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UTILISING INTERNET OF THINGS IN DEMAND PLANNING PROCESS: CASE KALMAR

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Pro gradu -tutkielma käsittelee esineiden internetiä (IoT) ja sen käytettävyyttä yksittäisen kysynnän suunnitteluprosessin parantamiseksi. Tätä tutkittiin laadullisella suunnittelutoimintatutkimusmenetelmällä (ADR) kahden hypoteesin avulla, joiden kautta mitattiin ratkaisun sosiaalista ja teknistä vaikutusta. Tutkimuksen kohteena oli tapausyritys Kalmarin työtehtävä, jossa käsiteltiin pilvipalvelusta saatavaa dataa. Tavoitteena oli luoda yritykselle IoT-pohjainen ratkaisu, jonka jälkeen käsin tehtävää työtä ei enää vaadittaisi ja niihin käytetyt henkilötyötunnit voitaisiin vapauttaa muihin tehtäviin. Teoreettisessa osuudessa syvennyttiin kahteen aiheeseen: IoT ja kysynnän suunnittelu. Tutkielmassa avattiin niiden käsitteet ja nostettiin esille niihin liittyviä haasteita ja hyötyjä. IoT esimerkiksi on vielä alana globaalisti jakautunut eikä sen määritelmää ole standardisoitu. Jakautuneita käsitteitä selkeytettiin kokoamalla yhteen kuvauksia IoT:sta eri näkökulmista, jotta lukijalla on selkeä kuva tutkimuksen sisäistämiseen. Kysynnän suunnittelu on puolestaan jokaisen tavaroita tai palveluita myyvän yrityksen kulmakiviä. Siihen liittyvät päätökset kertovat onko yritys esimerkiksi keskittynyt tavaroiden välittämiseen, valmistamiseen vai myyntiin. Palvelupuolella siihen kuuluvat päätökset myyntiä tukevan kapasiteetin hallinnasta. Tällaisia ovat muun muassa päätökset pilvipalveluiden serveri hallinnasta tai tapahtuman henkilöstösuunnittelusta. Itse tutkielman ratkaisu muodostui tietojärjestelmätieteen, IoT:n, kysynnän suunnittelun ja tapausyrityksenä olevan Kalmarin kokonaisuuksien tuntemuksesta. Tutkielman tulos mitattiin kahdella mittarilla; sosiaalisella ja teknisellä, joista sosiaalinen puoli arvioitiin haastatteluilla ja työtunteihin kulutetulla ajalla, ja tekninen puoli mitattiin IT-ratkaisujen määrällä ennen ja jälkeen prosessimuutoksen. ADR -menetelmää käyttäen pro gradu -tutkielmassa rakennettiin uusi interaktiivinen sivu, jossa yritys pääsi tavoitteiden mukaisesti yhtenäistämään prosesseja ja hyödyntämään keräämäänsä dataa ilman ylimääräisiä työvaiheita.

Avainsanat: Huolintaketjun hallinta, inventaario suunnittelu, Esineiden Internet, myynnin ennustus prosessi, prosessien automatisointi

ABSTRACT

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Utilising Internet of Things In Demand Planning Process: Case Kalmar
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The purpose of this master's thesis is to study the Internet of Things (IoT) and utilising it in a single inventory planning process. The study was carried out with a qualitative Action Design Research (ADR) method with two hypotheses that measured the social and technical effects of the outcome. The case study was focused on a manual task that utilises cloud data. The aim was to create an automated IoT based solution that will eliminate unnecessary process steps and release those working hours that are used on it. Theoretical main areas were IoT and demand planning. The study opened up their conceptions, challenges and benefits. IoT, for example, is still divided globally, and there is no international standardised definition for it. This master's thesis includes IoT conceptions from various publications and attempts to build a clear picture for the reader in order to internalise the study. Demand planning, on the other hand, is one of the cornerstones of every organisation that sells goods and/or products. Decisions related to inventory control are a significant part of organisations' strategy. They determine whether an organisation deals, manufactures or sells goods. With services, decisions include controlling that capacity that supports sales of services. These can be server ownership questions or booking staff for an event. The solution itself was created based on knowledge from information science systems, IoT, demand planning and case company Kalmar defined elements. The study was evaluated with social and technical hypotheses, where the social aspects were measured via interviews and the number of working hours used, and the technical hypothesis was evaluated based on IT solutions needed before and after the process change. With the ADR method, an interactive site was built where the company can benefit from the streamlined process and utilise the data it collects without unnecessary steps.

Keywords: Supply chain management, inventory planning, Internet of Things (IoT), sales forecast process, process automation

GLOSSARY

BIE	Build, intervene and evaluate (ADR method stage 2)
ERP	Enterprise resource planning (system)
IoT	Internet of Things
LOB	Line of Business
ROP	Reorder point (of goods)
SAP	ERP system
WIP	Work in progress

FIGURES

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1 INTRODUCTION

This master's thesis studies the benefits of Internet of things (IoT) and especially IoT in demand planning and proactive forecasting. The importance of IoT is globally exploding, and it is considered the most disruptive technology along with artificial intelligence and robotics (PwC, 2018). IoT consists of identifiable items, which are connected through a wireless network (Welbourne et al., 2009). IoT can be formed with multiple sources like RFID tags, sensors, and mobile phones (Atzori, Iera, & Morabito, 2010). IoT's benefits include real-time analytics, human-to-human and machine-to-machine communication, new product and service offering possibilities, and optimised customer service (PwC, 2018). Harvard Business Review noted similarly that IoT not only brings billions (USD) in revenue but also cost savings and service customisation (Reddy, 2016). An example of such improvement is Harley Davidson's factory that was able to cut down production time on customised bikes from 21 days to six hours (Reddy, 2016). That is a significant improvement and speaks to the volumes and possibilities that IoT can offer to businesses. This research uses a case study to utilise the benefits of IoT to remove manual work. The case company has IoT platforms, but those are beneficial to demand planning only through manual steps.

The case study itself in this thesis is carried out in cooperation with a cargo handling company. With the information and support provided by them, the study researches whether IoT can be used to change into a proactive data processing compared to the original reactive one. The original method relies on active human interference to avoid stock-outs. Stock-outs decrease customer satisfaction and overall performance. The case organisation's interest in this study is, therefore, to find out if that step could be automated and if they can remove the slow and multi-person involved comparison by different departments. The current step-up is not only time consuming, but it decreases the benefits of IoT applications and devices case company already has. An ideal solution would save working hours, decrease stock-outs, and improve productivity.

To find out if automation can be accomplished, action design research (ADR) with social and technical evaluation aspects is used. The study opens up the current process, and then by creating a new solution, it aims to discover a more user-friendly and time-efficient way to handle the said process.

The hypotheses of the study are: "Implementing a single IoT step will decrease human effort" and "Implementing a single IoT step will decrease the number of IT solutions needed". The first hypothesis aims answer to the social aspect of the study, and the latter one will focus on the number of technical solutions used. Academically, the main goal is to study what kind of socio-technical benefits utilising the current IoT set-up can bring in one single process. Another goal is to formulate a class solution that will help in similar problems.

This master's thesis consists of two main parts: a narrative literature review and a case study. Literature findings were searched mainly from JYKDOK and Scholar. Materials were selected based on two criteria. Either the source had to be peer-reviewed, or it had to demonstrate business value to the case company. Business sources demonstrated mainly practical benefits and challenges that were not found in academic literature research. The narrative review begins by introducing IoT in the next chapter. That is followed by demand planning (Chapter 3). Chapter 4 after that, has three sections; it concludes the interest for IoT in demand planning, reviews literature findings, and explains the need for the study. The literature part is followed by empirical research; Chapter 5 presents the selected research method: Action Design Research (ADR). This is continued by the presentation of the case organisation, the current solution as a case study subject, and the design of the new solution (Chapter 6). Chapter 7 presents study results: it discusses the two hypotheses and includes the study results and limitations. Chapter 8 summarises the conclusions of the study.

2 INTERNET OF THINGS

Internet of things (IoT), as explained in the introduction, consists of devices, which are connected via wireless network (Welbourne et al., 2009). IoT has also been defined as “sensors and actuators embedded in physical objects are linked through wired and wireless networks” (Lueth, 2014). Vermesan and Friess (2011) wrote that IoT is used to create self-aware systems with smart environments, like smart cities. The name Internet of Things was first presented in 1999 when RFID technology was promoted, but it became popular nearly ten years later, around 2010, when IoT started spreading (Lueth, 2014). IoT term is often connected to machine-to-machine communication (M2M), Web of Things, Industry 4.0, Smart systems and other similar topics or alternative names. (Lueth, 2014). The International Telecommunication Union (ITU) listed that IoT has five fundamental characteristics that are interconnectivity, things-related services, heterogeneity, dynamic changes, and enormous scale. Interconnectivity means that within IoT, anything can be connected to information and communication infrastructure. Things-related services assume that physical things and their associated virtual things provide services. Heterogeneity stands for the possibility of variating devices to interact with services and devices that are in different networks. Dynamic changes are changes in power, connection, and location. For example, smart lights can wake up/sleep while detecting movement, devices can turn on/off based on the internet connection, and GPS’ in cars are constantly working on the move. The last characteristic feature of IoT, enormous scale, refers to the number of devices and the amount of communication they can produce compared to previous technologies (ITU, 2012).

The following sections include IoT’s architecture (Section 2.1), use in everyday life (Section 2.2), use in organisations (Section 2.3), challenges (Section 2.4), and its importance in the future through its benefits (Section 2.5).

2.1 Internet of Things' architecture and distribution style

Architecture is the structure of anything constructible and can be used to rebuild the original version. Kruchten defined in 1995 software architecture as the dealer of the design and implementation of the high-level structure of software that works with abstraction, decomposition, composition, style, and aesthetics. Architecture in general context can be referred as the formation of elements that support each other to build an entity. In addition, it can be used to find weaknesses, strengths and calculation points. A well-built architecture enables organisations to save time, effort, and costs, and IoT's architecture is not an exception to that. In order to function, IoT requires components that are built on software architecture (Ricquebourg, 2006). Applications transform the fed data into a form that is useful for the user. The most common IoT architecture is layer architecture (Muccini & Moghaddam, 2018), where each layer represents a building block. Other types of IoT architectures besides layers that Muccini and Moghaddam presented are cloud based, service oriented, micro services, restful, publish, and information centric working architecture. Cloud based architecture has clouds as the core with big data processing and contextual information sharing. Service oriented architectures have the main application as the service enabler to IoT components. Micro services are independent, small, and agile architectures. Restful one is what the Internet is based on. The network of restful is decentralised, reusable, and large in scale. Publish type relies on open messages that can be subscribed to. Information centric networking architecture operates to provide intelligent communication (Muccini & Moghaddam, 2018).

With IoT, there is neither a global agreement nor a standard for the architecture, but the one by ITU (an agency within United Nations) is widely used. ITU's purpose is to provide global recommendations for standardisation. The agency divided IoT into four architectural layers: (1) application layer, (2) service support and application support layer, (3) network layer, and (4) device layer. (ITU, 2012). Three of the layers have two different capabilities listed. Each capability provides something that data processing needs. The device layer has device and gateway capabilities, the network layer has networking and transport capabilities, and the service and application support layer has generic and specific support capabilities. Capabilities are explained in Table 1 below, which is constructed using ITU's (2012) model. Each layer has an example(s) of a component that could operate in said layer. The main idea in ITU's and other IoT architectures is that one needs a device that can be connected, a network that transfers the device's data, some type of service that processes and stores the data, and an application that presents the information/data in a usable form. For example, in a fridge, one needs a sensor to detect the temperature, an internet connection to send it, and an application that gathers the feed but can also be used to monitor and view the data. In some cases, the (1) application layer comes from the same provider as (2) the service support and application support layer and 4) the device layer. Many products for common consumers are like that. If an individual buys a smart watch for health tracking, it is standard that the same manufacturer has created or owns the application for its usage. In the said application, one can see real-time data of their activity but also track their records and history. In such cases, consumers have no need to buy services separately, only have an internet connection that enables the features (layer 2).

TABLE 1. Examples of components that are divided into layer IoT architecture. Gathered by the author.

Layer in architecture	**Short description of layer's purpose**	**Example(s) of a needed component for IoT**
Application layer (ITU, 2012).	Gathers information/data from different sources, presents in a preferred form.	QlikView, QlikSense and health trackers.
Service support and application support layer (ITU, 2012).	Can monitor, control, and adjust connected devices. Generic capabilities: data processing and data storage. Specific support capabilities: enable various requirements like e-health (ITU, 2015).	A cloud or a smart service. Amazon Web Service (AWS), Google Cloud
Network layer (ITU, 2012).	Networking capabilities: Control functions for connectivity (ITU, 2012). Transport capabilities: Access and transport for IoT service and application specific data information (ITU, 2012).	TCP = Transmission Control Protocol, Ethernet
Device layer (ITU, 2012).	Gateway capabilities include the possibility to connect to controller area network (CAN), Wi-Fi, Bluetooth and other technologies. Device capabilities include sending, receiving, gathering, and uploading information. In addition, devices may have sleep/wake-up functionalities (ITU, 2012), like security cameras becoming active on the motion.	Smart devices like sensors, RFID tags, and cameras.

