou, C. K. (2014). Exploring the user acceptance of business intelligence systems in Taiwan's electronics industry: Applying the UTAUT model. *International Journal of Internet and Enterprise Management*, *8*(3), 195. https://doi.org/10.1504/IJIEM.2014.059177
47. IBM. (2023). What is business intelligence? Retrieved from https://www.ibm.com/topics/business-intelligence
48. Işık, Ö., Jones, M. C. & Sidorova, A. (2013). Business intelligence success: The roles of BI capabilities and decision environments. *Information & Management*, *50*(1), 13–23. https://doi.org/10.1016/j.im.2012.12.001
49. King, S. & Peterson, L. (2007). How effective leaders achieve success in critical change initiatives - part 1: Building and sustaining momentum. *Healthcare Quarterly*, *10*(1), 53–57. https://doi.org/10.12927/hcq..18649
50. Kohnke, O., Wolf, T. R. & Mueller, K. (2011). Managing user acceptance: An empirical investigation in the context of business intelligence standard software. *International Journal of Information Systems and Change Management*, *5*(4), 269. https://doi.org/10.1504/IJISCM.2011.045833
51. Kotter, J. P. (2012). *Leading change*. Boston, Mass: Harvard Business Review Press.
52. Kulkarni, U., Robles-Flores, J. & Popovič, A. (2017). Business intelligence capability: The effect of top management and the mediating roles of user participation and analytical decision making orientation. *Journal of the Association for Information Systems*, *18*(7), 516–541. https://doi.org/10.17705/1jais.00462
53. Laukkanen, S., Sarpola, S. & Hallikainen, P. (2007). Enterprise size matters: Objectives and constraints of ERP adoption. *Journal of Enterprise Information Management*, *20*(3), 319–334. https://doi.org/10.1108/17410390710740763

54. Letmathe, P., Schweitzer, M. & Zielinski, M. (2012). How to learn new tasks: Shop floor performance effects of knowledge transfer and performance feedback. *Journal of Operations Management*, *30*(3), 221–236. https://doi.org/10.1016/j.jom.2011.11.001
55. Lewin, K. (1975). *Field theory in social science: Selected theoretical papers*. Westport, Conn: Greenwood Press.
56. Liff, S. & Posey, P. A. (2004). *Seeing is believing: How the new art of visual management can boost performance throughout your organization*. New York: AMACOM.
57. Liker, J. K. & Meier, D. (2006). *The Toyota way fieldbook: A practical guide for implementing Toyota's 4Ps*. New York: McGraw-Hill.
58. Lindskog, P., Vänje, A., Törnkvist, Å. & Eklund, J. (2016). Sustainable Lean in psychiatry? Assessment through socio-technical principles. *International Journal of Quality and Service Sciences*, *8*(1), 53–71. https://doi.org/10.1108/IJQSS-07-2015-0056
59. Luo, W. (2016). Responsibility and skills requirements for entry level analytics professionals. *Journal of Organizational and End User Computing*, *28*(4), 1–14. https://doi.org/10.4018/JOEUC.2016100101
60. Mann, D. (2015). *Creating a lean culture: Tools to sustain lean conversions* (3rd ed). Boca Raton: CRC Press, Taylor & Francis Group.
61. Meißner, A., Grunert, F. & Metternich, J. (2020). Digital shop floor management: A target state. *Procedia CIRP*, *93*, 311–315. https://doi.org/10.1016/j.procir.2020.04.083
62. Meißner, A., Müller, M., Hermann, A. & Metternich, J. (2018). Digitalization as a catalyst for lean production: A learning factory approach for digital shop floor management. *Procedia Manufacturing*, *23*, 81–86. https://doi.org/10.1016/j.promfg.2018.03.165
63. Microsoft. (2022a). Power BI pricing. Retrieved 5 April 2022, from Microsoft Power BI website: https://powerbi.microsoft.com/en-ie/pricing/
64. Microsoft. (2022b). Why Microsoft Power BI. Retrieved 6 April 2022, from Microsoft Power BI website: https://powerbi.microsoft.com/en-au/why-power-bi/
65. Mills, G. E. & Gay, L. R. (2019). *Educational research: Competencies for analysis and applications* (12th ed). NY, NY: Pearson.
66. Moica, S., Ganzarain, J., Ibarra, D. & Ferencz, P. (2018). Change made in shop floor management to transform a conventional production system into an 'Industry 4.0': Case studies in SME automotive production manufacturing. *2018 7th International Conference on Industrial Technology and Management (ICITM)*, 51–56. Oxford, United Kingdom: IEEE. https://doi.org/10.1109/ICITM.2018.8333919
67. Moore, G. C. & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, *2*(3), 192–222. https://doi.org/10.1287/isre.2.3.192
68. Ohlig, J., Hellebrandt, T., Metzmacher, A. I., Pötters, P., Heine, I., Schmitt, R. H. & Leyendecker, B. (2020). Performance management on the shop floor – an investigation of KPI perception among managers and employees. *International Journal of Quality and Service Sciences*, *12*(4), 461–473. https://doi.org/10.1108/IJQSS-04-2020-0051

69. Popovič, A. (2017). If we implement it, will they come? User resistance in post-acceptance usage behaviour within a business intelligence systems context. *Economic Research-Ekonomska Istraživanja*, *30*(1), 911–921. https://doi.org/10.1080/1331677X.2017.1311232
70. Renaud, K. & van Biljon, J. (2008). Predicting technology acceptance and adoption by the elderly: A qualitative study. *Proceedings of the 2008 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries Riding the Wave of Technology - SAICSIT '08*, 210–219. Wilderness, South Africa: ACM Press. https://doi.org/10.1145/1456659.1456684
71. Richardson, J., Schlegel, K., Sallam, R., Kronz, A. & Sun, J. (2021). *2021 Gartner Magic Quadrant for Analytics and Business Intelligence Platforms* (p. 38). Gartner. Retrieved from Gartner website: https://info.microsoft.com/ww-Landing-2021-Gartner-MQ-for-Analytics-and-Business-Intelligence-Power-BI.html?LCID=EN-US
72. Robson, C. & McCartan, K. (2016). *Real world research: A resource for users of social research methods in applied settings* (4th ed). Hoboken: Wiley.
73. Rogers, D. L. (2016). *The digital transformation playbook: Rethink your business for the digital age*. New York: Columbia Business School Pub.
74. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed). New York: Free Press.
75. Rößler, M. P., Spiertz, D. & Metternich, J. (2014). *Lean production and willingness to change: German industrial survey* (p. 11) [Survey]. Darmstadt: Technical University of Darmstadt. Retrieved from Technical University of Darmstadt website: https://tuprints.ulb.tu-darmstadt.de/3929/
76. Roussel, J. (2020, December 15). Leader Standard Work: A Foundation for Improvement Culture. Retrieved 3 April 2022, from KaiNexus website: https://blog.kainexus.com/continuous-improvement/continuous-improvement-leadership/leader-standard-work/leader-standard-work-a-foundation-for-improvement-culture
77. Schmarzo, B. (2017, May 31). What is digital transformation? Retrieved 23 January 2022, from CIO website: https://www.cio.com/article/230121/what-is-digital-transformation-2.html
78. Sieberg, R. (2019, October 24). Integrated Analytics: SAP Analytics Cloud now embedded in SAP S/4HANA Cloud. Retrieved 7 April 2022, from SAP website: https://blogs.sap.com/2019/10/24/integrated-analytics-sap-analytics-cloud-now-embedded-in-sap-s4hana-cloud/
79. Society for Information Management. (2020). *The 2020 SIM IT trends study: Issues, investments, concerns and practices of organizations and their IT Executives*. Retrieved from https://trends.simnet.org/trends-study-archive
80. Statista. (2022). Size of the business intelligence and analytics software application market worldwide, from 2019 to 2025. Retrieved 5 April 2022, from https://www.statista.com/statistics/590054/worldwide-business-analytics-software-vendor-market/

81. Tague, N. R. (2005). *The quality toolbox* (2nd ed). Milwaukee, Wis: ASQ Quality Press.
82. Torres, D., Pimentel, C. & Duarte, S. (2020). Shop floor management system in the context of smart manufacturing: A case study. *International Journal of Lean Six Sigma*, *11*(5), 823–848. https://doi.org/10.1108/IJLSS-12-2017-0151
83. Turban, E., Leidner, D., McLean, E. R. & Wetherbe, J. (Eds.). (2008). *Information technology for management: Transforming organizations in the digital economy* (6th ed). Hoboken, NJ: J. Wiley & Sons.
84. Twin, A. (2021, July 6). Key Performance Indicators (KPIs). Retrieved 4 April 2022, from Investopedia website: https://www.investopedia.com/terms/k/kpi.asp
85. Velaction. (2011). QCD / Quality, Cost, Delivery. Retrieved 21 April 2022, from https://www.velaction.com/qdc-quality-delivery-cost/
86. Venkatesh, Thong, & Xu. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157. https://doi.org/10.2307/41410412
87. Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, *11*(4), 342–365. https://doi.org/10.1287/isre.11.4.342.11872
88. Venkatesh, V. & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x
89. Venkatesh, V. & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926
90. Venkatesh, V., Morris, M. G., Davis, G. B. & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425. https://doi.org/10.2307/30036540
91. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003
92. Wade, M. J., Macaulay, J., Noronha, A. & Barbier, J. (2019). *Orchestrating transformation: How to deliver winning performance with a connected approach to change*.
93. Ward, J., Hemingway, C. & Daniel, E. (2005). A framework for addressing the organisational issues of enterprise systems implementation. *The Journal of Strategic Information Systems*, *14*(2), 97–119. https://doi.org/10.1016/j.jsis.2005.04.005
94. Webster, J. & Martocchio, J. J. (1992). Microcomputer Playfulness: Development of a Measure with Workplace Implications. *MIS Quarterly*, *16*(2), 201. https://doi.org/10.2307/249576
95. Weyer, S., Schmitt, M., Ohmer, M. & Gorecky, D. (2015). Towards Industry 4.0—Standardization as the crucial challenge for highly modular, multi-vendor production systems. *IFAC-PapersOnLine*, *48*(3), 579–584. https://doi.org/10.1016/j.ifacol.2015.06.143

96. Wixom, B. H. & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information Systems Research*, *16*(1), 85–102. https://doi.org/10.1287/isre.1050.0042

APPENDICES

Appendix 1: Summary in Slovene language (Povzetek v slovenščini)

Magistrsko delo se osredotoča na sprejemanje novih digitalnih rešitev v organizacijah. Tema je pomembna, saj je kar 84% podjetij neuspešnih pri digitalni transformaciji svojih procesov (Forbes, 2022), pogosto zato ker uporabniki ne sprejmejo novih rešitev. V delu je posebej obravnavan primer mednarodnega podjetja Hilti, ki svojo obstoječo rešitev za poročanje, Digital Shop Floor 1.0, nadomešča z rešitvijo Digital Shop Floor 2.0. Cilj magistrskega dela je identificirati najpomembnejše dejavnike sprejemanja nove rešitve za poročanje in podati priporočila, ki jih bodo odločevalci v podjetju lahko uporabili za doseganje visoke stopnje sprejemanja. Naloga želi odgovoriti na naslednja raziskovalna vprašanja:

- Kateri so najpomembnejši dejavniki sprejemanja nove informacijske rešitve?
- Kako lahko odločevalci v Hiltijevem obratu spodbujajo sprejemanje in se izognejo odporu uporabnikov do nove rešitve za poročanje?