There are alternative models for ITU's (2012) layer structure. Depending on the source, the number of layers varies between 3 and 6 (Muccini & Moghaddam, 2018). Following three architecture examples were chosen to provide a comprehensive overview from an organisational, an academic, a scientific, and a business point of view and one can conclude that even though IoT has not yet been standardised globally, studies agree on a similar architecture. Matharu, Upadhyay and Chaudhary (2014) presented their view on International Conference on Emerging Technologies (ICET). Lee and Lee published their view on the architecture on Indiana University's Business Horizons, which focuses on important business issues. Gubbi et al. (2013) presented a version in "Future generation computer systems" (FGCS) journal, that has been highly used by peer-reviewed publications. In the following table, the three models are aligned with ITU's to provide a comparison of views.

TABLE 2. Elements/layers of IoT from four architectural models. United and merged by the author based on descriptions.

ITU, 2012	**Matharu, Upadhyay and Chaudhary, 2014**	**Lee and Lee, 2015**	**Gubbi, Buyya, Marusic and Palaniswami, 2013**
Application layer	Application layer	IoT application software	Visualisation
Service support and application support layer	Middleware layer	Middleware	Addressing schemes
		Cloud computing	Data storage and analytics
Network layer	Network layer	WSN	WSN
Device layer	Perception layer	RFID	RFID

Besides the architecture, IoT's structure varies depending on the way of data distribution. There are four styles in classification: centralised, collaborative, connected intranets, and distributed (Muccini & Moghaddam, 2018, Roman et al., 2013). The centralised style is the most common one, and it relies on a cloud, server or fog network (Muccini & Moghaddam, 2018, Roman et al., 2013). Many organisations use it, as they refuse access to IoT applications unless the user is logged into the company's server. The opposite of the centralised style is the distributed style, which consists of various entities that work together and are unknown to each other (Roman et al., 2013).

2.2 Internet of Things in everyday life

IoT environment is not tied to organisational machines to work as it can be set up by any individual who owns smart devices (Rouse, 2018). If one thinks about common consumers, they can create IoT solutions like smart homes for themselves. A smart home means creating a space that uses computing and information technology to provide security, entertainment, convenience (ease-of-use), and comfort (Harper, 2006). Different smart home service providers can offer technological control over anything from lighting to heating (ComfyLight, 2018, Webasto, 2020).

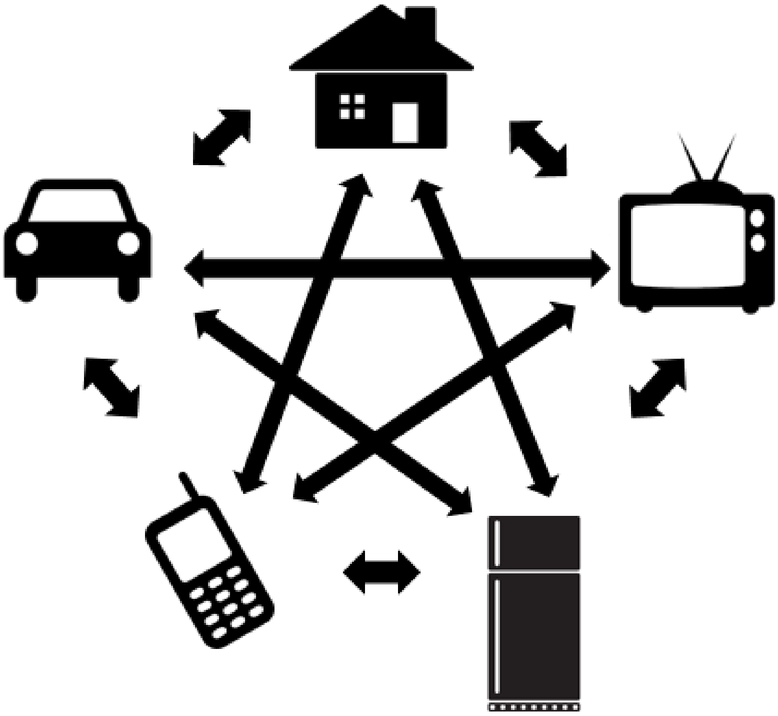

FIGURE 1. Example items in IoT environment. Individual object graphs from Pixabay, 2020.

Phones are a typical example of an end-user IoT system controller (Rouse, 2018). They can monitor various devices like house appliances and vehicles. If an IoT network is set up in one's car, users can enjoy features like preheating cars' inside temperature and the engine, receive information when the temperature is at the preferred level, and even track the car's location. Set up like that only requires a box with a SIM card and an application. As for home, there are categories like security, house appliances, and entertainment. Television programmes can be recorded remotely, and a fridge can send an alarm if the temperature is too low or even send pictures of the content (Samsung, 2020). As for security, systems can inform of an unauthorised entry, and the entry warning can start a video recording at home and send it to a phone or call the security directly (Verisure, 2020). Home security systems can even imitate one's movement around the house with lights, so it seems like somebody is at home (ComfyLight, 2018). In governmental aspects, IoT can be used in health care, crowd monitoring, traffic management, infrastructure monitoring, and in providing water, building management, and environmental services (Gubbi et al. 2013).

Besides consumers, organisations use IoT appliances every day. Research and advisory company Gartner listed in 2016 IoT technologies for organisations to include many of those that consumers have and some others. Suitable solutions for businesses are security, analytics, device management, short-range

IoT networks, wide-area networks, IoT processors, IoT operating systems, event stream processing, IoT platforms, and IoT standards and ecosystems. These were regarded as aspects that will affect strategies, risk management and technological aspects of organisations if implemented (Gartner, 2016). If one considers security, many companies use access control with individual access cards to track movements and time. Cards help automatically to determine whether employees are using office hours or, for example, over-time (JotBar Solutions Oy, 2017). For event stream, individuals and businesses can use applications like Zoom, which is Microsoft's IoT solution. As for IoT platforms, they include global operators like Qlik, Google Cloud, IBM, and Salesforce. Based on the width and extensiveness of IoT services, it can be concluded that many use IoT to some extent every day.

2.3 Using Internet of Things within organisations

Besides the daily use, IoT can bring structural changes to operating models when it is benefitted more widely. Organisations can gain from data in IoT architecture, for example, by creating a smooth data flow that provides information not only to customers or the organisation itself but also to suppliers. Such data flows can begin from any source applicable. The operating system can be one of the sources, and the data they provide becomes useful when it is connected to another information source in the system via an interface device (Chi, Yan, Zhang, Pang & Da Xu, 2014). Such a system knows what the told input means; like if the operating system indicates that machine hours are reaching 5 000, a system has the knowledge to indicate that the machine needs a new maintenance kit. Without further connectivity, the machine cannot act with that data alone, and operators need to order the parts themselves once they see that hours are closing in on a maintenance spot. Such actions demand a lot of management with large fleets of machines. However, if connectivity is existing the input goes forward, and it can create a purchase suggestion or a purchase order for the customer before the need is at hand. If there is no stock available in the organisation for the item in question, the enterprise resource planning (ERP) system will order those parts from suppliers, and the business can start stocking immediately, proactively.

Figure 2 shows how the data could run in the network. Based on possible future sales, the system creates a sales order for the supplier and then it can create a purchase order suggestion to the customer. That is one example of how an item can communicate information forward that other parts in the network can use to create suggestions, give alarms and error codes. The IoT network, therefore, operates to both directions and prepare organisations' to demand and supply before the need is urgent. The knowledge before an incident or demand gives an advantage in the market, and that (among other benefits) cause IoT to be attractive to organisations.

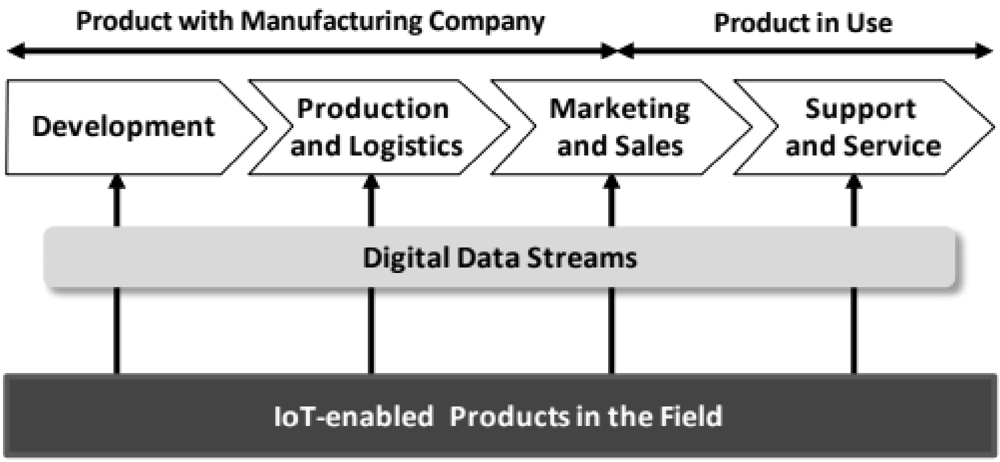

FIGURE 2. IoT covers and produces data for the whole supply chain from customer usage to future development (Bilgeri, Gebauer, Fleisch, & Wortmann, 2019).

There are situations where a machine can simply provide an alert or have a light go on, and IoT has no immediate advantage to organisations or the supply chain. For simple maintenance, the gap might not be big between manual knowledge and automated answers, but when issues get more complicated, and errors are detected in complex machines, IoT can become widely beneficial. In consumer cases, cars have both types of notification, simple and complicated. If a car's fuel light goes on, a driver knows to refill, but if another more unknown light goes on, one might need the car's computer system to be connected to another source in order to know how to proceed with a light or an error message.

That kind of connection can forward data to the manufacturers, which then provide support or spare parts. Data could then be utilised in quality improvements with suppliers and in preparations for parts. That provides car manufacturers valuable business information. The same is true with terminal machinery. If the battery is low, a light can suggest that and problem can be solved easily by recharging. On the other hand, if the operating system would need to indicate a more detailed issue, then the lights are not providing enough detailed information about the problem. The case study focuses on what happens when there is an indicator of a need and how the case organisation, suppliers, and customers could prepare for it more proactively with IoT. IoT, however, comes with its own obstacles and challenges.

2.4 Challenges of Internet of Things

Technology's development has rapidly lifted IoT to a high priority, but its beneficiaries still have to face the challenges that come with it. IoT's challenges can be divided into structural, device- and user-related challenges (Khan and Salah, 2018, Matharu, Upadhyay and Chaudhary, 2014, Gartner, 2016, and PwC, 2018). Gartner (2016) stated that IoT requires new technology and skills in organisations. Setups, devices, and service providers are yet immature and implementing IoT will come with obstacles (Gartner, 2016).

Matharu, Upadhyay and Chaudhary wrote in 2014 a paper on "Challenges and Security Issues of Internet of Things". According to them, IoT has many security aspects that require further research. The security issues are different in each layer of the previously presented IoT architecture. See Figure 3 below for details.

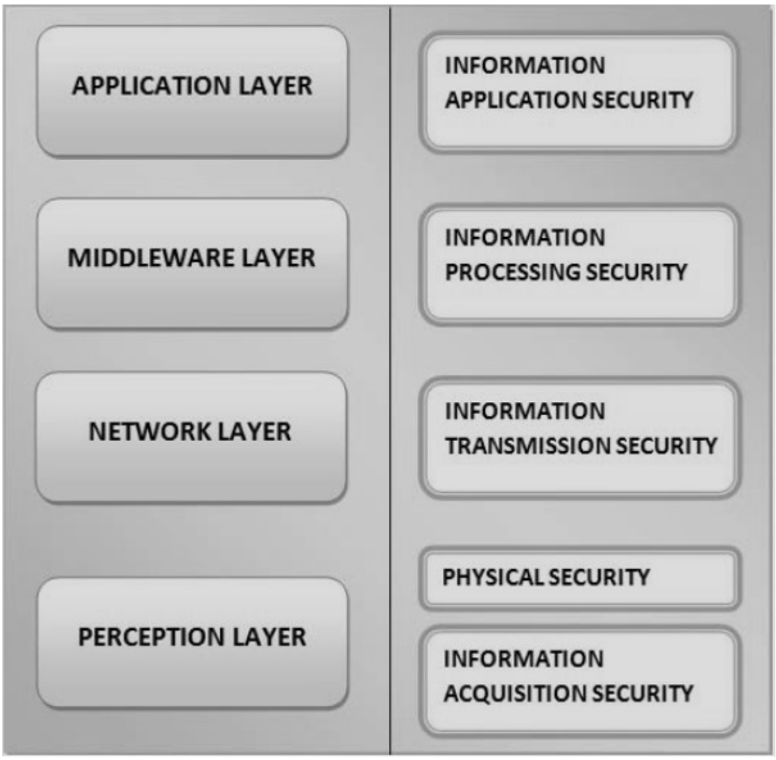

FIGURE 3. Security issues in IoT architecture by Matharu, Upadhyay and Chaudhary, (2014).

This architecture, as stated before, varies to some extent from the one presented before by ITU (2012). It describes how various challenges are divided into layers according to the structure. Matharu et al. presented that problems occur as information goes through the network. To improve IoT security in any layer, its requirements have individual challenges that must be acknowledged first. Challenges exist in 1) connectivity, 2) differences in devices, 3) naming and identifying objects, 4) unintended access and safety, 5) unauthorised interference of data transference, and 6) collection of relevant data (Matharu et al., 2014). Next, the six challenges are discussed in more detail.

Firstly, connectivity affects IoT structure a lot, as it relies on the connection between devices. If the internet is lost, the system cannot operate as it should and communicate. Matharu et al. suggest using devices that use energy mechanisms to better connectivity. Secondly, in their study, there is the issue of varying products from multiple suppliers. Items that are produced by different companies are not necessarily compatible and need standardisation. ITU characterised that IoT devices are heterogeneous, but they still should be standard enough to be able to operate together (ITU, 2012). Thirdly, as millions of objects are connected globally, they should be identified individually, but currently, there is not enough address space (Matharu et al., 2014). Qin et al. (2016) also noted that searching for individual objects from the Web would be important in the future. Authors Matharu et al. (2014) suggest taking IPv6 protocol to use to solve the issue. The fourth challenge concerns the security of the objects. Many devices can be placed in positions that are critical for their functionality (like water plant control devices), but if unauthorised people access them and have the possibility to damage or alter them, consequences can be catastrophic (Matharu et al., 2014). Devices in important locations should be protected manually with fences or other physical means that are not vulnerable to IT attacks and can protect data's reliability. The fifth challenge comes with data's protection. One should place security mechanisms and encryption on the transference of data to ensure that a third party or anyone else cannot alter or misuse it (Matharu et al., 2014). VPN is commonly used to secure data flows. 6) Lastly, Matharu et al. (2014) point out that one should only gather relevant data from large databases to optimise data amounts. ITU (2012) also noted this as communicating devices produce enormous amounts of data, and its management is a crucial activity.

Khan and Salah (2018) found similar challenges and solution suggestions in their study "IoT security: Review, blockchain solutions, and open challenges". Firstly, they suggested encryption to secure devices and information as information goes through the network. Their idea is similar to what Matharu et al. in 2014 suggested. Secondly, Khan and Salah point out the need for authentication, authorisation, and accounting. Each party that is involved should be authenticated and authorised to secure access, but the global protocol is missing (in 2018). Thirdly, they point out service availability. Denial of service is one way to decrease the quality of service (Khan and Salah, 2018,) and that causes IoT to be less attractive for end-users (Hill, 2018). Another weak point is energy efficiency, as IoT items are generally low powered and can be overrun by high-energy peaks. As a network of multiple objects, IoT is also vulnerable to single-point failures (Khan and Salah, 2018) when connected objects can have various levels of security within. To summarise, both Khan and Salah (2018), and Matharu et al. (2014), acknowledge that IoT architecture has weak points that are open to attacks that can expose entire layers or even the entire structure to miscellaneous intentions.

The consulting company PwC published a presentation with sections about IoT in 2018. Sections are new digital technologies, IoT, real cases with IoT application, and business approaches to IoT. In the said presentation, they listed more practical and humane challenges that are associated with implementing IoT: (1) lack of IoT strategy, (2) security hazards, (3) interoperability within platforms, (4) scaling (from pilot phase to production), (5) understanding roles, (6) monetising and selling IoT, and (7) organisational issues; lack of skills, innovation, governance, and operating model. To avoid or minimise the listed challenges, one could begin by aligning IoT with business and pay attention to security from planning to use. The third point could be avoided by researching the platform connectivity before implementing solutions, then handling the fourth issue by scaling with a holistic view. To tackle the fifth point, organisations could define one's role in IoT (whether to buy or build the solution). The sixth issue could be faced pro-actively by communicating IoT to users, so it is appealing to them. The last, the seventh issue, can be faced by collecting a team of skilled personnel who are familiar with IoT implementations (PwC, 2018).

Orlikowski (1992), like PwC, noted humans as important factors in organisational adoption of technology. According to her, IoT, like other technologies, is a product created and used by humans, and it operates in a social context (Orlikowski, 1992). Therefore, human actions reflect on its productivity as well. Humans, human skills, global laws, guidelines, caution, security, and issues with product differentiations are aspects that must be considered. The implementations of new technologies can also bring unforeseen consequences and set organisations exposed to situations they are not prepared for (Orlikowski, 1992).

Besides data, people, and security challenges, one should not forget the challenges that may result after IoT is implemented. A secure IoT network demands the resources to operate. Security procedures require a lot of network, memory, resources, and endurance of various environments (Matharu et al., 2014). Data centres alone consist of software, hardware, power, and cooling, which require planning and resources (Banerjee et al., 2009). Centres also have an environmental impact that is globally noted (Banerjee et al., 2009). Organisations require notable resources to compensate above limitations.

Brous et al. (2020) wrote about IoT's further gains, which are diminished if there are no policies and guidelines to follow at use. The implementation might also restrain organisations unexpectedly. Farahani, Meier, and Wilke (2015) stated that using new technical solutions is challenging for already complex supply chains without limiting their capabilities along. The ease of IoT is short-lived if more manual work has to be performed to benefit from it. To gain an advantage, one should collaborate with their suppliers, customers, and partners to create a worthwhile situation for all parties (Farahani et al., 2015). That aligns with IoT data flow presented before, as full data access reduces the need for manual interference. The streamlined data chain should be customer-organisation-supplier, instead of limiting it to customer-organisation and then continuing with manual orders to suppliers. If not fully implemented throughout the supply chain, IoT cannot deliver all its capabilities and benefits. Deep level implementation comes with new risks. If organisations are not protecting data's privacy, it might spread and lead to public and even legal actions (Brous et al. 2020).

2.5 Benefits and future of Internet of Things

Despite the challenges, IoT has many benefits that have caused it to be attractive globally. As the research conducted is for a case company, the collection includes academic and organisational benefits from respected sources in each field.

Demand for IoT increases yearly due to cost-saving possibilities and rapidly spreading technical solutions. It is fast-tracked by the price decrease of technical hardware and megabits (PwC, 2018). The benefits of big data, clouding, and increasing device ownership contribute further (PwC, 2018). Interest towards IoT shows in surveys, according to Intelligent Enterprise Index by Zebra, 86% of the companies in their survey are planned to increase their IoT spending for the next year (from 2017 to 2018), and a rising number of respondents used IoT solutions to communicate with their employees more often than daily, (82% in 2018), (Zebra, 2018). Key findings from the next year, 2019, support the increasing implementation as average spending on IoT solutions grew by 39%, and real/near-real-time communication rose from 39% to 50% (Zebra, 2019).

IoT based smart solutions are also popular at health and governmental levels, as IoT is expected to aid in different challenges like energy harvesting, safety, and ageing population (Vermesan & Friess, 2011). According to Gubbi et al. (2013), solutions can be used to monitor crowds in case of emergency or to track movements in public places. IoT also provides the possibility of remote patient monitoring and intelligent transportation with real-time information and path guidance (Gubbi et al., 2013).

Forbes estimated that IoT market would be growing by billions of dollars (USD) each year (Forbes, 2018). IoT is also considered by PwC (2018) to be the most disruptive technology along with artificial intelligence, and robotics and it has been heavily invested in by organisations. KPMG's global survey supports the findings, as according to their survey's outcome, IoT will 1) drive the greatest business transformation, 2) enable the indispensable consumer technology, and 3) drive the greatest benefits to life, society, and the environment (KPMG, 2018). Various benefits explain the high value of IoT. The first one, business transformation, comes from the supply optimisation possibilities that IoT and IoT platforms provide. Optimisation possibilities are, e.g. "increased visibility, transparency, efficiency and meeting the ever-increasing customer expectations…" (KPMG, 2018, 4). As for consumer technology and markets, IoT gives consumers the possibility to control their own homes and devices and track their personal development through wearable fitness solutions (KPMG, 2018). IoT gives power to individuals on things that before required external assistance or were not available at all. To demonstrate, previously one could track their health at the hospital or other centres like clinics, but now basic body measurements and tracking is available through IoT solutions anywhere. As introduced in section 2.1, a watch gathers information and a smartphone can be used to scroll and analysis the data it provides. Studies have also shown that if individuals track their health related activities, they are more likely to finish those activities well. Oral's smart toothbrush and application, for example, encouraged users to proper brushing with detailed movement follow-up. Followed participants ended up brushing their teeth longer than regular toothbrush users (Lee & Lee, 2015). These combine partially to the third point. Through health and sports devices, smart city, and smart home solutions, IoT drives the greatest benefits to life, society, and the environment. Together with AI and robotics, IoT brings many new solutions like service robots (KPMG, 2018).

Gartner (2020) supports above findings as they stated that 63% of the companies that started IoT projects expected return on investment within three years and 61% of the companies they studied were already at high level of maturity with IoT. Those add to other results that demonstrate how organisations have noted IoT's business value.

Brous et al. (2019) concluded in their study that organisations get real-time and accurate knowledge to better their management, maintenance, and strategy. Big data will reduce costs when weaknesses within can be scoped better. They also noted that improved velocity and transparency would provide a better service and public image and regulations are easier to enforce. IoT might even open up new revenues from the holistic point of view, and when data sources become more heterogeneous, planning is more efficient (Brous et al. 2019).

Carcary et al. (2018) wrote a systematic literature review on IoT's benefits and challenges in which they divided their findings into the UTAUT model. With categorisation of performance expectance, effort expectancy, and social influence, they noted that real-time data visibility/sharing, improved business analytics/decisions, and enhanced efficiencies were mentioned several times as expected benefits. However, it is important to note that the challenges with lacking standards, security, and privacy were mentioned in the literature even more often. (Carcary et al. 2018).

Supply chain management, which is the case study industry, is among the top industries to apply IoT in end-to-end solutions (Forbes, 2018). Statista published in 2020 an estimation of IoT global spending figures by industries. Transportation and logistics was sharing the lead with discrete manufacturing by yearly spending of 40 billion US dollars (Statista, 2020). Those figures align with the previous findings. Matharu et al. (2014) listed possible IoT applications in the logistics industry to include supply chain control, smart product management, item tracking, fleet tracking, real-time traffic information, and route guidance. Sundmaeker (2014) noted that IoT could provide streamlined demand-supply ratio when suppliers have access to real-time stock situations. (See Section 2.3 Using Internet of Things within organisation). In the case study, the demand-planning side of logistics is studied, and Sundmaeker's notion of meeting supply and demand is at the core.

3 DEMAND PLANNING

Saffo defined demand planning, also referred to as forecasting, as following "forecasting aims to give information for the future based on current data and it must have a logic that can be defended" (Saffo, 2007). Demand planning can be divided into two main types: service and goods. The planning of each of them varies, as their consumer product is different. Services attend to provide experiences where tangible aspects are supporting the intangible ones, and with goods, it is vice versa. The following subsections introduce both of them briefly and then open up demand planning in supply chain management with more details. Demand planning includes calculations, item categorisation, environmental factors, and rules.

3.1 Demand planning as a part of service management

Services are intangible artefacts that are produced based on demand. They are created when a producer and a consumer are present (Gadrey, 2000). For common consumers everyday services include energy, cloud services, and live entertainment. Demand planning is focused on elements that are behind the scenes. Tangible parts are not at the core of what customers pay for, but they can be used to differentiate from competitors. Energy is an everyday service, but to provide it companies have to maintain power plants and power networks. In events, organisations have to plan resources like personnel and beverages. Personnel of service providers are those that change goods into income (Gadrey & Delaunay, 1987). Demand planning for services is a blend of tangible and intangible elements that can be shaped for branding purposes, like providing tablecloths with restaurant names. The service is produced, distributed, and consumed in one moment, and it cannot be repeated in the same exact way again. It is not possible to store or move services (Gadrey, 2000). Another social aspect of service is queuing. Customers tend to dislike it and can change their minds about buying the service if they have to wait a long time to receive it (Slack, Chambers & Johnston, 2010). Therefore, the service provider can plan their resources based on upcoming demand to avoid that. Services are often consumed in a social context (Gadrey, 2000), where relationships between the consumer and the service provider are part of the quality.

The inventory of the tangible goods can be well organised for high-end services, but often organisations focus on the intangible, which is their core business. In supply chain management of goods, the focus is on getting physical items ready for consumers and therefore, their planning varies from service.