Naloga vključuje pregled literature, opis trenutnega stanja v proizvodnem obratu in novosti ki jih prinaša nova rešitev, opredelitev najpomembnejših dejavnikov sprejemanja, ter pregled obstoječih in načrtovanih pobud za doseganje sprejemanja. Glavna raziskovalna metoda so bili pol-strukturirani intervjuji s pomembnimi deležniki za vpeljavo nove rešitve. Z namenom postavitve ugotovitev iz intervjujev v širši kontekst magistrsko delo dopolnjujejo tudi podatki iz projektne dokumentacije, organizacijske sheme, in drugih dokumentov.

V magistrskem delu je bilo ugotovljeno, da sta po mnenju deležnikov najpomembnejša dejavnika sprejemanja zaznana uporabnost in relativna prednost. Ugotovljeno je bilo tudi razhajanje med mnenjem deležnikov in ugotovitvami iz literature. Deležniki družbeni vpliv vidijo kot nepomemben za sprejemanje rešitve, v literaturi pa je bila ta povezava večkrat empirično potrjena (Grublješič, Coelho & Jaklič, 2019; Hou, 2014; Kohnke, Wolf & Mueller, 2011). Nadaljnje empirične raziskave bi lahko preučile če ugotovitve držijo le na omejenem vzorcu intervjuvancev ali tudi na širši populaciji.

Poleg tega je v magistrskem delu podanih deset priporočil, kako lahko odločevalci v Hiltijevem obratu spodbujajo sprejemanje rešitve Digital Shop Floor 2.0. Najpomembnejše so postopno uvajanje nove rešitve v delovni proces, poudarjanje pomena nove rešitve, zmanjševanje zaskrbljenosti uporabnikov glede prehoda in večji poudarek na spodbujanju proizvodnih delavcev k uporabi.

Appendix 2: Interview with Interviewee 1

TILEN BURGAR: Could you just shortly tell me about your role on the SAC project?

INTERVIEWEE 1: I am the project leader. I am responsible also for the planning: from initial planning (we use the Scrum logic), sprint planning, sprint reviews with the core team. Basically, everything that is related to the project management, stakeholder management and final product release in the end. My role is basically coordinating the tasks, also defining the value proposition initially and updating it on a regular basis, based on our progress.

TILEN BURGAR: Can you give me a short history of how this project came to be and what were the main motivations for it?

INTERVIEWEE 1: So, there is quite some history in Hilti on digital shop floor management and on shop floor management in general as well, because shop floor management and standardizing the shop floor management has been worked on for many years. I do not know the exact number of years, but it is quite some progress that Hilti did in the standardizing the shop floor management across all manufacturing plants. Around three to four years ago within plant one, they started this initiative on digital shop floor management. I think what they first did was a market research, finding out what are the options that can be bought to implement. They found really nice examples, they also visited other countries, as well as companies to understand how they leverage the digital shop floor solutions. The conclusion was, however, that those available solutions on the market do not meet our requirements and there is still the need for adaption due to our SAP system setup. That is why we decided to go for the own development of the digital shop management. We always had this vision and that is why I talked about the value proposition in the beginning. We always had the vision of using this digital tool, not to digitalize what we have in an analogue way, but to use it to enhance the current shop floor management process and get more out of it. Another reason was to gain more efficiency and in the end productivity. So, the motivation was not to just digitalize what we had as analogue in the past for the sake of digitalization. The objective was to reflect what we have, take the good things, improve those, and use digitalization as an enabler for the whole thing.

TILEN BURGAR: So, you see those as the biggest positive impacts of implementing this system?

INTERVIEWEE 1: Initially, getting something more out of the digital tool than just digital to screen where we present the same information as before. That would not be really meaningful, but to really like to be specific, to understand where digitalization can help us, for example, with those deep dives, drill downs, those were not possible in the past. So now we have more data, but not in the sense of vast lake of data, but rather this kind of directed identification of root causes or at least point of courses for the colleagues, so they know, for example, if the defect cost is red, they can click, they can understand where it comes from. This was a new objective that we did not meet with analogue paper-based shop floor

management because we only had the final data point presented and then there was a lot of effort before and after the meeting to understand where this red figure comes from. Now this can be done with the reporting tools we have in place, instead of manual work together with Controlling, so it's also taking a little bit of effort away from the Controlling Department.

TILEN BURGAR: In your experience, what would you say that the users most like or dislike about the digital shop floor?

INTERVIEWEE 1: What they like is tremendously driven by the team lead - how they use it. When you ask for the team, you could probably distinguish between what the team leader likes about it, how they use it, and what the team itself likes about it. Because the team is quite guided in our current shopfloor process, it is mainly navigated by the team lead. In other plants, we have it differently, where always a different person leads the shop floor meeting. The team is consistent in terms of who is there, but the moderator changes. This is also a nice approach to get more engagement. I think the digital tool helps also that people engage in the discussion because it is more precise than saying, for example, the KPI is red, but we do not know where it comes from. In the past there were often discussions whether the data is correct. With this automated data visualization this discussion does not happen anymore, right? We do not have it anymore and that is a big, big advantage.

TILEN BURGAR: I think we still have it, but maybe not as much.

INTERVIEWEE 1: The intent, yes, is to remove it. Maybe we go step by step first, where we have the discussion a little bit still, but then in the future, we will not. And I think that is a big advantage - to not question the data that is presented, but to use it for action. The team can understand what actions we take and why we take them, because with the data deep dives you can better link actions to real point of causes. There are advantages of the past system as well because people brought the data point with them and then they marked it during the shop floor meeting and at the shop floor wall. This indicates ownership because they have to bring the data point with them in the morning and then they mark it on a sheet. This is now not possible, because it is automatically presented on a screen. This is a small disadvantage if you only look on this specific point of the new digital tool, but with all the benefits that we described already, it not too big, because there are benefits that are greater than this small aspect.

TILEN BURGAR: Was there a problem within the plant that some users did not want to use this? Or maybe they did not like it? Was there any resistance from this product?

INTERVIEWEE 1: It is probably a good question to ask also for the team leads who work daily with the digital shop floor. But my impression that I got from feedback is positive. Even before we had this final setup with the screens on the shop floor, they were doing an intermediate step by making print screens of the available reports and putting them on the analogue shop floor, which shows their engagement. I would say it is not as good as if you can drill down on an interactive screen, but it was only this step in between the screen

ordering and the screen delivery but already having the tool ready. So, I think this showed positive engagement by the team leaders. The team are guided mainly by the team leader, and I did not hear any negative feedback. But maybe this one is a good question for the team leads, to ask how their teams appreciate the new shop floor management.

TILEN BURGAR: You already mentioned why this self-built approach was taken, but can you elaborate on why specifically Power BI and why now specifically SAC?

INTERVIEWEE 1: That is a good question. There was quite some work done to identify the right tool when we decided to go for Power BI for P1 about two years ago. The final decision to go for Power BI was quite easy. It was, part of the Microsoft environment, and we have Microsoft as a provider for a lot of programs. That is why we stayed within this ecosystem. Also, the experience and skills for this was available, so we were as a lead plant for the digital shop floor management able to develop this on our own, with the people, experience, and tools that we had. So, we were not dependent on a third party or something. That is why we went for this solution within the Microsoft environment solution. It is good and a really individualizable solution, but I think the back-end is quite cumbersome. Sometimes it is, challenging due to the, let us say, not expert knowledge we had in the beginning on building this tool. As you told me also a couple of times that some reports are built in a quite difficult way. So, I would say it was a good solution and our experience level was enough to build it like it is now, but there are some issues with this this approach. That is partly the reason why the global approach is to go with SAC. But the more important reason to go with SAC is that we have SAP as the manufacturing execution system, and we plan to introduce SAP ME in all plants, and the SAC is from SAP. So, we want to stay in this ecosystem. There are also big advantages on the robustness of the system. I would say SAC is more robust than Power BI ever can be in the way how we build it, to my knowledge. The connection is closer to the source data. For Power BI, we sometimes have Excels in between, so we have the query output, then Excel, and then Excel into the Power BI report. This process is still quite manual. Well, it's not manual for the user, as they just see the report. So, for the user you probably will not get some nice answer to this question, but on the back-end there is a big advantage of using SAC. I think we had a good first step with Power BI. Now we professionalize it with SAC to go even further. With the, let us say challenge, that it is not only handled by us as the core team, but we have a big project team in the back-end working on the business warehouse, getting the right data from SAP into the business warehouse, building the queries and then we work on the front-end. So, there is lots more people involved, which is also a challenge, but in the end, I am really convinced that it is a more robust version than Power BI. It helps reducing those local efforts in troubleshooting problems, which takes up many hours every month. This I want to drive to almost zero. That is why I am behind this decision on to go with SAC instead of Power BI. Maybe I can connect this - there is a big information management project, to which our global digital shop floor is connected. The Information management project is not only in manufacturing but also in AMS and the other areas, even sales, where because of this shutdown of P22 in SAP and move to P72, the whole reporting

within Hilti is moved to SAC, and that's another argument why the digital shop floor probably should use the same reporting functionality. That is why we connected to this project. We benefit from the inputs adapted to shop floor needs and then in the end we have one kind of reporting and one tool instead of having Power BI all across the network in manufacturing, and the reporting in Hilti is actually a different tool - that would not make too much sense.

TILEN BURGAR: I know that Power BI is still used in different parts of the company. Is this a decision on the company level to go to SAC gradually?

INTERVIEWEE 1: I understood it like this. Power BI will not be shut down or something, but it's still usable and downloadable from the shop for individual small local solutions, but it's not the tool selected for global rollout for reporting.

TILEN BURGAR: We talked about the reasons for choosing firstly Power BI and later SAC. The way I understood it, user acceptance was not that big of a motivator. It was more the technical details behind the systems, right?

INTERVIEWEE 1: The main motivation was to generate more value for the team lead and team. It was not our motivation to introduce an additional tool for the sake of it. If everything that we talked about was possible with an analogue system, we would probably also be fine with an analogue system. But this nice functionality of a digital tool enables greater value. And to be specific, to go back to the point of the drill down. The drill down is a functionality, but the functionality itself does not bring value, it is only if people know this functionality and if they can use it in the right way to generate better actions. So, when we do the marketing for the solution, we tell users about how to achieve better decision making based on proper identification of the cause of the deviation. We do that rather than just showing them where they can drill down, without any further guidance. The case is that you need to do good actions (i.e., improve decision making) due to this functionality. That is the big motivator for the team. And, as I said in the beginning, our agile Scrum planning allows us to show intermediate results to the user, get feedback from them, and develop the solution together with them. We have a chance to build a really suitable shop floor reporting system together with the users. This then gets us to the point that I described, where we create more value than in the past, within the reports and within the dashboard.

TILEN BURGAR: Can you tell me some of the initiatives for introducing the system to the users?

INTERVIEWEE 1: The project set up was that we started off with planning what needs to be included in the digital shop floor. You can think of it like a funnel. We asked a lot of people in the beginning, and then we narrowed it down to two pilot plants – P9 and P4. Currently, we are in this pilot phase in the two plants, so we learn in the live environment what is good and not so good about the solution, what we need to improve, and so on. And then, the idea is to bring the solution to all plants, after we do a proper change management

process. For the change management, we start now by introducing our current working state for feedback to all stakeholders in the different plants in the first half of the year. In the second half of the year, we will continue with that, but we will also be even more focused with real life demos, where users can give more detailed feedback. The first half of the year is to get people on board with what we are developing, then in the second half is dedicated to focused feedback, and then the Go-Live is next year. A big part of how to get people motivated for this new solution is allowing them to contribute and really get them on board in the pilot plants to co-develop the tool and get a high acceptance for it. And when I say that it is not about motivating them for the new tool, but for the new value that the tool brings. Otherwise, the worst thing you can do is to build a tool, throw it over the fence, and say "it's there, now use it". This will not work if they do not know how. That why, as I described, change management is quite key to get high user acceptance. Training people is also a big part of it – it will be a big part to onboard the individual plants. The purpose of having pilot plants is also to test the solution – so it is not tested in only one coach area, but also across different levels – Level 3, Level 2, Level 1. This will help us understand the good points of our solution and where it can be improved before we do actually Go-Live in all areas. The initial feedback is positive – reduction of preparation time for the shop floor meeting is reduced by up to one hour. I would not say that this holds for all plants, but at least one plant gave me this feedback, that they do one hour of preparation daily per coach. With this you can see what impact we can generate, right? If we reduce this preparation time to zero, or close to that, there will be a really big impact.

TILEN BURGAR: Can you give me a rough idea of how the onboarding and training process is planned?

INTERVIEWEE 1: So, it will combine actual face to face trainings or digital trainings through teams, with a proper documentation. But the documentation will not be enormously extensive, because no one would ever read this in detail. We will rather offer trainings with different training dates, so everyone can join. Before the Go-Live, we will really show them how to use it and also do the last mile on tailoring the solution to individual plants. To a certain degree, we have a standardized solution, but from the feedback from the pilot plants we also understood that we cannot standardize everything to the lowest detail level. That is why we will have a certain level of standardization, but then plants can individually still do some adaptation that is needed and appreciated a lot. So, we will do this beside the trainings. So, we will do the trainings on how to use it in the shop floor routine. For example, we can do a virtual shop floor meeting, where we show the tool to the team, how they can drill down, fill in action items, and so on. If they then assign people to these action items, that person gets a notification. We will explain all these things and show them in a live demo. We will also be open for questions, because only if we have a good understanding altogether, we will go for the Go-Live. Before that we need the acceptance of the team lead before the Go-Live, otherwise the tool will not be successful, and the training should lead us there. There will be

also digital training videos that will enable us in the future to have a more interactive training approach instead of this pure documentation in a Word or Power Point file.

TILEN BURGAR: For the next question, I made a list of user acceptance factors from academic literature, and I would like you to select the most and least important ones in your view, and give your reasoning:

- Perceived usefulness.
- Perceived ease of use.
- Social influence.
- Result demonstrability.
- Computer anxiety.
- Relative advantage.
- Compatibility.
- Visibility.
- Trialability.
- Voluntariness.
- Image.
- Personal innovativeness.

INTERVIEWEE 1:

Most important:

1. Relative advantage – I think this is key. If we develop something that is only equally good, we will not get high acceptance.
2. Trialability – We are doing the pilot to increase the acceptance instead of just developing it for the core team and then "throwing it over the fence".
3. Result demonstrability – This is closely connected to the advantages we want to achieve – to be better than the old system, to show concrete data, etc. And this is also connected to perceived usefulness because that means the system is generating meaningful results and enabling users to derive actions.
4. Ease of use – If we have a really complex system, independent of how good it is, the feedback will not be positive. If users do not know how to use it, we will not get high acceptance.

Least important:

1. Voluntariness – Our approach will be that users will be so motivated to use it, they will generate the pull themselves. It will be a standard approach in the end, but we do not want to push it. The idea is rather to show them the value of the tool, as I discussed before. It is also about motivating users to want the solution because it is better as in the past. Then, I think, voluntariness will not be a big part of the decision process anymore.

2. Image – I do not think the system does any image change. It shows that we are modern, but that is not the reason we are developing the system.

TILEN BURGAR: Do you think, specifically for P1, the fact that we have an existing digital shop floor system will change anything about getting users to accept the new system and the approach to implementing it?

INTERVIEWEE 1: Approach yes, and with acceptance, it will just help use. I would say that because they are already a little familiar with digital reports and the benefits of it, this will help with acceptance. Our leading principle is to improve what we currently have. In terms of the front-end, yes, it is a new visualization, but there are more changes on the back-end, which do not really affect the user. I am confident that we will do the shift in a smooth way. What we also discussed with the plant manager, is that we will not bring the SAC reporting tool to P1 before it is developed to an equally comprehensive point or state. Because, if we bring a new tool that is actually better in terms of functionality, but less informative because it only includes one to three KPIs, we will not get high acceptance, because users are used to having more information. The tool can be super good, but if the information level is limited, they will not accept it. So, the approach is that we will firstly work with other plants that are less advanced in shop floor management. They will already benefit from the 1-3 KPIs that are already live in SAC, because this is more than they currently have available. But for P1, we need to come to a state where we have more KPIs available, at least the steering KPIs. This will not be for quite some time before we finish all the SAC work. In other plants, we can rather go step-by-step and introduce KPI-by-KPI, to improve the value of the whole system. In plant one, we need this "big-bang approach", where all the information is included right from the beginning.

TILEN BURGAR: Is the new solution visually similar to the current one in P1?

INTERVIEWEE 1: Yes, especially on the first page, which is the dashboard where all the KPIs, target values, and the traffic light are shown. This is standard shop floor rules in this 1-3-10 rule. It means that we see in one second whether we are on target or not with the colour coding. In the past we had green or red magnets, which you had to assign manually based on your interpretation, which sometimes caused arguments. Now, with the digital display we have mathematical logical rules where we compare the current state to the plan. Having this similar look will help people who are already familiar with the current version, to accept the new solution more quickly.

Appendix 3: Interview with Interviewee 2

TILEN BURGAR: Could you shortly tell me about your role on the original digital shop floor project and then also the SAC project?

INTERVIEWEE 2: I was the person doing the moderation on the paper shop floor, and we had the idea to always be up to date with our data and have a core place where it is produced and published. We also wanted to avoid work on the coaches' side, who had to print out reports and post them. When they had a question, they had to email me and ask me for drill downs, so then I had to investigate on my own Excel files. I had a partner who was enthusiastic and saw how a digital shop floor worked in another company, and he had the idea to make our shop floor digital as well. So first we made a prototype, and we investigated different software solutions. Shortly before we decided on a fancy outside solution, Power BI came along which worked nicely for us as it was included in the current Hilti software suite and no extra programming knowledge was necessary to work with it. As we want to go with standard software, we decided to choose Power BI instead of selecting an external company with external fees and a new programming language to learn. With the prototype we selected the easiest report and the most complex one and said that if we can make a prototype for both, we can also make everything in between.

TILEN BURGAR: Besides cost, what were the main reasons for choosing Power BI?

INTERVIEWEE 2: It was very important that people can answer their business questions on their own. You cannot standardize who needs what. Content needs to be fit to the needs of the user. That is very important. The controller always thinks that he knows what others want to know, but this is wrong. The controller can give guidance, but you will recognize very soon, when you publish such a tool, that during the training and usage different interesting questions come from the audience, which shows that people are digging to different angles and views. You may not have thought that these views are interesting, but they have different targets in regard to leading people, KPIs, and so they look further. For example, one of the key figures was the CIP report, where some people looked at the points, other to the values, the next ones to just the pure number of improvement initiatives. So, the short answer is the availability of different angles and views.

TILEN BURGAR: Do you know why SAC was chosen for the global project?

INTERVIEWEE 2: This is a very long story which started many years ago. The testing of different software alone took years. So, I was involved in one solution, and they took two years of my career that we tested and implemented Cognos. Finally, we failed with user acceptance and the integration to SAP, as Cognos had its own language, server, and so on. We needed to replicate data and transform it into new database structures. I think that SAC is a logical consequence because Hilti is an SAP company. I was involved in a very early phase, when we drove to Waldorf in Germany where they had a really early solution of a dashboard solution. But it looked really like DOS, you know, very old fashioned. SAC was

always behind the others, like Tableau and Qlik, but I think they by buying some competitors developed the solution and ramped it up. I think the data integration and the SAP knowledge is why the global project went with SAC. But in the plant, as you see, we were not closely connected to the headquarters – we had no reporting business partner in the headquarters. With my knowledge, we started developing an 80/20 solution – so we took the business warehouse data but we designed the dashboard on our own, due to the fact that we did not get global resources and participation in the project. If we had waited for the SAC dashboard, we would not have a dashboard right now.

TILEN BURGAR: What were the main positive and negative impacts from implementing the DSF?