3.2 Demand planning as a part of goods management

Unlike services, goods are tangible, and consumers can purchase them again. Goods are owned by an individual, either the producer or the buyer, and they exist without social relationships (Gadrey, 2000). Organisations lack a personal relationship with the consumer while they use the goods, so getting the items in the agreed condition is valued more than social relationships. Conditions are often price, availability, and quality. Differentiation can be performed with price and delivery times, just like with services, but the structure is different. Feedback is received after receiving the goods, and if the customer is not happy, organisations can orchestrate corrective methods like reproduce the item for the unsatisfied customer again. With goods, the customer is also entitled to return the goods or alter the purchased items themselves. Delivery time is a competitive advantage related to supply chain management.

3.3 Demand planning; a part of supply chain management

Due to fast developing technology, supply chain management is under disruption and as a part of that, demand planning is changing as well (Palsule, 2020). Supply chain management as a whole includes all activities within product delivery as one system entity (Hugos, 2018). Demand planning ensures that availability is at an ideal level in relation to holding, ordering, and shortage costs. Maintaining a large stock serves customers and sales, but that leads to increased operating costs and the increased need for storing space. Examples of operating costs are labour and scrapping of rusted items. Finding the balance for all the aspects is at the core of inventory planning (Hugos, 2018). Other parts of supply chain management consist of day-to-day operations at the warehouse, like receiving and shipping of goods, forwarding, and purchasing. Every business decides in their strategy what kind of storing they are capable of and interested in, while choosing how many and how much products to hold at hand. There are five key points to consider in supply chain. Those are inventory, production, location, transportation, and information (Hugos, 2018). These points and related decision areas are described in Table 3 below, and their significance is addressed next.

TABLE 3. Five areas to consider in the supply chain (Hugos, 2018)

Point	Related decision areas
1) Inventory	Raw materials, semi-finished, finished, WIP and ROP
2) Production	Capacity, quality control, workload, and equipment maintenance
3) Location	Production and inventory locations
4) Transportation	How to move products? Via truck, air, rail or sea?
5) Information	Which data should be collected, kept, shared, and investing in IT?

Some companies are known specifically for their smooth supply chain and optimised inventory planning. Organisations use technology to differentiate themselves from competitors. Well-known examples are Amazon and Wal-Mart (Green, 2019). Amazon uses various IoT solutions, which enable offerings like sensor fusion stores where one can shop simply by walking through the store while taking and leaving items on the shelves (Amazon, 2020). Such automation decreases salary costs, manual labour, and provides real-time information to automated planning. Wal-Mart, on the other hand, asked their major partners and suppliers to mark every case with a RFID tag so they would get a holistic view of their supply chain (Wal-Mart, 2004). They reported later that, for example, the tracking of certain fruit changed from seven days to 2.2 seconds. (Naidu & Irrera, 2017). Amazon and Wal-Mart operate their demand differently from each other and the case company. Amazon has large distribution centres with high volumes, Wal-Mart has fresh goods, and they invested in quick refills from suppliers, and case organisation's spare part industry follows global terminal equipment sales where customers operate high-value machines. In terminal business, the demand is not individual consumer and trend (=social media) sensitive, but the prediction of spare part needs is at the core. In the study case, the organisation has several local warehouses and service sites close to customers, and they are supported by global distribution centres. Holding "everything everywhere" is not an option since it is not only highly expensive to hold, but spare parts also age and eventually require scrapping.

The sections of Hugos' (2018) list are used by organisations to decide their business model. Organisations might not produce anything, but they operate as a shipping platform like eBay (point two in Table 3). Unlike Amazon and Wal-Mart, some companies also might not choose to invest in tracking and inventory but prefer buying items locally on short notice. These kinds of businesses include high-end restaurants that are not gathering inventory (point three in Table 3). In addition, the location of the business may restrict the choices one has (point four in Table 3). If the company decides to keep their distribution centre close by and they locate in a country without harbours, then they are more likely to invest in truck or rail deliveries. As for point five, information, investing in it requires servers and maintenance. Companies without IT skilled personnel might need expensive outsourcing, or they might limit the collected data heavily. All the decisions affect companies' supply chain management, and the interest point demand planning is an important part of it. Well-implemented IoT and ERP oversee all areas, and through that, organisations get a more holistic picture of them and their effect on other parts of the supply chain. See Figure 4 below as an illustration. Deciding how to choose the focus on each point depends on what is the operating model and what customers in the industry appreciate.

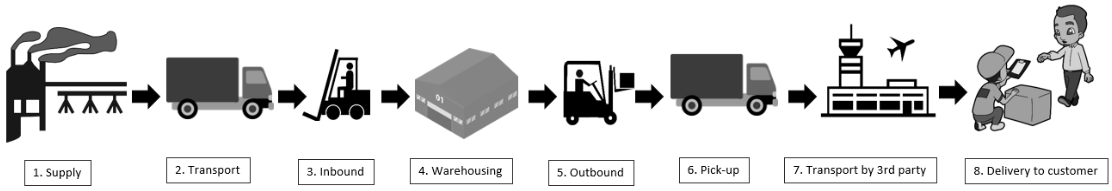

FIGURE 4. Supply chain from machinery industry illustrated. Determining whether to hold inventory at the supplier or at own facility indicates what type of business organisation operates. Created by the author based on end-user experience

3.4 Understanding inventory planning

Inventory planning is at the core while making decisions on planning for goods. In inventory planning, the planner uses calculations to determine what to store and how much to store it (Muller, 2003). Once a business model is established, different calculations are used to find ideal levels of stock. At first, economic order quantity (EOQ) is calculated. EOQ by Harris, 1913, finds the optimal number of parts to hold in order to keep the costs under control. Besides that, planning needs to know the optimal point to order more goods. To find the optimal reorder point (ROP), organisations calculate when and how much should be ordered. The formulation is straightforwardly achieved by calculating general consumption during the lead-time and adding safety stock to it. Lead-time is the number of days that organisations wait for refill, and safety stock is securing demand for that period.

As for holding inventory, a well-known rule of thumb while deciding which items to store is to follow the Pareto principle, where 20% of items count for 80% of the total value. Items are divided into A, B or C classes according to their place in the Pareto scale (Ramanathan, 2006). Class A items are considered the most valuable ones, and class C items are the least valuable. With that scale, the inventory consists in value mostly A class items, but in quantity mostly of C class items. Together with Pareto classification, optimal quantity (EOQ), possible internal classifications, and reorder point, organisations calculate what items they should hold and how many at once.

Other factors like item categories and general environment affect planning as well. The first item categorisation concerns relationship of products. There are dependent and independent items that either rely on the sales of another product or have a demand of their own (Muller, 2003). In the study's case, think that if a straddle carrier is sold to location x, there is a high chance that there will be demand for spare parts of that carrier in the said location at some point. In this research case, the related items are considered dependent, and storing them is wise to reflect, in some extent, the sales of those machines they belong to. Some spare parts can also be independent. The case organisation can sell glasses to cabins that customers have originally bought from other suppliers. In such items, storing them is more connected to global carrier presence rather than sales of individual machines. Muller states that with dependent items it is important to have the right parts and right quantity at the right time so one is prepared for demand. Dependent items are filled as replenishments, which indicates that orders are coming in (Muller, 2003). Implementing an automated preparation of dependent items is the main task for the study. The aim is to have each part of the kit items ready for customers' maintenance kits based on pro-active forecasting instead of having parts ready based on historical demand, which is not including new sales or IoT data.

Besides dependent and independent products, another item categorisation involves products' usability. Fisher (1997) wrote in Harvard Business Review that while choosing the supply chain model, one should look at whether their product is functional or innovative. Functional products tend to have predictable demand and innovative products unpredictable demand (Fisher, 1997). Functional products are therefore relying on an efficient supply chain where the interest lies on steady demand and low operating costs, and innovative products work on a market-responsive supply chain where one needs speed and agile turns (Fisher, 1997). Spare parts are functional products by default.

Demand can also vary due to fluctuations. Products can be stable with random peaks, vary with seasons (winter clothing, Christmas and other holiday products) or go through cyclic demand. Another inventory type is safety inventory, where the focus is to ensure availability when demand and order lead times are not steady (Hugos, 2018). Safety inventory is used for example in war zones where one needs medical supplies but cannot predict when a new shipment is coming in. In addition, factors like politics, natural causes, economics, demography, technology, and market conditions change planning needs. In practice, organisations face likings of economic sanctions, change of public opinion, and hackings.

Spare parts have steady demand generally, but big machinery sales can create random peaks in some countries. In addition, global economics affect demand as customers attend to buy more spare parts during depressions instead of new machines, and therefore parts go through cyclic demand (Kalmar, 2020[1]). To conclude the demand planning for the parts in the case study it can be stated, that they are dependent, functional, and have both stable demand with random peaks and cyclic demand. Therefore, the planning would

[1] Kalmar. 2020. Historical sales reports.

benefit from IoT's advantages in pro-active planning in order to ensure high customer satisfaction and smooth operations.

3.5 Demand planning rules

Demand planning as a concept is now established, but it can be seen and controlled in various ways. Signs in the market can lead one to choose poorly or well in business planning. Saffo wrote in Harvard Business Review a comprehensive list of rules that affect planning. Once those are understood, it is easier to see why IoT brings benefits to demand planning.

At first, Saffo (2007) states that a cone of uncertainty must be defined. According to the article, breadth of uncertainty is the most important factor to define as it rules in and out what can be expected. It is better to have one that is too broad than having a too narrow one, as that can leave one exposed to surprises or missed opportunities. Those that are likely to happen belong in the middle, and those that are less likely to occur are on the edges. Cone should be editable as markets change.

Secondly, Saffo points out the S Curve. S curves that appear suddenly are potentially part of a bigger curve with bigger opportunities. Before the escalation of the S curve, one should read the signs on the left of it to be ahead of others. Similarly, in the case study, black boxes are used to detect what will be needed in the near future when inputs like computers or sensors give certain information. A common mistake with the S curve is time estimation. Forecasters overestimate the short term (sudden increase where profits are high) and underestimate the long term (left side of S curve) (Saffo, 2007). One example of such thinking is the time that it took portable phones to become common (took longer than expected) versus the time it took for them to become smart devices (took less time than expected) (Dyroff, 2018).

Rule three on Saffo's list is embracing the things that are not fitting. Human behaviour attends to ignore those signals that reflect something unknown, and those can be misinterpreted as failures even though they can include disruptive innovations.

As a fourth rule, it is not advised to rely on one reliable source of information too much. It can cause one to reinforce those ideas that they already have and focus on them too heavily. The key finding from the rule is rather to rely on multiple small indicators of unreliable information than on a few from strong sources. Forecasting should be performed repeatedly and in such a mindset that one is not afraid to challenge their own findings and believes and drop them once they are proven wrong (Saffo, 2007).

Fifth on the list, Saffo suggests looking twice as far in the past as one looks in the future. The rise of the internet might have seemed unforeseen, but the popularity of television was one indicator that such service would be required. According to the said list, changes and turns in history are what one can use to predict future events, but recent history and straight lines are not solid indicators for forecasting as turns bring change (Saffo, 2007).

The last rule is to know when not to forecast. Sometimes changes that seem game changers might seem to require dramatic actions, but it is actually better to wait and stick with the forecast one has (Saffo, 2007).

Saffo's rules demonstrate how varying markets are and how it can be difficult to determine whether one should act majorly, to a small degree or at all. One can also conclude that history is not a steady market forecaster, but it can give insight into what to expect. Even though the given rules can apply for all business forecasting like investment decisions, they are solid indicators in demand planning as preparing for demand comes from business strategy.

4 CONCLUDING IOT AND DEMAND PLANNING FINDINGS IN LITERATURE

This chapter consists of three sections. At first, a conclusion on how demand planning benefits from IoT. The second section consists of literature findings, and the third section explains the need for the case study and the research.

4.1 Need for IoT in demand planning

IoT as a technological advantage is changing how demand planning and supply chains are operating. Ellis, Morris and Santagate (2015) analysed IoT in supply chain planning and execution. They highlighted that Internet of Things enables real-time information sharing for multiple directions, but it demands real collaboration to become a reality. That means cooperation with customers and suppliers to get a comprehensive view. Yerpude and Singhal (2017) wrote in their study, "Impact of Internet of Things (IoT) Data on Demand Forecasting", that Industrial revolution 4.0 has begun, which means that IoT systems will play a vital role. The First Industrial Revolution occurred once water and steam were harvested for production use (Schwab, 2016). The second revolution came from electric usage, the third had electronics and information technology with automation, and the fourth one is considered to combine technologies that affect physical, digital, and even biological worlds (Schwab, 2016). The Fourth Industrial Revolution is said to improve the effectiveness of supply chains and decrease the cost of trade (Schwab, 2016). The usage of the internet in inventory management has been the most popular with notifying customers on stock situations, but information sharing between suppliers or warehouses is not as popular (H. M. Beheshti et al., 2007). In the study, the internet and IoT are focusing on internal customers and internal processes where IoT could streamline inventory management.

According to Yerpude and Singhal's (2017) study, IoT can bring five major benefits to demand forecasting; agility, strategic advantage, revenue growth, cost savings, and accuracy and relevancy. Agility enables faster changes due to real-time data and fixing the course from an unprofitable direction. Strategic advantage means that one is able to see changes in the market quickly and act accordingly. Some cultural areas have taken preparations even further, as Farahani, Meier and Wilke (2017) noted that countries like China and Brazil are asking their customers what they prefer, and they are thus strained to keep up with quickly changing short-term demand. The third point on Yerpude and Singhal's list is revenue growth that drives from demand monitoring and proactive responsiveness. That is also what the case study aims to improve. Fourth on the list are cost savings; there is no need to wait for data like before since it comes in real time, and that means that responsiveness for external and internal parties is much faster (Yerpude & Singhal, 2017). In the case study, the fourth point is very important for end-users. Availability and speed of information mean that corporations and organisations can remove unnecessary data processing roles, which brings salary savings. Fifth on the list is accuracy and relevance. As IoT can provide a constant flow of information, the forecast can be set and altered whenever there are changes in the market (Yerpude & Singhal, 2017). To put briefly, IoT enables planning to be fast, to see markets dynamically, to grow revenues by customer monitoring, to relocate resources, and to be accurate and detailed in modelling (Yerpude & Singhal, 2017). The listing regarding IoT and demand planning support the previous findings (2.5 Benefits and future) about IoT's gains and state that IoT creates business value to supply chain management and other departments.

Farahani, Meier, and Wilke (2017) wrote that the supply chain is an industry that has been for decades trying to get a holistic picture of the processes. Supply chain management systems (SCMs) and Advanced Planning and Scheduling systems (APSs) have been developed to gain competitive advantage, and logistics has followed trends quickly. According to Farahani et al., IoT is one of the technological innovations that is relevant in supply chain management along with mobility, cloud computing, social networks, and big data. Despite the advantages, according to a survey by SAP's Business Transformation Services (BTS), companies are still afraid to take new solutions to use as they might not be secure and keep their private information safe (Farahani et al., 2015). By using Gartner's data, BTS listed that IoT gives visibility and provides automation and those factors supply chain struggles to overcome. According to respondents of the survey, visibility's benefits were knowledge of product location and quantity, transparency, geo-location services, sales distribution, fine-tuning inventory planning to cut costs and improve service, decrease waste, and product quality. Farahani et al., also state that if one has end-to-end supply chain visibility, they are more likely to head for the same goal as others in the loop. End-to-end systems are seen as part of a control tower system that connects multiple aspects and therefore improves cooperation as well. To be able to achieve the IoT network, the first step is generally considered digital product history. That is created via tracking that enables life cycle recording, and generally, in logistics, RFIDs, barcodes and SIM cards are used to track products (Farahani et al., 2015). In the thesis' case study, the source of information comes from multiple devices that the black box in the customer's machine collects and that is combined with ERP and cloud data. All that data is used to gain the advantages that end-to-end systems provide, like proactive forecasting.

4.2 Literature conclusion

When the research for the case began, a research plan was formed for the needed sources. The sources were divided based on different criteria. At first, was understanding IoT; how it is built, how it works, and why it is invested in globally. The IoT part began by studying the structure of IoT to understand what is needed in such environment and what kind of differences there are in IoT networks. Results indicated that there are different types of architectures and data division types. The most common architecture type is layered (Muccini & Moghaddam, 2018) and data is often divided in organisations in a centralised form (Roman et al., 2013). Globally multiple architecture structures are used, but ITU's from 2012 is the closest to a standard one.

After understanding IoT's structure, the study focused on its usage. Various sources acknowledged that IoT is widely used by individual consumers who enjoy its benefits in settings like home controlling, vehicles, and sports. The consumer market has changed the way traditional organisations have operated. Before easy access to IoT, consumers would for example receive phone calls if their home alarms triggered, but nowadays, service providers also grant direct video feed that homeowners can see. IoT has given consumers more independency. Organisations use IoT to similar actions as consumers but also to provide faster data sharing, real-time editing, and controlled movement tracking. As for business value, IoT can open up visibility to whole supply chains (Bilgeri, Gebauer, Fleisch, & Wortmann, 2019). Data movement from suppliers to customers and back is considered one of IoT's major benefits to logistics planning, and that is the case study's backbone.

Once the business need for IoT was established, it was time to gather its challenges and benefits. The most important references in those sections were studies by Khan and Salah (2018) and Matharu, Upadhyay and Chaudhary (2014). To get the organisational aspect, highly valued consulting companies like Gartner, KPMG, and PwC were used. Those sources had important information on the issues and gains that organisations have when they are implementing IoT. Studies on challenges had similar results from different aspects. IoT is not globally standardised, which leaves it vulnerable. The weak points can be in any point of architecture or then be caused by human interference. As for gains, organisations are investing billions of US dollars into IoT every year to gain efficiency, customer satisfaction, and to see the organisation in a holistic way. Thus, IoT is considered to be one of the most important and valuable technological achievement of the current time.

Chapter 3 introduced demand planning and explained how it is a part of supply chain management. Supply chains consist of multiple areas that vary in operations (Hugos, 2018). For example, organisations that sell fresh food or rely on consumer trends operate differently than machinery organisations like the case company. Those aspects affect where each industry decides to invest in and in which part IoT is especially beneficial. Demand planning also has rules and certain calculations that are important to include in the case building. The research also included noting that organisations practice different types of stocks and planning. Understanding demand planning needs was crucial for the design of the solution, or otherwise end-user issues could remain unsolved.

4.3 Open questions with demand planning and IoT

Although several studies include IoT's benefits and advantages to demand planning, they were missing practical, real-life examples on the advantages to individual steps. In larger production scales, like the example of Harley Davidson, it can be seen that implementing IoT to factory brings major improvements, but those have to take into consideration big-scale implementation changes in organisations, training, and other aspects that are not necessary given in smaller projects. Looking at smaller steps taken into operation, how has each step affected areas like forecasting inventory or the workload of individual employees? IoT is said to decrease human effort, but studies with measurement of a single demand planning step alone in an organisation could not be found. Encouraging results could indicate that smaller projects bring concrete benefits that are worth the effort, and a structured process in smaller projects saves valuable working time. The study will look into how one can reduce labour time and how much effort can be saved by creating a bridge between the IoT database and spare parts' planning procedure. Through the study, the aim is to find out how IoT will, or will not, benefit demand-planning tasks and provide inputs that decrease the need for human interference. By automating only one step in the process, one will see how much IoT's capabilities help demand planning even on a smaller scale and if the benefits from literature sources are accurate with specific set ups like the one in the case study. The following chapter presents the research method that was used to find that out.

5 RESEARCH METHOD

To begin the research, one had to choose the appropriate methodology and define how to measure the results. It turned out that the best option is the action design research (ADR) method with social and technical aspects as evaluation criteria. Measuring the outcome varies from the major implementation processes as they attend to focus on productivity on a holistic scale. The study investigated whether the changes affect single employees' workload and whether the IT solutions could be streamlined. While finding the best research method, in beginning one is obligated to define what kind of problem the research is trying to solve. The study includes three major topics, and their combination determined the method. At first, an information technology system; secondly, the demand process improvement; and thirdly, utilisation of IoT for the case company. Those areas limited the choice of methodology, and they narrowed it down to ADR based on several findings from the literature. In the following section, a conclusion how ADR is the most suitable method and explain why both social and technical aspects were important for the evaluation in the research. The second section focuses on how the case study has been carried out, and the third section describes the interviews as a part of the process.

5.1 Action design research

The first theory that led me to ADR was ITU's (2012) statement that IoT can be seen as a vision with technological and social implications. That caused me to search for pragmatism methods that can be measured in social and technical matters. Secondly, Baskerville and Myers wrote on MIS Quarterly how action research (AR) involves theoretical establishing, problem setting, adjustments between practical action and theory, and how it demands participation. According to the said article, social reflection is needed for solving human-based problems (Baskerville & Myers, 2004). While looking into action research, study showed that it requires active participation and using the experience to change the organisation (Checkland and Poulter, 2020). That matched the case study need perfectly: the researcher has access to the process and the opportunity to change it based on the research results. The design part was discovered when March and Smith, 1995, wrote that design science creates technology-oriented artefacts that serve a human purpose, and the outcome is evaluated based on value or utility. The creation ought to work and be an improvement, as they put it. These statements led the researcher to select ADR as a research method.

ADR is a combination of action research (AR) and design science research (DSR) (Sein et al., 2011). ADR method aims to change reality by solving a problem. With those criteria, the action design method suits the study the best as one is studying something by using it (AR), but it is also technical, and it must bring benefit to an organisation and its individual employees (DR). Sein et al.'s (2011) ADR method fits the case study for its "back and forth" type of working process. Unlike other DR methods, the ADR method works without stages, and it is not evaluated after being built (Sein et al., 2007). Like Baskerville and Myers (2004) stated, an essential action research point is to adjust the theory also according to the practical actions, and in this case, Sein et al.'s method works better as it is more of a constant adjustment.

In an ADR setting, there is a problematic situation in an organisation, and an IT artefact is designed to solve it (Sein et al., 2011). In the case study, a slow, manual process needs an improved IT process. In the ADR method, there are four stages, which are 1) Problem Formulation, 2) Building, Intervention, and Evaluation (BIE), 3) Reflection and Learning, and 4) Formalisation of Learning (Sein et al. 2011). ADR method stages are illustrated in Figure 5 below, and the main principles of each stage after Sein et al. (2011) are described.

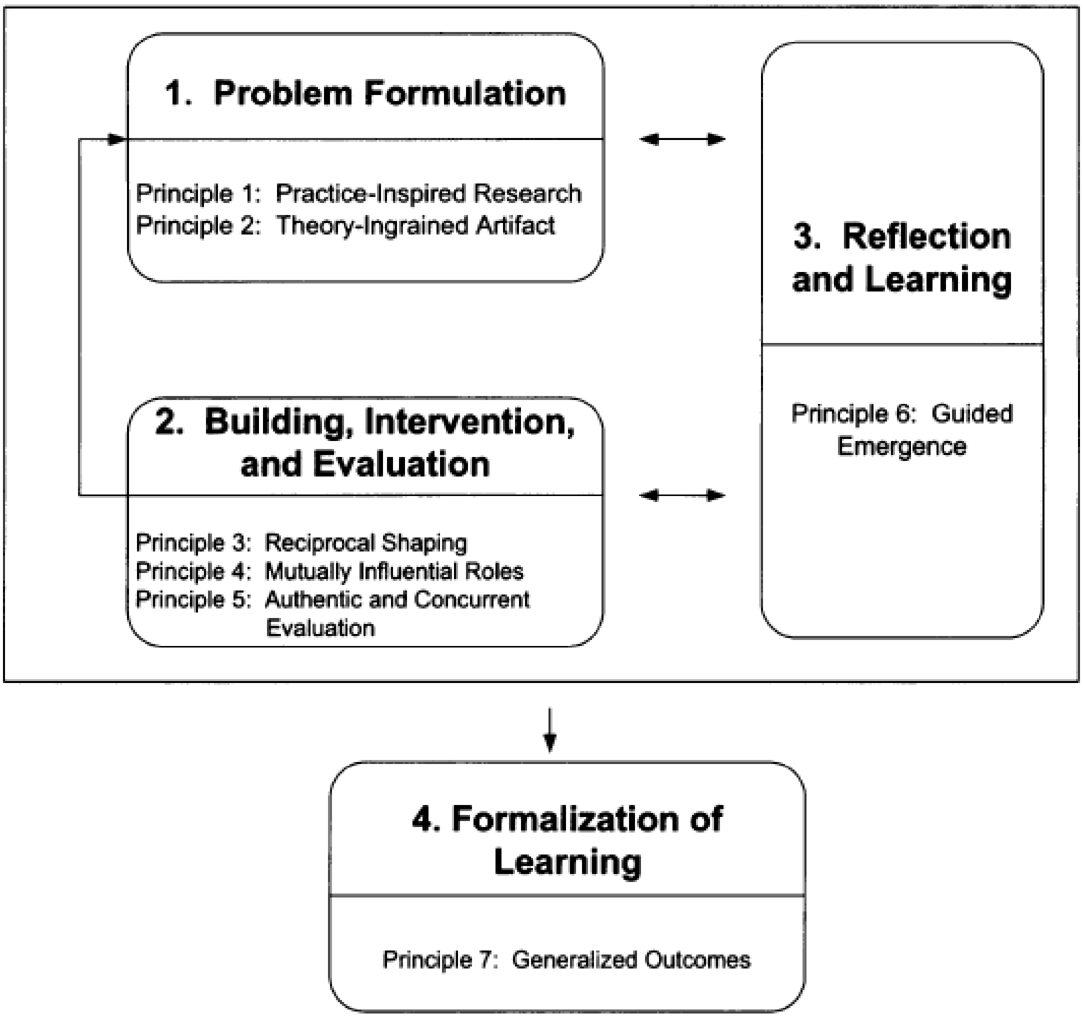

FIGURE 5. Stages and principles of ADR method illustrated by Sein et al. (2011, p. 41)

The first principle, in stage one (Problem Formulation), is noting that in this method, the researcher should not try only to fix the one specific issue but to find a solution that can be used for other similar cases (Sein et al. 2011). In the case study, the end goal is to find a type of guide that could be applied to other similar processes. Therefore, the first principle suits here. The second principle is about theory-ingrained artefacts. Previous theoretical bases and existing technological advancements should be identified here. In stage 2 (BIE), the first design is scoped, and it is shaped in cycles based on organisations' needs. In BIE, the artefact is **b**uilt, then **i**ntervened by the organisation and then **e**valuated. Afterwards, the artefact is at realised design, and it produces an IT-dominant or Organisation-dominant BIE. The case study turned out to be an Organisation-dominant one, where end-users had the opportunity to give instant feedback early on, and they were invested in the evaluation of the solution. The stage also includes three principles which are reciprocal shaping (design shapes organisation and vice versa throughout the process), mutually influential roles (researches and practitioners both bring value), and authentic and concurrent evaluation (evaluation is constant, not a separate stage to return from) (Sein et al., 2011). Principle five, separates ADR from other DR methods, like DSRM by Peffers et al. (2007), where evaluation is its own stage that can result in a return to previous stages. In the ADR method, the later evaluation is more of a summary where research's value and utility are assed (Sein et al., 2007), and otherwise, there is a constant evaluation. Below is an illustration of the build-intervene-evaluate (BIE) model that the case study used in stage two.