INTERVIEWEE 2: One positive was that we trained on the fly – whenever we had a report ready, we trained. We did not do it in one "big bang" and announce 20 reports all at once, but we did it one by one. Like this, the user had time to learn and understand the whole concept. We let the users participate in creating the structure, wishing for new reports, adding a traffic light that indicates when a KPI is green or red. For example, in the T area, we just added a red or green traffic light, which we connected to an Excel file, so there was no report yet. And the negative things, I mean, what we did in the background, I would say we established the whole structure three times. The first was our prototype, the second that we designed all the Excel databases, links, and schedules, and then you joined and made the third clean-up of everything. We invested a lot of time, and the learning curve was tremendous. I like that we are the early mover and the first plant to implement the DSF, but the global team decided to go with other software for the global version, which I feel is not as flexible as our version, if I compare it to the SAC dashboard which was in progress when I saw it. I think Power BI is much more powerful than SAC, because it can more easily be adapted to different needs. Of course, the global data pool is a problem related to Power BI.

TILEN BURGAR: What was the feedback from users on the shop floor after you started implementing the reports? Did they like it? Was there any resistance?

INTERVIEWEE 2: They liked that we had one structure and that they could easily understand each report, if they understood the first one. They liked the one look and feel, where we invested a lot in the beginning. We had a colleague in Kuala Lumpur who helped us with the design, branding, research on where the navigation bar should be, and so on. We learned that we cannot standardize everything, but that there must be different kind of charting and presenting depending on the KPI. They also liked fast implementation of improvement proposals. It sometimes took me only an hour to get something in there, because it was in the database and it was only drag-and-drop, or just renaming, changing the chart type, or something. I think this tremendously supported the acceptance. I thought that we should in the future go by releases, where users have a wish list and everything, but in the end, I always worked on-demand, because it is so supportive for the acceptance.

TILEN BURGAR: When designing the system and structure, and also when trying to drive adoption and acceptance, did you consult any academic literature?

INTERVIEWEE 2: Yes, we did on visualizing what data should be visualized based on trend, and which based on a comparison to a previous time period. If you want, I can take a picture of the books, I still have at home. We did the following: We took the old report and we tried to transform it 1:1 into the new world. We avoided to create new charts and new things in the first wave. Then new ideas came automatically, because once we had the databases set up, we immediately saw how powerful Power BI is and how many options we had in terms of visualizations. We did not ask the users what they need and define charts and views together with them, because we were afraid that we would promise something that we could not later fulfil, which would generate disappointment. So, we said that minimum we need to have the same content as in the old paper reports, plus, when there was a quick win available to the report designer, he offered it. By this "free of charge" offer of new visualizations, we also gained a lot of acceptance. Power BI also offered us a lot of functionality, where we said: "hey, cool!".

TILEN BURGAR: Now I have a special question for you. I wrote some of the most important user acceptance factors from academic literature, and I would like you to select the most and least important ones in your view and give your reasoning:

- Perceived usefulness.
- Perceived ease of use.
- Social influence.
- Result demonstrability.
- Computer anxiety.
- Relative advantage.
- Compatibility.
- Visibility.
- Trialability.
- Voluntariness.
- Image.
- Personal innovativeness.

INTERVIEWEE 2: I can first tell you the outcome of my doctoral thesis: "Content fit to users' needs, so usage will increase if the relevant information is found for the user to do their job. It was not the ease of use or design, but it was the content that mattered."

Most important:

1. Compatibility – This is the most important. It is why the app store is so successful, because every 12-year-old girl or 15-year-old boy finds things they like in the app store. Because they can pick and choose the apps they like. And it is the same in

reporting, every user can choose which reports they like and need, bookmark them. We also gave each team in the plant their own view, which showed only the relevant information for them. By this, we gave our users exactly what they need so they do not need to click and dig through the information for the whole plant so they can find what is relevant for them.

2. Perceived usefulness – this is of course also important.

Least important:

1. Image – I think that this is not important – that by using a software my image within the company would change. Maybe if you are an expert in a very complex engineering software or something then maybe this would be true, but not within the shop floor context. I think as a leader, if you find cool information to lead, I think that can push your career – let us take the example of the FlexTime report, where you can immediately see who my "low runners" and "high runners" are. I think if you are proactively managing this without advice from your boss above, you can improve your image, but I think people are not using it per default due to that reason.

TILEN BURGAR: What were some of the initiatives and your approach when trying to drive user acceptance?

INTERVIEWEE 2: It was having a core team working on it and training the user base piece-by-piece for each report. Then, at the same time we tried to send the signal from the management, that they are behind the project and support it. They always repeated that it is an important project which will help us in the future, that we can later base other projects on this, and so on. We also followed some principles when creating the reports. Whenever we struggled with technical difficulties, we thought about how important it is to spend another hour solving it, versus skipping it and working on something else. We always tried not to have a hundred percent, because we knew that if we went for it, it would last forever, and we would never achieve it. We more tried to offer something which provided a good scope and content useful for their job, but at the same time having a timeline on how to add the missing pieces. We were constantly in touch with stakeholders about our progress and we also did enthusiastic presentations of where we are to managers and to engineers. So, we invited everyone to the P1W area or the Olli room, where we held enthusiastic presentations, and showed users where to click and how to use the system hands on. We held to the German saying: "Do good things and talk about it.".

TILEN BURGAR: Was there any problems, maybe some users who did not want to use it or could not use it?

INTERVIEWEE 2: From the technical point of view, there was no problems with access and we got good support with the licenses for every user. Otherwise no, I have to say that this all went really smoothly.

TILEN BURGAR: So, no complaints from people in the shop floor?

INTERVIEWEE 2: No, I mean, they thanked us once for not printing all the reports and wasting the paper. We also got positive impact from external auditors when they walked across the plant and saw our installations. The hybrid approach of paper and digital was mainly driven by our board member because he always thought that there needs to be information that is permanently visible and said that we are not a technology company, but some things like safety instructions and legal requirements need to be physically posted. Here we also came to a technical boundary that we cannot install so many screens to cover all the topics. That's why we went for the hybrid version.

TILEN BURGAR: Now with the implementation of the completely new SAC-based system in Plant 1, it's quite a unique challenge because the users are used to the old one, what do you think are the most important points for this to be successful?

INTERVIEWEE 2: The user adopting it has to think it is cool, otherwise you have no chance. If it is a global decision to go with it, the first point is that we need to build up knowledge on it and implement our own wishes and be able to react. I told you before that a big success factor for our old system was that we could update it within one hour of a users' request. If this is difficult within the new system, then I recommend that the plant also has its own resources, so they do not need to wait for the next release to get important information. The management also needs to walk the talk. But this is the most difficult part.

TILEN BURGAR: So, I got information from the project lead that the new system will be implemented in P1 at the latest time, because the current system is so good and everyone is used to it. Do you think this is a good approach?

INTERVIEWEE 2: Yeah, but I would recommend going with a hybrid approach, to make the new version accessible and visible, maybe use it for a new report which is not available on our version, which maybe enhances and enriches the information that is available. This is how you make users excited, so they "jump" already in the phase where the project is not officially "live" to this new system. This is especially relevant where the new system has the advantage of the live link to SAP, so more detailed information can be presented as in the old version (e.g., costs).

Appendix 4: Interview with Interviewee 3

TILEN BURGAR: What is your role in P1 and how do you use the digital shop floor within it?

INTERVIEWEE 3: I'm the production coach for metal anchor production. I am responsible for two different technologies and the entire product value chain. We produce the bolt, and then in the assembly line, the finished anchor. That also includes indirect functions like logistics, engineering, and quality. All these guys get together in the shop floor on a daily basis for 15 minutes. So, all production employees present in the respective shift, plus quality, logistics, engineering, me, and the process experts. We meet, we open the digital shop floor board and then we go through accidents, quality topics, an overview of where the machine is at (ahead of schedule or behind the schedule). Then, we go through the daily topics which are designated on different days, such as product availability, costs, people, profitability, etc. I use the digital board to access a lot of the reports, such as OEE reporting, cost reporting. A couple of other things are available for the employees themselves. For example, the GEOS results are always accessible through the board. The company calendar, shift plan, priority machines, and the back-order list are all available for employees to access. There is also a link to the tooling page on the digital shop floor which is relevant for our process experts. Overall, the digital shop floor is for me a daily tool that I use to gain a general overview of what is going on.

TILEN BURGAR: As a user, what are your impressions of it? Is it easy or hard to use?

INTERVIEWEE 3: It's largely really well done. There is still improvement potential in terms of the drill down possibilities in the different reports, and also in terms of the structure itself, regarding how the daily assignments are divided. That is not part of the functionality of the shop floor, but rather how we structure it ourselves. I think there is no major issues, but there is a couple of reports where I do not know if they are really that useful for a daily shop floor with the production members because I am not sure what they get out of it. For example, personal productivity is one such topic, where I can tell my team what the productivity is, but it does not really lead to a consequence. I cannot say for example: "you are unproductive and you are productive". That would not go well and it is not the purpose of the meeting. That is pretty much it. There are a couple of reports that could be changed or the drill down possibilities improved and that is about it. Maybe the links to the other digital shop floor pages and communities could be better organized. But that is a topic of visualization, so a minor topic.

TILEN BURGAR: What is the most important functionality of the digital shop floor for you?

INTERVIEWEE 3: I mostly use an Excel file which is linked through the HSE topic on the digital shop floor. Here we track accidents, quality topics, and also the AIP list, which we just started using in digital for this year, to get away from the written board. Next, the OEE

report is very important. Here, I usually drill down to the machine level, filtered for just the last calendar week. I also use the variable costs report often.

TILEN BURGAR: Since you started at Hilti after this solution was already implemented, can you tell me how were you first introduced to it and if there was any training?

INTERVIEWEE 3: Yes, I only started in January. My predecessor was still around, so he just taught me. He showed me the different pages and the structure of the shop floor. I also tend to browse around by myself and see what I can get out of these reports. So, there was some training, but it is also somewhat self-explanatory. If I were completely new to the whole production setup it might be a bit confusing, but then again, it is OEE, productivity, accidents, quality, times, so nothing too complicated, I would say.

TILEN BURGAR: Do the workers on your team also use the digital shop floor on their own, or only as part of the shop floor meeting?

INTERVIEWEE 3: That varies a lot. Not all of them use it. And I do not know how to share them the link properly. I am not sure if I just copy this link and send it to them or how they should access this.

TILEN BURGAR: Did you ever encounter any resistance to using the digital shop floor in your team?

INTERVIEWEE 3: No, I do not think so.

TILEN BURGAR: As you know, there is a big project where the dashboard will be made within SAC instead of Power BI, as we have it now. Do you predict any problems with implementing this on the shop floor? Since the users are so used to the current version.

INTERVIEWEE 3: I do not know the SAC that well yet, but my assumption would be that anything that is not available in data through SAP cannot be implemented. So, all these links I guess would be gone. Not sure if this can be implemented in SAC. As long as it works and the layout does not change completely where everything would be new, then it can work. It is always about how much it changes. If it is just a different link, nobody cares, but if it is a completely different layout and functionality and some things do not work as before, then it would be a hassle.

TILEN BURGAR: Do you expect any problems with implementation?

INTERVIEWEE 3: I do expect some problems because every implementation has its issues, but it depends on how well they do it, right?

TILEN BURGAR: Do you think workers being used to the existing system could be a problem or advantage for implementing a new one?

INTERVIEWEE 3: The workers do not use the existing system, so they will not use a new one (clarification: outside of a shopfloor meeting). In the shop floor meeting context, I do not expect any problems, as long as it works.

TILEN BURGAR: What are the most important considerations for implementing a new system? How would you drive user acceptance? The answer can be in the context of your team – how would you get your guys to use it?

INTERVIEWEE 3: The production does not really need to use this much – they do not need to enter anything. All of this, they would usually just look at for information. There are some buttons where they should use the dashboard to go in and enter their times and everything. But that is just a communication topic – I need to tell them to do that. There are a couple of improvements I can think of, but nothing major where I would say it would change the acceptance. I think making it easy to access would help – so that you could have a button on the desktop which would take you to the P1MB digital shop floor. Because having to go in and maintain the favourites in the browser just makes things more complicated. And we (clarification: interviewee and interviewer) do not mind, but I have guys that don't look at their emails.

Appendix 5: Interview with Interviewee 4

TILEN BURGAR: Can you explain your role in P1 and how you use the digital shop floor within it?

INTERVIEWEE 4: My role is unit manager. I use the digital shop floor on Level 2. This means we have a daily meeting with my unit management team, the quality guys, and logistics, where we use the digital shop floor to discuss our KPIs. It is on from Monday to Thursday. On Friday we use the tool to check our CIPs together with the coaches to see the progress.

TILEN BURGAR: What are some of your impressions of the digital shop floor?

INTERVIEWEE 4: I think it is very positive. I like it. We have everything in digital form, and nobody believed before the crisis where we were used to sitting and standing together on the shop floor, that we can have a mixture where some people are there on the shop floor and some online. The regular updates of the KPIs are also very good. Everything is correct and I like it.

TILEN BURGAR: When this was first being implemented two or three years ago, how was it first introduced or communicated in the plant?

INTERVIEWEE 4: That is a difficult question. I'm not sure I can answer that.

TILEN BURGAR: Maybe from your perspective.

INTERVIEWEE 4: I think we tried it out.

TILEN BURGAR: Was there any specific trainings for people in the plant?

INTERVIEWEE 4: I can remember that the Controlling Department did a lot. We came together and checked the diagrams and gave feedback for optimization. I would say it was a continuous improvement of the digital shop floor. First, we started and then improved.

TILEN BURGAR: So, people in the plant were involved in making it better?

INTERVIEWEE 4: Yes, everybody in the plant came and said: "I would like to have this and that, can we implement it?" And yes, I think this is now the result where we are now. And I think we are still in the process. It is always changing a little bit.

TILEN BURGAR: From your side, do you see it as being easy to use or is there any potential for improvement here?

INTERVIEWEE 4: I think it is very easy to use and also easy to find. I am not very experienced in digital things, but for me it is not a problem to find all the KPIs I need from the digital shop floor. It is very easy.

TILEN BURGAR: Did you ever have any concerns? Maybe that some data would be wrong or something like that?

INTERVIEWEE 4: Yes, sometimes there is a doubt if everything is correct. Sometimes it is a problem but I think it is a normal thing.

TILEN BURGAR: Would you say that the digital shopfloor is voluntary or mandatory for the users in the plant?

INTERVIEWEE 4: I see it as voluntary. Obviously, now we have to use it, that is clear, but people like it. I would say they like it, and they use it. Yes, it is a must, but they like it. I have good feedback from everywhere.

TILEN BURGAR: Who are the user groups who get the most value out of it?

INTERVIEWEE 4: Coaches because they have so many possibilities. For example, with maintenance cost, with quality costs. I have seen your grid which shows very well where the quality topics are. You can find out what your biggest tool topics are by looking at it. It is very good for analysing your cost and quality problems. I believe it is a great tool.

TILEN BURGAR: Do the workers on the shop floor also use it on their own or only as part of the shop floor meetings?

INTERVIEWEE 4: I am not so experienced on Level 1. I think they use it, and the coach has the possibility to show them where they are, but not more. I would say it is more information and where they are in regard to their targets and KPIs.

TILEN BURGAR: Do you remember when this was being first implemented – was there anyone that maybe did not want to use it or was annoyed by having to use a new system? Anything like this?

INTERVIEWEE 4: No, I do not know anybody. So, I think there was no big resistance against the digital shop floor. Then Corona came, and there was no other choice.

TILEN BURGAR: Which things would you say are the most important to drive acceptance of such a system?

INTERVIEWEE 4: That the data is correct, not old and right on time. So that you can believe they are correct. I think it's also important that it's easy to handle and navigate such a digital shop floor, so everything you need is available.

TILEN BURGAR: Do you think there is also a social component so that the users are more likely to use it if their boss and co-workers also use it?

INTERVIEWEE 4: Yes, for example, if I see that my people like to have it in digital form think it is the future, then it helps. Maybe I do not find the right English words, but if people

see other people using it, they are also happy about that and use it more themselves. Then people like it and the trend is that they like digital things, I think this can be the right way to go for that, yes.

TILEN BURGAR: To explain the question a little – people sometimes do not like to use new things because they do not like to change and use new things, but if they see everyone around them changing, they are also more likely to do it.

INTERVIEWEE 4: I think it is a trend we have in our community that the people go for more digital solutions and that they like it. The younger people more than the older ones. And I think there is not much resistance.

TILEN BURGAR: Probably you are aware that SAC will be implemented at some point to replace the current dashboard. So, there will be a new dashboard with the same reports as the current one. How do you feel about that? Do you think that this could cause some problems?

INTERVIEWEE 4: I do not know the system, but every new system can bring some problems. That is what I do not like – if we have an established system for two years and then we start again at zero, and we have to learn everything again. Maybe I am too old, I do not know. Sometimes the changes are too fast for me.

TILEN BURGAR: This is an important point. Do you think the users in the plant could also see it in this way?

INTERVIEWEE 4: Yes, and it is not only this point. We have a lot of things which change too often – my contribution, my development, how you fill in your holidays, etc. A lot of things are changing too often.

TILEN BURGAR: So, then you have to learn new systems every year, right?

INTERVIEWEE 4: Yeah, continuous change. It is something I feel happens too much. And the new systems can bring some problems, I am sure.

Appendix 6: Interview with Interviewee 5

TILEN BURGAR: What is your role in P1 and how do you use the digital shop floor within it?

INTERVIEWEE 5: I am doing controlling so I am responsible for all for all reports, KPIs, and in general all the numbers we have in the plant. The digital shop floor we use on a daily basis because we use it in every shop floor meeting in the morning from Monday to Thursday and that is where we discuss the KPIs. There we see basically how the plant is going forward and if it is going well or not.

TILEN BURGAR: What are your impressions of the digital shop floor as a user? Maybe some positive and negative aspects?

INTERVIEWEE 5: I think the digital shopfloor is a good platform to see each KPI and it gives good overview of every KPI we have in the plant. It also shows very well how it is working right now. I do not know if I can say something negative as a user to be honest.

TILEN BURGAR: Maybe potential for improvement?

INTERVIEWEE 5: I think Power BI is just not the perfect cloud platform for that, because there are like small things that could be improved. For example, and this is perfectionism, but if we have one report where the date says “day/month/year” and another report which says “day.month.year”, and I think this is just something where Power BI should provide the right format.

TILEN BURGAR: It there some other reasons why you think Power BI is not the perfect tool?

INTERVIEWEE 5: From an outside view, I might say that it is that I have the feeling that it is hard to always handle it. That it is very complicated in the background. That is how it seems, I guess from for the outside.

TILEN BURGAR: When you first started at the plant, where was there any training regarding the digital shop floor?

INTERVIEWEE 5: No, not for me.

TILEN BURGAR: So how was it introduced to you?

INTERVIEWEE 5: It was introduced to me because my predecessor, was responsible for it and she built it. But there is no training for it. And we are responsible for some of the key KPIs at the shop floor, so that is how I learned about it. But you know that I am not updating it. So yeah, that is how I learned about it. And she also told me in my application, in the

application process, she told me about it. That is how I learned, because she was just very proud of it because she built the whole thing.

TILEN BURGAR: Did you feel, and I am not asking you as part of Controlling, just as a user of the digital shop floor, that maybe there should be some training or is it easy enough to use without it?

INTERVIEWEE 5: I think training would be necessary, especially regarding what each KPI means. Because I think the use of the platform is not too hard, if in the background it is it is done right. So, for example, we have the different days and if every report is on the right day, I think then you cannot do much wrong. But then I think for example I had the problem that for me the numbers were wrong, and then you told me I have to click on this icon on top to fix it. I think this is something that people do not know, and I told other people from the plant as well to do so. It is small things that people should know. And then especially, they should know the background of every KPI. So, training would be good, yeah.

TILEN BURGAR: Another option would be to display this information on the reports, correct?

INTERVIEWEE 5: Exactly. Yeah, exactly.

TILEN BURGAR: In general, would you say the system is easy to use? So, not meaning the definitions of the KPIs, just in general.

INTERVIEWEE 5: As a user I think it is easy to use. So, you know, we have the different reports connected to every day in a week and then you can only choose to view one day or all the reports, so I think then it's easy to understand. I mean, if you know what you are looking for, usually you can find the report. Then it is easy to just choose it.

TILEN BURGAR: Is the use of the system voluntary or mandatory for your job?

INTERVIEWEE 5: Mandatory.

TILEN BURGAR: So, you need it to do your job?

INTERVIEWEE 5: Of course, yeah. I need a daily on a daily basis.

TILEN BURGAR: Who in the plant gets the most value out of the digital shopfloor?

INTERVIEWEE 5: I think the production units.

TILEN BURGAR: And why?

INTERVIEWEE 5: Because they are responsible for achieving the planned result and the KPIs help them on a daily basis to see where they stand and where they should stand. They also have their targets and if they do not reach their targets, they can easily see why they did

not reach it. Then they can work in it and see one week later if they improved or not. So, definitely the production units, because most of the reports I think are with numbers for the production units.