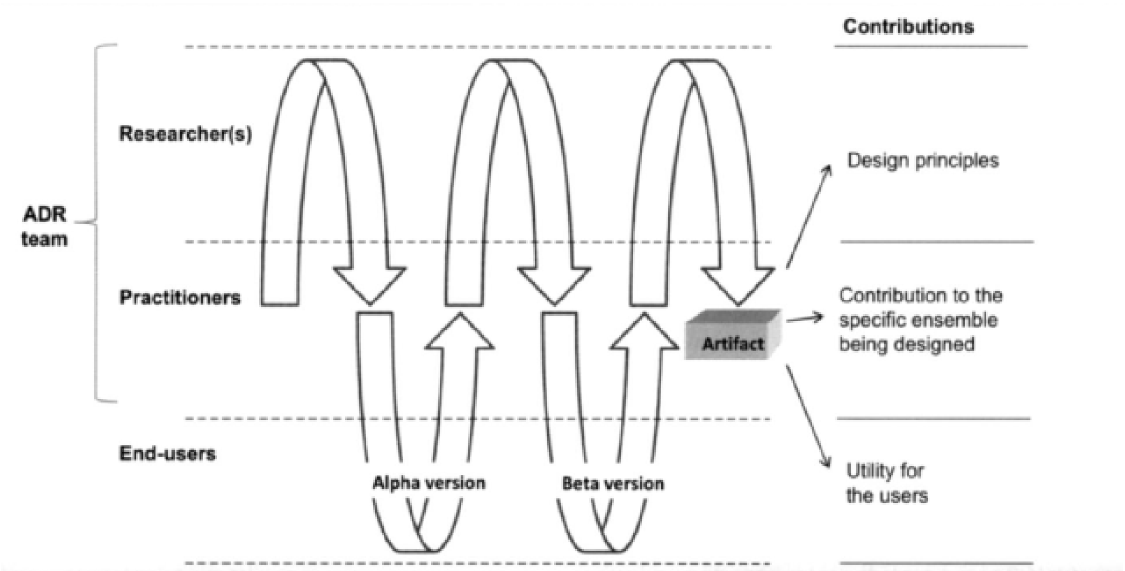

FIGURE 6. The Generic Schema for Organisation-Dominant BIE, illustrated by Sein et al. (2007, p. 42). Used in the design phase of the study to get fast-phased feedback and on-going evaluation

In stage three (Reflection and Learning), the research is compared to a wider range of similar problems where it could be used. There is a possibility to create a solution in a situation where different departments in one company face varying issues or needs with a single procedure or vice versa. Principle six, guided emergence, highlights that the result is not only a design; it is the outcome of shaping organisation, participants, and constant evaluation (Sein et al., 2007). Expected and unforeseen consequences alter the design principles and the ADR method user should be open to changes. In the last stage (Formalisation of Learning), where a generalised outcome should be a concept for a class of original issues, the solution is reflected to the original literature that was used in the original design and the IT artefact and organisational changes are described. The last principle, seven, states that the researcher needs to generalise the unique issues, solutions, and derivate design principles (Sein et al., 2011).

ADR method requires collaboration from end-users, practitioners, and researchers to create an artefact that contributes to all parties.

5.2 Research structure

The research began by going through the existing process, utilising internal documents, literature on related topics, and conducting interviews with the end-users. At stage 2, one aimed to find out if there is a way to benefit from IoT in the process without having human interference or by minimising it. The research scoped what the business' needs are, and by operating so, the hypotheses were formulated: "Implementing a single IoT step will decrease human effort" and "Implementing a single IoT step will decrease the number of IT solutions needed". Stage 2 also included various casual interviews with different employees to find out more about the system's structure and possibilities. After designing the outcome and altering it based on participant and end-user experience, the case was at stage 3, where end-user requirements were confirmed. Lastly, at stage 4, the design was moved to product development, and the outcome created a working method that can be used in other similar IoT projects. Below a figure with actions from each stage.

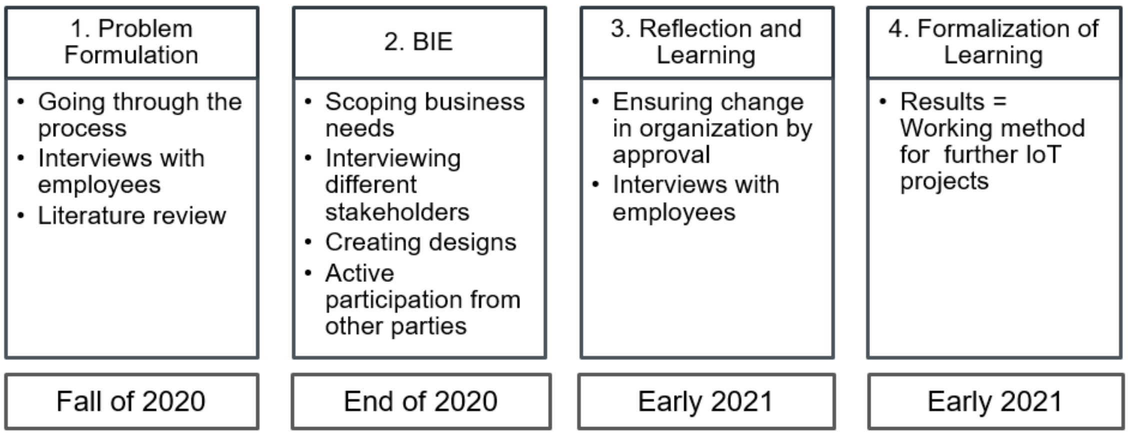

FIGURE 7. Concrete steps of each ADR stage during the research and the timeline. Created by the author.

The hypotheses and organisational aspects were at the core throughout the study to ensure a realistic outcome. The first hypothesis was evaluated based on the human experience. Interviews with those employees that spent time on the process, and they estimated whether the solution increased or decreased their weekly and monthly tasks. The second hypothesis was evaluated based on the IT solutions that had to be used. End-users had four different solutions to operate the process with, and the aim was to decrease that number. Preferred outcome after the study would also extinguish email exchange between end-users regarding this process. These measurement methods were agreed upon by the case company to meet their business need, and the researcher saw them fulfilling as they answered the open questions and could be studied in a form that was beneficial to the organisation and to the research. They also filled the statements on literature about the importance of both social and technical evaluations.

As the study reaches the second phase (BIE), some supporting questions are added to reinforce that the research gives results to the business organisation. The following questions are separate from the formal interviews on social aspect, and different stakeholders answered them.

1. How is data utilised from IoT in the original setting?
2. How different devices are connected?
3. What is the targeted outcome of the study by the business organisation?

The first question aims to clarify what is the role of IoT in the case organisation, and/if there is a role, how is the origin process utilising it. This question was answered by various employees that work with the case company's data, and it gave valuable input for the designing phase. The second question investigates the physical devices and their connectivity to the database. According to previously mentioned studies, in Section 2.4 (Challenges of Internet of Things), the variations in models and manufacturing can be the reason why IoT is difficult to benefit from and why the variations can endanger the devices to attacks (Khan & Salah, 2018 and Matharu et al., 2014). Devices that the organisation uses could bring challenges, and that is important to include as interoperability can rely on this. An employee who was an expert with related devices was interviewed to minimise the risks and to know what kind of connectivity the solution required. The third question emphasises what the organisation needs from the study and what are their additional interests beyond hypotheses. This question was answered by several employees from the data, digitalisation, and supply chain management departments. This question gave input to the measurements for the outcome. The individuals who answered questions 1-3 were interviewed casually without recordings, and their role was mainly to provide supporting material to the study. Most of the interviews concerning the above questions took place during the end of 2020.

After initial information gathering and building the baseline, designing and developing the solution began. At that stage, end-users got to see demonstrations, which they could test and give feedback on. After the design was considered complete, the outcome was reflected with the use of interviews, literature, and math (number of solutions used) to analyse the solution and formalise the learnings.

5.3 Interviews

As one needed to find out the issues in the current process, the researcher used the tool themself, but to find out why and how current end-users need to improve it, the study included interviews with the end-users. Sein et al. (2011) wrote that while the problem is formulated in the ADR method, the problem formulation can come, for example, from end-users as in this case it came. That indicates that while the issue that the study aims to solve is problem based, developers and designers of the solution could and should take end-users into the process. In this study, they were included via interviews. For interviews, Marks et al. (2002) suggested that developers and users use common words that are familiar to both and consider both positions while designing solutions. Using common words decreases misunderstandings, which helps interviewees and interviewers to be on the same page. The interviews were planned to be used in answering the social aspect of this action design research study, and they gave the opportunity for the employees to open up about their needs and views of the process and the desired solution. Therefore, the study process gathered information from the respondents twice: once before designing, and once after the design was completed. Between these, there were unstructured discussions and evaluations according to the methodology.

Interviewees had been chosen based on their responsibility at the case organisation. The respondents were the two individuals that were manually working in the original process. To explain their forecast method, demand-planning procedure, and what they would ideally be like, the planner to give their expertise on the matter. The other person was the individual who had the role of data analysing in the original process; they are referred to in this research as the analyser.

Interviews were conducted via video calls using a semi-structured interview that consisted of pre-selected questions. Questions were sent via email beforehand, and during video interviews, respondents had a possibility to explain their answers in more detail. They were also given the opportunity to add via email or additional video call to their responses throughout the study process if they felt that there was something to note. Each interviewee received those questions that were related to their own work area. During the analysis phase, both respondents' answers were used, as planned, in the evaluation of the first hypothesis: "Implementing a single IoT step will decrease human effort". Interviews answered to local practices of use that Sein et al. (2011) highlight in the ADR method. If the solution would only be measured through technical aspect, it is possible that it would not solve the issues that people working in the process have. In this case study and the ADR method in general, the outcome must bring value to users.

5.3.1 Interview on demand planning

The individual referred to as the planner was interviewed with the following questions:

1. What is the forecast method for demand planning?
2. What issues are in this procedure in your own words?
3. What should be the planner's role?

4. What kind of solution would diminish your manual work?
5. Open discussion and notes

Interviews with the planner took place in the latter part of 2020 before the design process began and again in the beginning of 2021, when the design was introduced. Each interview lasted approximately 45 minutes. After the first interview, the results were used in the design phase, where the base was sketched to match their needs. During the second phase (BIE), the study got more feedback from the planner and altered the design based on it. The second interview supported the evaluation phase. The interviews were not recorded as requested by the interviewee, but the researcher had an opportunity to study various materials and use the tools that the planner uses. The interviewee was also available for questions throughout the process. In the end, the planner evaluated the outcome and gave their approval for production.

5.3.2 Interview on maintenance analysis

Before the interview with the analyser, they sent written notes and participated in an unstructured video meeting on the problem, so one was able to begin the design before the actual semi-structured interview. The analyser was the key member in problem formulation and evaluation as they had many roles in the original process. They gave information on the IoT application's structure and their current tasks and wishes about the solution and its functionalities. For the interview, they were presented with the following questions:

1. What issues are in this procedure in your own words?
2. What should be analyser's role?
3. What kind of solution would diminish analyser's manual work?
4. Open discussion and notes

The interview with the analyser was conducted at the beginning of 2021, when the design was still formulating. The interview lasted one hour and was video recorded. Like with the planner, the researcher also got access and guidance to the analysing tools and applications. When the final design was completed a month after the first recorded interview, the analyser approved it via email with their feedback and evaluation.

6 CASE STUDY

This chapter consists of the case study research sections. At first, introducing the case company, the origin process, business needs, and components (6.2). In section 6.3, the design process and design outlook are presented.

6.1 Overview of the case company and original process

The case study for this research was executed in cooperation with Kalmar, which is part of Cargotec Corporation. Cargotec consists of three cargo-handling business units: Kalmar, McGregor, and Hiab. Kalmar offers equipment, automation, software, and services to terminals, whereas MacGregor focuses on sea and Hiab on road and land (Cargotec, 2020). Below is an illustrated view of the business units' focus areas.

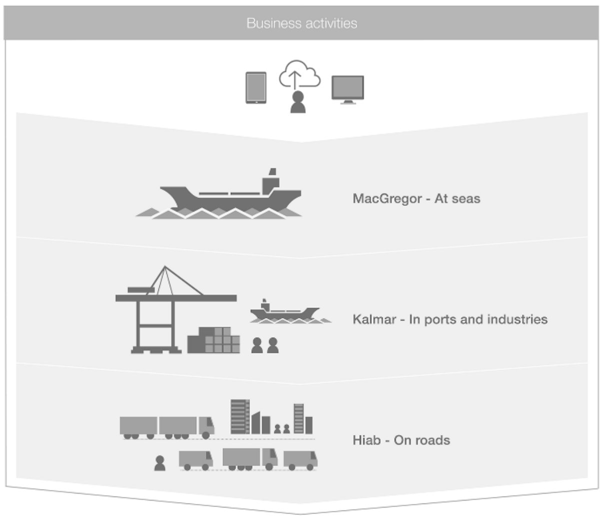

FIGURE 8. Cargotec Finland Oy business units as in 2020 (Cargotec, 2020)

Equipment that Kalmar sells include forklifts, various carriers, stackers, and tractors that operate in terminals. Customers can also purchase performance management tools for their machines and other cloud services. Data from those tools can be utilised in different IoT platforms. In maintenance planning, external customers use an application called Insight, and internal customers can additionally use QlikSense. They operate on a cloud service and can be used to monitor various details like machine hours. This data is utilised to determine when machines need maintenance services and/or maintenance kits. In this study, the focus is on those machines that can be tracked in the QlikSense application and therefore, the solution will serve internal customers and internal personnel. The aim was to determine whether Kalmar could benefit from maintenance spare parts' demand planning from IoT data. Data to QlikSense is received through black boxes placed in customers' forklifts and other machinery, but it requires manual processing and two individuals before it can be utilised. Those individuals are the ones referred to as the planner and the analyser. Based on the original way of operation and interviews, a process flow that needs to be changed formulated. The flow is in Figure 9 below.

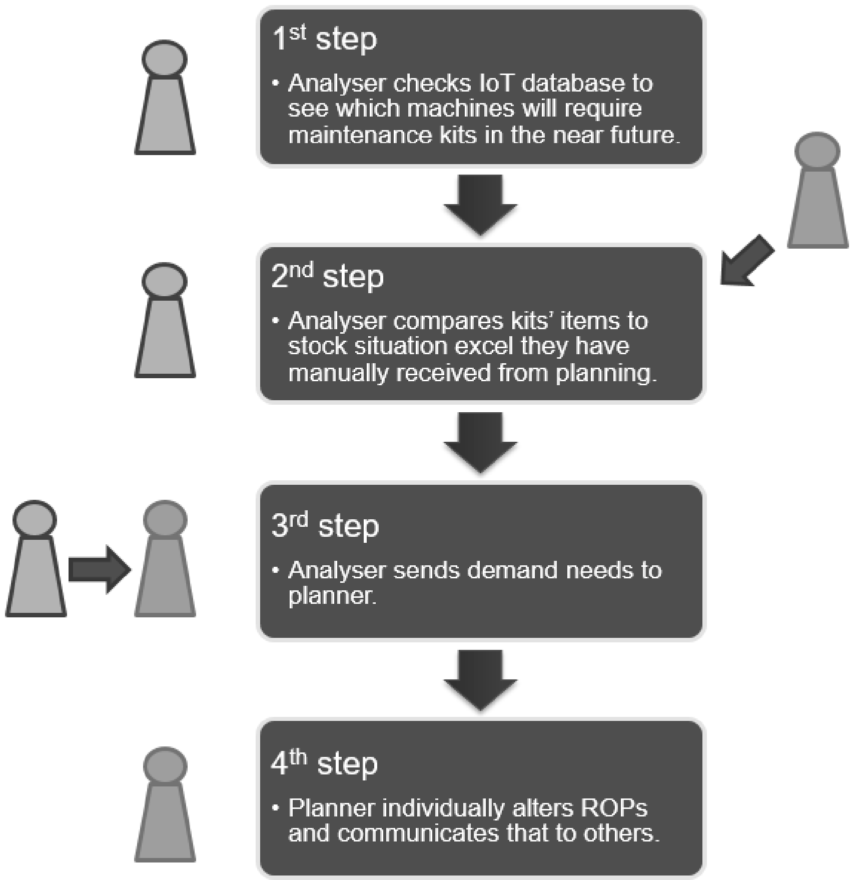

FIGURE 9. Manual steps to be removed from the process. Created by the author based on information provided by the case company

The original model of working decreases the benefits that IoT gives and employs at least two individuals in the organisation. To begin, the first individual, referred to as the analyser, gathers information from the IoT database and observes customer inputs. Secondly, they check the manual parts list and compare it to the manual stock list received via email. This stock list can be outdated, as it is not read directly from ERP. In the third step, the analyser sends a manual demand list to the planning department. Next, the planner will upload future demand on a planning tool, Servigistics, that feeds ROP changes to ERP. Depending on the changes, the planner sends an email or confirms otherwise that the changes are completed. Any unnecessary steps in this process Kalmar is aiming to delete.

6.2 Components of Kalmar IoT data flow

Kalmar's IoT network is presented in Figure 10 below. Each part has a role in the data formulation, and the following subsections open up their importance. Some undifferentiating elements like the machines and replaceable components were left out. ITU's (2012) layers from Table 1 are used to demonstrate how IoT architecture is built in the case company. The structure follows layers; at first, IoT applications (QlikSense, Kalmar Insight), secondly service support and application support (Cargotec Cloud), thirdly network (3G/4G), and lastly devices (Gateway and Control system).

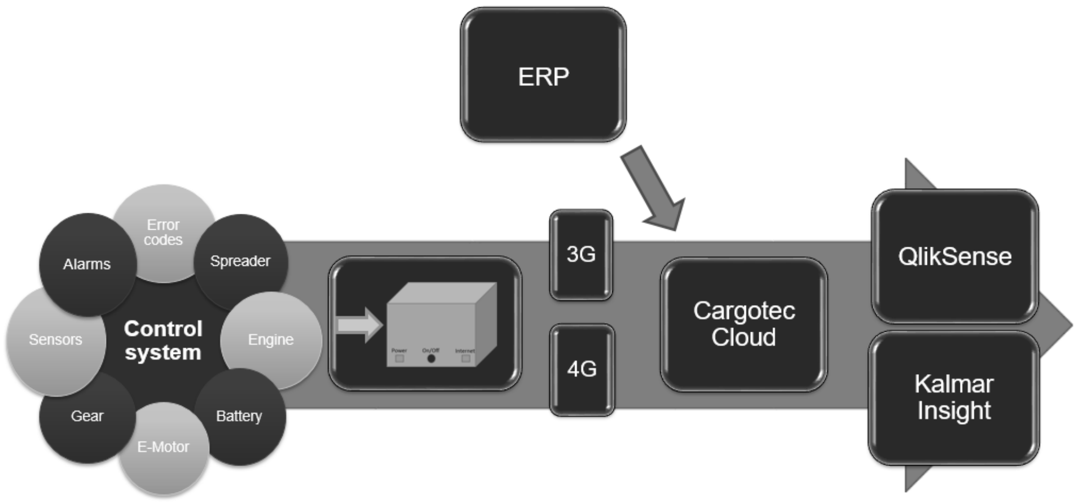

FIGURE 10. Data flow in Cargotec network from device layer (left) to applications (right). Created by the author based on information provided by Kalmar (2020). Only includes IoT applications that use maintenance data relevant to the study

6.2.1 From applications to network

The case application QlikSense receives data from Cargotec Cloud. QlikSense has views to show machine hours globally, and those are tracked regularly to see if customers need maintenance kits. Another view in QlikSense is the imported manual kit list which includes all part numbers and information on which machine they belong to. The list is then compared to the stock situation received via email from planning. QlikSense is a visual tool that has the possibility to provide detailed listing; see Figure 11 for illustration.

Plant	Service Statior	Sold to Customer no	Ship to customer no	Equipment number	Serial number	Date of Maintenance
Finland 1	5455400	23	23	1000056	1400700	20210601
Finland 1	3244300	3	3	1000057	1400701	20210602
Norway 7	4322342	56	55	1000058	1400702	20210607
Norway 7	4322342	656	565	1000059	1400703	20210604
Norway 7	4324343	565	565	1000060	1400704	20210804
Norway 7	4324234	55	55	1000061	1400705	20210606

FIGURE 11. View of Kalmar's QlikSense. The above example of a dummy machine listing and below it a world map with machinery locations. Darker areas indicate a heavy presence

Another IoT application Kalmar uses is Insight. As previously mentioned, QlikSense is used for/by internal customers, whereas Insight is used mainly by external customers. Because this case study investigates internal process, the focus is on QlikSense, while Kalmar Insight is mentioned here as the outcome could possibly encourage changes in that application as well.

Next, the service support and application support layer. Before data is visible at the applications mentioned, it is sent to Cargotec Cloud, which operates as Cargotec's IoT data ingestion, data storage, application programme interface, and as a data access site. Cloud collects data from third-party clouds, gateways, and corporate systems like ERP (SAP) and sales tool Salesforce. From

Cargotec Cloud, different IoT applications use the collected data and associated information.

In the network layer, data flow to and from the cloud is protected by VPN to secure the company's data and it is transferred by using 3G or 4G phone services.

6.2.2 Devices

The last layer (Table 1) contains devices. In the case study, there exist three categories of devices: gateways, the operating system, and various devices in machinery.

Gateways are shipped to customers with configurations or programmable logic controller (PLC) programmes. See Figure 10 for illustration, where the grey box imitates gateways.

Data is collected in machines through Controller Area Network (CAN) connectivity. CAN is a communication bus that sends and receives real-time control messages (ISO 11898-1:2015), and it is used in cars, planes, hospital equipment, camera, and other various devices (Zhang, 2010). CAN empowers the use of electronic control units in one interface instead of using digital and analogy solutions for each device (Zhang, 2010). Kalmar uses CAN to collect data for the operating system that receives inputs from multiple gathering points. On consumer markets, that is equivalent to a car computer that collects details on tyre, engine, and fuel information through CAN and then provides warnings and signals to drivers.

The operating system in machinery is an important data feeder and gives most of the data that black boxes gather. They follow many operative aspects like running hours, parts' movements, engine and transmission alarms, and pressure and malfunction alerts. Operating systems are created by Kalmar or their partners, which decreases the risk of incompatibility (reference to section 2.4).

Operating systems collect data from various devices, but a spreader works as an example to explain how devices bring value to customers and why it is important to focus on pro-active planning. Spreaders have a functional activity to collect containers, but they also give valuable information on machinery's productivity. One type of productivity is calculated based on the movements and sizes of the containers spreaders are moving. The movements that equipment gathers can be used to report global container movements and to list high-traffic terminals and their put-through speed. An internationally agreed standard is to measure container volumes by calculating how many twenty-foot containers a terminal can process (World Shipping Council, 2021). Such information is crucial for Kalmar's customers to measure, and it can be tracked even with an app (Navis, 2020). These kinds of cloud solutions and data are essential for terminals to follow so they know how effective their operations are. Any downtime in terminals decreases productivity, and therefore, proactive solutions are intriguing for customers. Below a picture of a spreader (Figure 12).

FIGURE 12. Spreader retrieving a container (Kalmar, Introducing Kalmar presentation, 2018)

In this kind of combination of devices, network and clouds, the issues of differentiation and manufacturing vary from consumer markets as most of the parts are Kalmar's own ones or designed and controlled through partner manufacturers. In this case, the issues of non-compatibility with devices are solved to a major degree before their implementation to machines. That helps with some of the challenges that, e.g., Matharu et al. (2014) presented in relation to IoT (see Section 2.4 Challenges of Internet of Things).

6.2.3 Enterprise resource planning

Besides gateways, another key data source to Cargotec Cloud is the main enterprise resources planning (ERP) system (see Figure 10). ERP systems include data and information from various departments like finance, human resources, operations, logistics, sales, marketing, and purchasing (Umble E, Haft & Umble M, 2003). Companies use ERP systems to get a holistic view of their operations. They offer a unified view of all functions and departments, and they can be used to insert, record, process, monitor, and report transactions (Umble et al., 2003). Below, Figure 13 describes an example of how multiple departments are involved in the ERP process.