TILEN BURGAR: What is your impression – do workers on the shop floor also use it? Or is it more used only as part of the shop floor meetings?

INTERVIEWEE 5: This I do not know to be honest. I do not know if anyone does. I hope they do, but I do not know. I do not know if they have the time to do so.

TILEN BURGAR: As part of your job, you mostly use it as part of the shop floor meeting, right?

INTERVIEWEE 5: Exactly, daily. I guess that is what all the production units do as well, but yeah, no, I cannot answer the question for them. I cannot say how production or how people are in the production really use it, but that is what I would guess.

TILEN BURGAR: What are the general impressions by the people in the plant? Is there a lot of criticism or mostly they just use it?

INTERVIEWEE 5: So, you mean by people in the production or the production units?

TILEN BURGAR: I mean generally, so it could be also coaches, unit heads.

INTERVIEWEE 5: They really like it because beforehand we only had the paper versions of reports. On the shop floor boards we had printed papers, which needed to be printed every day. And I think the digital shop floor version is way better than the old one, and that is why people also like it a lot more than the old version.

TILEN BURGAR: What are the most important things you have to achieve to drive acceptance of such a system. How would somebody encourage you to use it?

INTERVIEWEE 5: So, you mean how we get the people to use the digital shopfloor?

TILEN BURGAR: Exactly.

INTERVIEWEE 5: I mean, there is no other option.

TILEN BURGAR: Yeah, but how do you get them to use it competently, so they know what they are doing?

INTERVIEWEE 5: We have the old paper versions still on the drive in Excel from, but we are slowly stopping that, so they cannot use that anymore and they have to use it digital shop floor. They know also with digitalization going on in the plant and, for example, MES and other initiatives, I think this should be a standard. From my perspective, it would be the best to do trainings. In the plant we have captured that with the Go & See.

TILEN BURGAR: Can you explain quickly what the Go & See looks like?

INTERVIEWEE 5: It also happens in the morning after the shop floor meeting, which every unit in the plant has. If a unit has something new to show or an update or anything, then we create an appointment which is like 20 minutes in the morning and then we show everyone or every unit what this specific unit achieved. They also show what will be changed in the future and how this will help us being more productive in the plant.

TILEN BURGAR: Do you think there is a social component to people using the digital shop floor? For example, somebody did not use it in the beginning, but then they see their co-workers and bosses using it and then they are more likely to use it.

INTERVIEWEE 5: Yeah. I mean, I think that the daily shop floor meetings force the people to use it and I think that's where they learn the positive effects of it. And I think the social effect is very likely because everyone is using it, so if one unit would not use it then, this would be seen as a negative.

TILEN BURGAR: What is more important – the system being useful (data being relevant, etc.) or easy to use?

INTERVIEWEE 5: Useful, useful, for sure. Having useful data is the reason for having the digital shop floor. I think it being easy to use is a thing of perspective which we can work on with trainings and stuff.

TILEN BURGAR: So, as you know, a new SAC-based system will be introduced in the plant at some point. Would you say that the fact that there is an existing system in the plant will affect how the new one is then perceived by users?

INTERVIEWEE 5: I think it will be affected by the effect that they just got used to the Power BI version and they don't want to change to SAC. They just learned the Power BI and they do not want to learn the SAC now. Maybe more specific to your question, I think the way that we already have something digital in the plant, it will help them to better understand SAC.

TILEN BURGAR: What would be your recommendations? How would you approach getting users to use the new system?

INTERVIEWEE 5: Definitely trainings. From my perspective, there is no reason to keep up the Power BI report if we have an SAC report, so they are also forced to use it. But yeah, I think definitely trainings have to take place.

TILEN BURGAR: What do you think about this approach that the SAC development team is taking, where reports are built on a global level and more professionally? Do you think this is a good thing for the plant?

INTERVIEWEE 5: I think so, especially in regard to the whole company. I think having a global solution is way better than just us doing our own thing because then we will also have a level where each plant has the same report and then we can also compare results among each other. And I think it also helps us within the team that we are not responsible for all the numbers, and we can then compare our own ones to the ones published on SAC. Because right now I think we do our own thing and we compare to our reports, but we don't always know if it's right on right or wrong.

Appendix 7: Interview with Interviewee 6

TILEN BURGAR: Can you explain your role in P1 and how you use the digital shop within it?

INTERVIEWEE 6: The role is pretty simple, plant manager. So, manager for operations and innovations and let us say all the other surrounding stuff. On the other hand, I use digital shop floor as an information source for me personally - if I want to have any insights and also have the possibility to do a deep dive. This is either for when I do an investigation on how a department is doing, or most of the times also in preparation for my regular Level 3 shop floor management meeting. It does not mean that I do the full analysis, but at least a bit on what happened the last day or the last couple of days. That is mostly what I use it for and in the management routine to have a quick look on the traffic lights – green, red – where we have to focus on. That's roughly where I use the digital shop floor.

TILEN BURGAR: When this was first being implemented, so this was 2-3 years ago, what were some of the main motivations to digitalize this shop floor management process?

INTERVIEWEE 6: That was, I would say to have one source and also always an actual (up to date) one. We had the print-based shop floor before, which meant somebody had to print it and bring it to the board, which was kind of a waste. And to have it available also with the possibility of the deep dive. So, these are the major reasons - one source and having the possibility to deep dive.

TILEN BURGAR: What were some of the main impacts? Was there anything surprising?

INTERVIEWEE 6: I think not very surprising, but it also came along with a change in how we run the shop floor itself. For example, that we expect that the people are prepared and have the analysis done in detail for the shop floor meeting, to not then start arguing about not knowing the numbers and needing to go back to the department to check.

TILEN BURGAR: What was some of the responses by the users? Did they mostly like the digital shop floor? You can also explain here from your perspective.

INTERVIEWEE 6: Most of the users very much liked it, and one of the responses was: “I need more of that, I’d like to have this and this KPI, I want to have this analysis” and so on. I think that was the one of the positive responses on it. One other response was: “Are the numbers correct? Are they OK?”. Because often when they show negative trends, they start questioning the numbers, which is a human reaction. And I think that is something which has to be very carefully looked at when you do such projects that the numbers are reliable and are correct, so we do not have mix ups and hiccups.

TILEN BURGAR: From your perspective, is there anything regarding the system that you had doubts about through the last few years?

INTERVIEWEE 6: In some areas where we have a lot of human influence, like people productivity, where people have the possibility to adapt, correct or deduct or add on. Here I have questions. And also on the product availability, I also had question marks since we have 3/4 different reporting cubes, all ending in different results, at least visible to me, not knowing the details. And that is not something which feels good. Even then people think, well, if we have the experts then why do we have differences.

TILEN BURGAR: I do not know how much you were involved in the decision specifically, but do you know why Power BI was chosen initially as the tool for the project?

INTERVIEWEE 6: No, I do not know why it was chosen. I think it was just good at that time and people saw that well, it is a powerful tool, let us use it. It was better than Excel. But I do not know why. That is my guess.

TILEN BURGAR: When this was first being implemented, how was this communicated within the plant? How was this presented to the user? Were the trainings?

INTERVIEWEE 6: It was kind of highlighted in one department and then also trained. There was also kind of self-learning behind as well. The first rollout the approach was to try and get used to it and then there was more training on how to read it, but not too many details, I would say.

TILEN BURGAR: Do you in general see the digital shop floor as being easy to use?

INTERVIEWEE 6: Yes. Well, easy means I could use it without any major training. I had a couple of questions, but not many, and I think if I can do it as a non-specific user, yes, it is easy.

TILEN BURGAR: In your view, is it more important for such a system to be easy to use or useful (to have relevant data, etc.)?

INTERVIEWEE 6: It has to be easy to use and useful. If it is not easy, for example, you have to know any acronyms or other advanced things, or if you have to know programming, then people will not use it. So, it has to be intuitive and easy to use. Then it becomes alive, and people try to work with it. Otherwise, you only have the nerds and the geeks who will work with that. And it is not a common and widely accepted truth. I think that is quite important that it is easy and accessible for the people. If not, we lose too much.

TILEN BURGAR: Do you see the use of the digital shop floor in P1 as being voluntary for the users or mandatory?

INTERVIEWEE 6: One could say, well, without Corona, maybe not that mandatory, but the people which have seen the pilot reports, they all asked: “When can I have it?”. So, it was voluntary.

TILEN BURGAR: But from the point of view of a coach, for example, I do not see an option for them to not use it, right?

INTERVIEWEE 6: That is true, yeah.

TILEN BURGAR: Who would you say is the group within the plant that gets the most value out of the digital shop floor?

INTERVIEWEE 6: I would say coaches and unit managers, but also the plant management team.

TILEN BURGAR: Can you quickly explain why?

INTERVIEWEE 6: For coaches, because the data are available on a single source. They can use it on the shop floor. They can use it on their desk for preparation. And I think that is really a benefit, to have the possibility to work with one source of data which is then also transparent to the people. I think that is something which is quite good.

TILEN BURGAR: What is your impression – do the workers on the shop floor use it also on their own or only as part of the shop floor meeting?

INTERVIEWEE 6: It is more as part of the shop floor meeting. There are a few who are curious, but they are only exceptions.

TILEN BURGAR: Do you see an added value for them to use it?

INTERVIEWEE 6: I would say yes. Because if they want to see something specific, they can check it. I sometimes see people looking into flexible hours, CIPs, the task backlog, so they use it and work with it.

TILEN BURGAR: When this was first being implemented in P1, do you remember any resistance by some people? Maybe somebody who did not want to learn a new system?

INTERVIEWEE 6: I cannot remember any resistance. I think there was some who were a bit cautious and were worried about additional effort on their part that will come along.

TILEN BURGAR: If we then compare this to this new big project from the global team to introduce SAC, do you think then this is a big improvement in the effort part for the controlling department, since the new system will be managed by the global team?

INTERVIEWEE 6: SAC is a bit trickier because it is not customized to us and less intuitive at first hand to go with. It is a big change to what we have. And I think that that it is tricky because it comes with a global view and not with a customized view for our plant. That is something I see well, here this could be a bit trickier.

TILEN BURGAR: Which thinks would you say are the most important to get users to accept such a reporting system?

INTERVIEWEE 6: It has to be easy to assess and reliable. So, if you have to work with something, it has to be easy to use and it has to be reliable.

TILEN BURGAR: Have you noticed also maybe a social component to acceptance of this system? So maybe a user does not want to use such a system, but then they see a co-worker or their boss using it, and then they're more likely to do it?

INTERVIEWEE 6: I would not say that there is an effect, no.

TILEN BURGAR: So then if we go back to the SAC quickly, do you think for this specific situation we have in P1 where we already have an existing system that users are used to, do you think that implementation of the new one will be more difficult because of it?

INTERVIEWEE 6: Could be, since the new system comes fully fledged and in “one shot”, whereas the digital shop floor was implemented step by step and we learned as we went. When we now say, “we have a new digital shop floor”, whatever base it is and it comes already fully customized, there could be a bit of not-invented here syndrome. Meaning it does not come from us and we never really like it as much because of that.

Appendix 8: Interview with Interviewee 7

TILEN BURGAR: What is your role in P1 and how do you use the digital shop floor within it?

INTERVIEWEE 7: I am in the role of the of a unit manager. That is one out of three here in the plant, and that means I am responsible for providing our customers with their respective product that is in the right quality, the right time, and the right quantity, of course, but also at the right level of costs. So that is pretty much what we are doing here in the plant in the unit that I am responsible for and we do that in a team of three value streams, each standing for a specific product. We are supported by the logistics and engineering teams.

TILEN BURGAR: How do you use the digital shop floor?

INTERVIEWEE 7: So, as you know, we have our daily shopfloor meetings. We have a cascade from Level 1 to Level 3, and we do this on a daily basis. The idea is that we have a quick check in every day in order to synchronize our information. We evaluate how was the last day and we take measures if necessary to make the upcoming day better. In order to have this on a on a solid fact base and not by gut feeling, we review the respective KPIs more or less daily. But as we do it here in P1, we have one KPI that we review on each specific day for the last week. So, that is how we use the digital shopfloor board. And I personally prepare for the meeting one evening before, or the same day in the morning. I look at the numbers, I check how they are on a relative scale, using of course the colour coding. But I also use the deep dive, especially if a KPI deviates from my expectation. The more red a KPI is, the more I go into a detail, but also if it is super green, then also I want to know why that is the case. So, I prepare myself so that I am able to ask specific questions to the team.

TILEN BURGAR: So, if you discover something during your deep dive, then you would present this to your team and you would talk it over?

INTERVIEWEE 7: Yes.

TILEN BURGAR: When the digital shop floor was firstly implemented in the plant, I think it was 2-3 years ago, what would you say are the biggest impacts you saw either positive or negative?

INTERVIEWEE 7: Before we had the digital shopfloor board everybody was printing out the data on sheets of paper. You can picture that everybody came with a little book, which was a waste of time. It was also a waste of paper. The numbers were not just ready in some form such as a Power Point or a PDF, but the colleagues had to go through the system and derive the data, which all took a lot of time. So, for me personally, in my perspective, the biggest change was that the data is available in the way we need it the most. Everybody has the same source, and everybody looks at the same kind of numbers. We save a lot of time, so that is one big advantage. The other one is that with the digital board, we are very

dynamic. What I really appreciate is the drill downs that we are now able to do. So, we come from a very condensed perspective and in case we don't understand or like the numbers, we can come very quickly to the root cause.

TILEN BURGAR: Was there also any maybe negative aspects?

INTERVIEWEE 7: Especially in the beginning, the data was not accurate. There were a lot of false numbers and then at some point in time we did not know what to believe anymore. And since we are steering the production based on this data, it is dangerous, because we can take the wrong decisions. Then, also, sometimes data were not actual anymore. So maybe we were looking at data from last week or the week before, but we wanted, of course, to have them of their respective day. And also, in the beginning we had technical issues, long load times and all that. So, the usability if you want to take that word was not overwhelming.

TILEN BURGAR: What would you say is then more important for such a system – that it is easy to use or that it is useful (that it has relevant information)?

INTERVIEWEE 7: Relevant information. Because if it is easy to use, but we do not trust the data or it shows data that we are not interested in, then this does not make sense. So, for me personally accuracy comes first, and then the usability.

TILEN BURGAR: When this was first being implemented in the plant, how was it communicated and how were the users trained?

INTERVIEWEE 7: Honestly speaking, I do not remember that. There was a Go & See, which counts for a training.

TILEN BURGAR: There was no specific training with groups of employees or something like this?

INTERVIEWEE 7: No not that I know of, but this speaks in favour of the digital shop floor. It is so easy to use that any sort of training would be unnecessary. If I remember correctly, to Go & See was just fine.

TILEN BURGAR: Do you in general see it as it being easy to use, or could some improvements be made here?

INTERVIEWEE 7: Now what I hate is the resolution of the board – if you don't have it on the big screen but on your computer, you have to modify the size all the time. I understand the technical background of that, but it really stresses my nerves. That would be in terms of usability my next wish for improvement.

TILEN BURGAR: Yes, I know about this, but as far as I know, there is no solution.

INTERVIEWEE 7: Well, I can live with it, but I do not like it.

TILEN BURGAR: Yeah, yeah, same. Would you say that the digital shop floor is voluntary to use for the workers in the plant, or is it mandatory?

INTERVIEWEE 7: It is not mandatory by the call of the management team, but there is no real other solution. You could go into the SAP, but you would not really do that because now we trust the data on the digital shop floor and it is more or less there on time. For 95% of the weeks, in terms of steering the shop floor, you would not want to use anything else than the digital shop floor, but it is not mandatory.

TILEN BURGAR: So, it is not mandatory, but everyone basically needs to use it as part of their job?

INTERVIEWEE 7: Everyone needs to use it. But you should also have this interview with the coaches because I'm just talking out of my perspective. Maybe when they prepare for the shop floor meetings, they use other sources such as SAP for instance, and that I do not know.

TILEN BURGAR: Yeah, I talked to them, and they just use the boards. Who would you say is the group of users that gets the most value of the digital shop floor?

INTERVIEWEE 7: I am a romantic guy, so my answer would be everyone at the same level. Because we all have the common target to steer the production. That accounts for Level 1, 2, and 3. So I do not consider this as a reporting tool for me personally, or for the plant manager. It is for us. We all need to have the same kind of information at the same point in time. We need to synchronize our thoughts on that and what we think should be done next. So, it is crucial for all of us.

TILEN BURGAR: If we maybe turn around the question, do you think the workers on the shop floor also get as much value out of it? Because I got some information from other coaches that they are not that interested in using it outside of the shop floor meeting, of course.

INTERVIEWEE 7: That is true, outside of the shop floor meeting nobody uses the data. But my wish or my hope would be that the direct productive colleagues are just as interested in the success of their work as everybody else. And if you are interested, you need to know where you stand. It should be more than a feeling if the product availability is going up or down, you need the numbers. And if that is true, the blue-collar workers and the management team should be equally interested, and it would be just as valuable for them as it is for the management team. But then of course, I am also a realist. I know that some people come here because they love it and some people come here because they want to have the money and that is it. So, I think it is a mixture.

TILEN BURGAR: Yes, of course. Then can we say that the main vehicle for the use of the system is definitely the shop floor meeting?

INTERVIEWEE 7: Yes, for me personally it is 95%. Sometimes if I prepare for whatever kind of meetings, I get the numbers and I make snapshots and paste them into the presentation, since it is pretty. But 95% is the shop floor meeting.

TILEN BURGAR: Do you remember when this was being implemented, or even now, was there maybe somebody who did not want to use it? Was there any resistance to it?

INTERVIEWEE 7: Yes. And the argument was that if it is too easy to get the data within the shopfloor, then nobody feels responsible for it. It just come there, click, go, and then say, aha, very interesting. But if you are responsible for that, you will prepare in advance. You bring the numbers with you. You probably do not remember, but the previously everybody had to take a pen and write the numbers onto the board and that was a psychological thing, something that has to do with commitment. It is my number. I am responsible. I am bringing it. I feel bad if I put my cross here and there and that is red. I do follow that thought to some extent and it makes sense. So, it was not applause only.

TILEN BURGAR: So how was this resolved?

INTERVIEWEE 7: I think a mixture between management decision and explaining the advantages.

TILEN BURGAR: Which things are the most important for getting a user to accept such a system?

INTERVIEWEE 7: Explaining the advantages, what is in it for you as the user.

TILEN BURGAR: Do you think there is also social component to acceptance? By social I mean that for example if you are somebody on the shop floor and you see that your co-workers are using the system and your boss is using the system, then you are also more likely to do it.

INTERVIEWEE 7: I have not thought about that. That could be true. If everybody uses the system and asks questions, then you would not want to be the one who says: “I don’t know, I didn’t check”. But I do not know.

TILEN BURGAR: You would not say it is a major factor if I interpreted your response correctly?

INTERVIEWEE 7: No.

TILEN BURGAR: Then as you know, there is a new reporting system coming at some point, maybe in half a year or a year. What are some of your first impressions from what you have heard about it?

INTERVIEWEE 7: I am not looking forward to that, I am worried that we are losing a lot of transparency that we have now with the digital shop floor that you and everyone else has been working on. We now have a customized tool that fits exactly to the needs that we have in Plant 1. And from my understanding, and I am just saying some number, we will lose 70% if the reports. And that makes me sad when I think about it.

TILEN BURGAR: How would you from your point of view approach implementing a new reporting system such as SAC in the plant? Because we know that it is quite difficult because people are now used to the system, and you will have to get them now used to something new.

INTERVIEWEE 7: It is probably a classic thing for change management and the same journey that we had with the digital shop floor, which I now do not remember any more because we love it so much. But I also assume nobody wanted it then because we had our papers and we loved it. And then we did a lot of explaining, Go & Sees, and so on. I think the same will hold true for SAC because it does have advantages. For example, I think especially you are now investing a lot of effort in maintaining the system and updating the data. And then when we have some deviations, I am calling and asking why a specific number is not matching to something else. I think one of the advantages of SAC is that it is a direct source. So, I think if we explain all this during the change phase, then we will be more on board. But as of now, we as a plant management team are more on the worrying side. At least I am.

TILEN BURGAR: Do you think that the fact that there is this existing system will make it more difficult to implement a new one or will it be easier because of it?

INTERVIEWEE 7: About the technical implementation, I do not know.

TILEN BURGAR: No, I don’t mean the technical side, but more from the side of user acceptance.

INTERVIEWEE 7: No, I think the big step was from papers to the digital tool. I think from one digital tool to another one is not that big of a step.

Appendix 9: Interview with Interviewee 8

TILEN BURGAR: What is your role in P1 and how do you use the Digital Shop Floor?

INTERVIEWEE 8: I am a Quality Manager in Plant 1. I am responsible for the operational quality management. I am a team lead, so I have eight people with me that are responsible for the whole quality operations, failure management, sample inspections and of course the costs of non-quality topics. So, we need the data from the digital shop floor for our defect costs for example, so every order that has a scrap inside or rework is displayed at the digital shop floor. We need the frequent data to steer and monitor our activities, where it is necessary to improve some things, and so on. Before we had the digital shop floor, we had the analogue versions where 20 to 30 different sheets of paper were printed out every day. If someone was sick this was not updated and so on. The data was not validated and required a lot of manual work to keep updated. Then, around three years ago, we started with the digital shop floor initiative. I was in the team along with some other employees and two interns, where we evaluated digital shop floor solutions. At this time we were doing a benchmark for Industry 4.0 along with the university in Aachen. We benchmarked some very good companies who have already implemented Industry 4.0 activities. We also visited a company in Italy (GKN) and they have implemented a digital shop floor solution called Solunio. It was an internally developed solution by one of their IT guys. At the end he decided to leave the company and build Solunio on his own, while he also kept GKN as his customer. They have 23 plants worldwide and they were able to get all the live machine information (running / not-running, OEE information, performance, availability, quality) from 1800 machines on the digital shop floor. It was very cool – you entered on a world map, you picked your plant, then you would see it from a birds' perspective, you would see all the machines in green or red, showing if they were running or not. When we saw this, we thought it was very cool. Then, you could do a drill down into the machine to see the current job order, which operator is working on it, how long each order takes, and so on. We thought this is very cool and we want to have it exactly like this. So, we started the pilot phase with Solunio. After two or three months in the pilot phase, they visited our plant a few times, and it looked and felt good, but at the end we did not manage to get them on board because we realized how deep Microsoft and SAP solutions are at Hilti. We had a lot of the data saved in SAP and queried through Excel, and Solunio was not meant to work with these inputs. It would have needed a lot of programming with Java for example, and we did not have any resources or know-how about this. With our current system of having data in SAP and having queries to it in Excel, it would not be possible to publish it into Solunio. The price was also an issue – Solunio was not cheap. From a price perspective we did a one-to-one comparison with Power BI. We compared all the functions and then also considered the financial implications. We decided at the end that Power BI also offers us more functionality and it was also something that was already available in the software suite, so it required no additional financial investment. The whole team also had in the back of their minds that the solution will eventually be replaced by SAC, as this was a corporate-level decision. Essentially, we

needed a solution for the intermediate period of three to four years. So, one of the main goals was also to get people used to working with digital data. When then the Coronavirus situation happened, everyone was very happy that we had the data available in digital form on the digital shop floor. This made it very easy for us and it was a big benefit. At the end we decided for the Power BI solution, but we also struggled here to find people who could create the reports. We had some IT-oriented people (mostly interns) help us here.

TILEN BURGAR: There was never a full-time employee only working on this?

INTERVIEWEE 8: No, just for digital shop floor never. The idea was to make the work of the controllers, who maintained the old paper shop floor reports, easier, so they do not have to run all the queries daily and update all the reports manually. It was also the idea to make the back-end simple and to make their lives easier. At the end though it was so complicated to build up every report and the back-end was not built well. Nowadays, I think the front-end of the solution is simple and easy to use. We publish a report and 350 people in the plant can see it and can work with it. Regarding the ability to do drill downs, we could do more in my opinion. We do not offer it for every report yet. But even the functionality of having automatic updates is very good. For example, through the day different people can enter costs of non-quality data into our SharePoint list, and then the report refreshes at 6 AM on the next day, and the data is automatically visible to everyone in the plant. This is perfect for us. On the other hand, for the Excel files Controlling deals with, it is not the same. There someone from Controlling needs to open it, update it manually, and then you can see it on the Power BI report. The process is not automatic. So, on the back-end, the system was not really good. But on the front-end side, I think it is OK. Of course, we have some issues, such as having a slow network, IT limitations, hardware issues, so it is not perfect, but I think it is a good way forward.

TILEN BURGAR: What would you say were some positive impacts on work in the plant?

INTERVIEWEE 8: Firstly, that we kept the same KPIs and logic that we had before on the paper shop floor. I think the accessibility is very important. I can easily access it from my desk and do not need to walk down to the shop floor to read a printed graph or KPI. I can also easily see when it was last refreshed and also who is responsible for the report, so if it is not up to date, I can ask them where the problem is. Then, the drill down functions are also important. With the old analogue charts, we had no drill downs and no possibility to see why something happened. If you can drill down to more granular data, you can maybe identify why an indicator is red (i.e., negative). From this 1-3-10 logic, where you should be able to identify if an indicator is red or green in 1 second, see the reason in 3 seconds, and prepare countermeasures in 10 seconds, we do not have this yet. We currently have the 1 and 3, but the 10 is lacking. Of course, when promoting the system, we sold it in a way that we will also achieve the 10. The possibility is there with digital solutions, but maybe Power BI also has some technical limitations, where some things are not possible.

TILEN BURGAR: Did you see any negative impacts of implementing DSF?

INTERVIEWEE 8: The set up. From a financial perspective a digital shop floor is not cheaper than an analogue one, it is more expensive. You need the hardware, the people with the IT know-how to build it, and so on. It is also more complicated, because you need to deal with technical issues, access rights in the plant and so on. But how it is currently set up with the links and everything, is good. Another thing which is not nice is the screen resolution issue, but this is a Power BI issue, and it has nothing to do with the digital shop floor itself. During this benchmark phase we saw different digital shop floor solutions. At Siemens for example, we saw a very cool digital shop floor, which had a very similar Monday to Friday logic and all the data. But it was built on their own platform. It was very fast – so they clicked on something and they immediately had the data. With Power BI it is not as fast – you click something and you have to wait 5, 10 seconds, and then it opens. This is something which is also important in my opinion, that you can work with it and it brings benefit for you, and you have common data, which is the same for everyone. We had once the problem that when I looked into the report, it showed me different data than the dashboard did, and then you don't know which is correct. So having a common source of data is really necessary for a good shop floor.

TILEN BURGAR: You mentioned that you compared Power BI and Solunio, were there also any other solutions that you also compared?

INTERVIEWEE 8: No, I do not think so. I think we only saw these two. We saw that Power BI was becoming more popular in this time. We first tried it with Solunio because it looked very nice – they had some eye-catchers. For example, you could see a forklift driver in the plant on the bird-eye view. In the end, our network here was not capable of that. But this was cool. You could also see the work-in-progress. You could see a machine and how many packages were wating to be completed on each. But of course, GKN put millions into developing this, so it was a really large investment.

TILEN BURGAR: When this was implemented, what were some of the reactions from the users?

INTERVIEWEE 8: At the first rollout, the accessibility was an issue. Then, we also did not have the hardware components, the touch screens did not really work properly. Logging in and out also did not work properly. But then, when people worked with it, I think the feedback was OK. On the other hand, we had some problems with the data, some of it was not correct and we could not explain why. The Controlling Department then always had to investigate why the data was wrong and deliver new data. So, we had the typical problems of going from the pilot to the live phase. I think nowadays, when I walk through the plant and I see that the shop floor is running everywhere, I think it is OK.

TILEN BURGAR: Was there any reactions like someone who really did not want to use it and was super against it?

INTERVIEWEE 8: I think not, I did not hear of anyone not liking it. I mean, we did not suddenly stop having the analogue version. We had a hybrid system where we had the screens, but still the printouts were available. Nowadays, most of the KPIs come from the system digitally, and only some minor ones are done manually in Excel and printed out. For sure we also have the print outs that are legally required, like safety instructions and so on. I think having this hybrid version was a good idea.

TILEN BURGAR: What was the initial plan or process of showing it to the users?

INTERVIEWEE 8: I think we started with two or three places in the plant on Level 1, and then later we also brought it to Level 2 and 3. The shop floor did not really change – from one day to another there was a new screen and the KPIs were visible there. I am not really sure, because at this time I was not really working on the project anymore.

TB: Was there any trainings for it?

INTERVIEWEE 8: I think so, yes. We did not really have participations lists of who attended, but we held them and explained the functions of the system. The functions were displayed and shown to the people, and from then on, the coaches worked on it.

TB: Would you say its voluntary or mandatory for the users to use the DSF nowadays?

INTERVIEWEE 8: I think it was a good progress to get to the digital shop floor and I think we should definitely stay with it, because having the same data in each unit is important. For the people in the plant, I also saw a lot of them working with it and discovering something new. The capability of having a digital whiteboard is also used in the plant nowadays. In the diamonds unit we also use the Smartenance software on the digital boards, where the machine operators can see all their daily checklists. You can see all the machines listed, and all the tasks that have been done and need to be done today, such as cleaning, changing tools, etc. These things are now available because we have the hardware. We have the screens in the plant, which we can use for different things. This is better than having analogue boards. This are the capabilities that having a digital shop floor brings you.

TB: Who is the group in the plant who gets the most value out of it?

INTERVIEWEE 8: In my opinion the leadership team. During the shop floor meeting the leadership teams on Level 2 or 3, and the coach on Level 1, get the most use out of it.

TB: Is it only used in the context of the shop floor meeting or do people also use it outside of that?

INTERVIEWEE 8: I use it for preparation for the shop floor meeting. So, I can go inside and look for what to expect for today, so that I can prepare. So, it is good for preparation. For analysing, it can be, but we soon end up in the raw data, for making better analyses. For example, to analyse, I need to compare. Only having information on the defect costs does

not tell me anything, I need to compare it to the job order, the production where it was running, the people who worked on it, and so on. The comparison is what makes good analyses. When I currently look at the digital shop floor, you cannot really compare it, I just see the material and the job order and the date. For that, we would need to have more interactions within the data, but this is something for set up of the digital shop floor. I think the digital shop floor nowadays is similar to our analogue shop floor in the former times. When I saw the Solunio version for example, it changed the whole shop floor mentality. This was a cool thing and this is something we did not manage very well. So, we just copied the analogue reports and rebuilt them for the digital version, and at GKN Solunio really changed everything. They started the meeting with a screen only showing the Monday KPIs and the AIP list for Monday. Then, you could record something and store it. It is kind of like what we do when we click on 'Monday', but there is no workflow in it. So, they changed the way they work when they implemented the digital shop floor, and I think this is something that did not happen here.

TB: So, this would be the next step?

INTERVIEWEE 8: Exactly, this would be the next step. This was in my opinion just a copy of the system we had before to Power BI. For sure, some of the reports were completely new, such as the OEE report or the Variable Costs report. But it is good, for most of the KPIs I like that I can immediately see if they are red or green – do I have to worry or is everything OK. And this is good in my opinion.