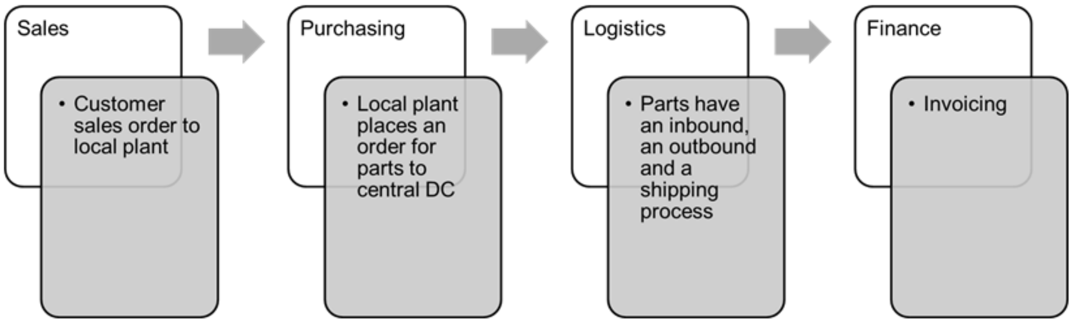

FIGURE 13. Simplified SAP process example to demonstrate how collective ERPs are. Created by the author during end-user experimentation

Disadvantages of ERPs are considered to be the cost of implementation, customisation process, business process re-engineering, time-consuming training, and complexity of the systems and integration (Shehab, Sharp, Supramaniam, & Spedding, 2004). Kalmar uses Germany based SAP. SAP offers different product portfolios to their customers: ERP and finance, CRM (customer, relationship & management) and customer experience, network and spend management, supply chain management, HR and people engagement, and business technology platform (SAP, 2020). Kalmar has integrated SAP to Cargotec Cloud so ERP information can be used in different reporting, analysis, and sales applications online. In this study, the focus is primarily on supply chain management and its subcategory supply chain planning. How ERP plays a part in the design is presented in the following sections.

6.3 Designing solution

The design process for the targeted solution begins with noting the limitations and characteristics that IoT, business strategy, and other parts have. Before describing the individual parts of the process, let us establish what this study is aiming to achieve in practice. In Figure 14 below, a map of the desired outcome.

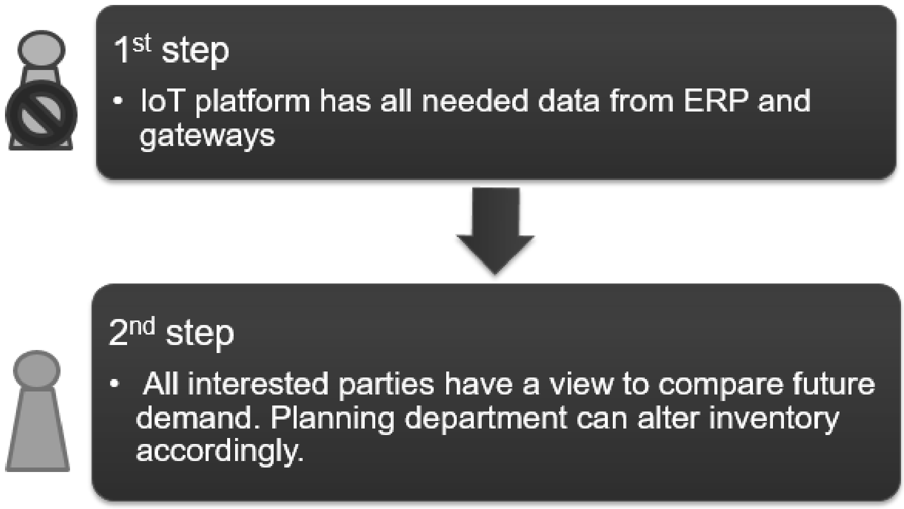

FIGURE 14. Targeted process. Planned based on interviews, IoT literature, and technical realities

The targeted process would mean that there is no need for any employee to check lists, compare stock situation, or send emails to and from planning. The new process could prove, once implemented, that IoT improves working processes even by simple steps that take hours from two different units and two different employees.

The next step is checking the parts in the process, and therefore, the study begins by considering elements in IoT implementation. Elements include academic, practical, and people-related issues that the literature review revealed. While designing new IT practices, it is important to align them with business process requirements, also referred to as a line of business (LOB) (Ellis et al., 2015). Ellis et al. write that companies achieve IoT capabilities through smaller, separate projects, just like this one. Projects are more likely to succeed if they are kept realistic and clear, and their previously determined benefits can be seen (Ellis et al., 2015). In section 2.4, alignment with business was regarded as important in order to gain benefits. In this case study, that is measured by human experience and by the number of IT systems used. If individuals using the new solution feel that there is no benefit to their tasks, then the social aspect of the project can be determined as a failure. If at the end of the implementation IT systems used to process the data are still the same, then the technical aspect can be determined as failed. If both aspects fail, then hypotheses are proven false. Ideally, the individuals feel that they have less work than before, and IT systems have been streamlined. Below, Table 4 presents the needs of both aspects, social and technical. The technical side has its limitations. Kalmar has ERP system SAP with stock data as the mandatory data to be connected to the new solution. Any other option would still have to be connected with that separately to alter and compare ROPs, which would not bring the needed change. In the literature section on challenges (Section 2.4), consulting organisations recommended that new solutions should be possible to connect to original data sources. That is where Cargotec Cloud comes in. As it already contains data from ERP and gateways, it would be best to create a solution in such an application that can process data from the Cargotec cloud.

TABLE 4. Needed changes by targeted solution. Gathered by the author based on business needs

Original Social aspect	**Targeted Social aspect**	**Original Technical side**	**Targeted Technical side**
2 individuals required	1 individual required	Use of multiple platforms; QlikSense, emails, Servigistics, ERP = SAP	Use of Servigistics only when changes are required to ROPs
2 departments involved	1 department involved	Tools used for monitoring are used for parts' comparison with outdated excel lists received via email	Tools used for monitoring and visualisation are used only for those needs (QlikSense)
Manual work needed in every step. Figure 9	Manual work required only when ROP altercation needed Figure 14, no exporting of lists from ERP and emailing	ERP is used to export excel sheets, and those lists of ROPs are sent manually	ERP is used for stock checking automatically via cloud

As stated in chapter 3.5, it is important to find a pro-active forecasting method so that organisations can prepare for lead times and demand. One obstacle is generally related to scoping. Saffo's previously introduced rules of demand planning include the aspect that one should not assume based on a single strong source of information but rather rely on multiple unsure small indicators. That in practice would mean selectiveness between customers and differentiating them based on indicators. Who is most likely (one strong source) and less likely (small uncertain sources) to buy? Therefore, the new design should, in theory, recognise that even though there is a strong possibility that one customer is on the verge of spare part needs, there are risks involved with heavy investments to serve them. Instead, organisation could focus preparations on areas where multiple smaller customers are about to reach service status even if their sales orders are not sure. By acting so, they can avoid a situation where many parts are shipped, for example, to west Europe for one customer only to find out that the customer buys from another source. Meanwhile, smaller customers in the eastern side of Europe, who are dependent on fast deliveries and smaller quantities, buy elsewhere as well. The organisation could end up losing all those sales. According to LOB, it is not necessary to include customer segmentation in the forecast, as all internal customers are promised 100% availability, and planning should include enough parts to prepare for all of them. As the cone of uncertainty includes only the internal customers, preparations are created based on the time it takes to receive products from suppliers to each distribution centre, not by estimating customers' purchase intentions. Therefore, their previous history of sales behaviour is not acknowledged in the outcome.

During the interviews, it was stated that the solution should be able to look one year ahead, but the special focus would be in a three-month period. That way the case company can source for items that are needed within a year, but the local inventory is planned for three months' needs. The solution must also be accessible for multiple users effortlessly, and the user experience ought to be clear enough, so complex training is not required. The requirements lean towards an IoT application that is already in use. Finding business' values for the change is part of the Alpha version in the BIE model (see Figure 6).

6.3.1 **Planning functionalities**

After business line needs are established, the next step is to plan the new design. Based on the business needs and my personal usage of the applications, it became clear that streamlining everything in one place would be ideal. Waiting for any part of the data creates unnecessary downtime in the process. One should be able to read the data in such a form that it is easy to use, and there is the possibility of separating individual information without assistance from other people. The best alternative, in this case, is to use a sheet form that has interactive columns. Important is to have those tables and fields that the planner or any other relevant user needs to see.

At first, the most important fields include the material code (part number), part description, and the quantity required. Then the planner needs to know the plant where the part would be shipped from. There is a possibility that the local front-line has the item on their stock, so the local plant code is the fourth column, and the fifth is their stock quantity. Then if that plant cannot serve the internal customer, the stock situation is checked from distribution centres. If the machine is located in Europe, then the sales order will come to European Distribution Centre, and if it is located in Asia, it will come to Asian Distribution Centre and so forth. Each plant has a default replenishment distribution centre (DC) where that front-line is most likely to order. The following columns include the related DCs open purchase order (PO) quantity, ROP and available stock. They are necessary for observing how the related DC is prepared for each item. For example, if the open PO quantity indicates that multiple parts are arriving from suppliers, then there is no need to transfer stock from other DCs. If that is not the case, other DCs stock availability is needed.

Column number 12 contains the date when the machine should be serviced with the kit. As previously determined, the list should include kits that are needed within a year. Due to the interactive nature of the report, the planner should be able to filter a three-month period from the planned date. The following columns (13-17) were requested for both ease of use and for providing front-line units with the possibility to differentiate the machines. For them, columns like country of location, machine number, maintenance kit, and running hours provide the necessary information and the possibility to filter those machines located in one specific country or market area. Table 5 shows the necessary data fields of the designed system.

TABLE 5. Each field and its purpose in the solution. Created by the author based on LOB

Field nr	**Column name**	**Purpose**
Field 1	Part number	Identifying item code
Field 2	Parts description	For ease-of-use
Field 3	Quantity	Gives quantity needed
Field 4	Maintenance/local plant	First plant for stock checking
Field 5	Available local stock	Quantity at maintenance/local plant
Field 6	Default repleshment DC	DC where demand would show
Field 7	Open PO quantity in DC	Tells whether purchases are expected
Field 8	ROP in DC	Current ROP. Can be altered by the planner
Field 9	Available stock EDC	DC where stock could be moved from
Field 10	Available stock ADC	DC where stock could be moved from
Field 11	Available stock USDC	DC where stock could be moved from
Field 12	Planned date	When customer needs the part (filtering for 3 months demand and view for 12 months)

Field 13	Machine country location	For front-line units to select their countries
Field 14	Machine nr.	Identifying machine number
Field 15	Maintenance Kit	Maintenance kit that item belongs to. For ease-of-use and filtering
Field 16	Running hours	Machines' current running hours
Field 17	Maintenance Plan	Different services have specific plans that include certain service actions or parts

6.3.2 Overview of design

Based on Table 5 described in the previous section, a designed overview of how the solution would look like in the IoT application. In the example Figure 15, an imaginary situation with dummy numbers. The table contains two machines in Australia that need two different kits and one machine in Finland that needs one kit. In this situation, one can note that plants can have a different available stock to one item compared to another plant. Their stocks are determined by using previously mentioned demand planning practices (Section 3.4). In the table's example, JP00 has more demand in ADC than in EDC as the ROP is set as five there and two in EDC. One can also detect that kits contain different parts, which can overlap. KIT007 contains JP00, JP01, JP02 and JP03, where KIT008 only contains parts JP00 and JP01.

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	Field 9	Field 10	Field 11	Field 12	Field 13	Field 14	Field 15	Field 16	Field 17
FLU Plant	Available local stock	Default repleshm ent DC	Open PO qty in DC	ROP in DC	Available stock @ EDC	Available stock @ ADC	Availabl e stock @ USDC	Planned date	Item number	Parts description	Quantity	Machine country location	Machine nr.	Maintena nce Kit	Running hours	Maintena nce Plan
AU01	1	ADC	10	5	5	10	5	1.3.21	JP00	Seal, blue	1	AU	AU117	KIT007	4950	DRGFI
AU01	1	ADC	10	5	5	4	5	1.4.21	JP00	Seal, blue	1	AU	AU118	KIT008	5500	FRK07
AU01	2	ADC	0	2	10	2	4	1.3.21	JP01	Rubber hose	3	AU	AU117	KIT007	4950	DRGFI
AU01	2	ADC	0	2	10	4	8	1.4.21	JP01	Rubber hose	3	AU	AU118	KIT008	5500	FRK07
AU01	1	ADC	20	5	8	5	5	1.3.21	JP02	Filter	1	AU	AU117	KIT007	4950	DRGFI
AU01	4	ADC	20	4	7	2	5	1.3.21	JP03	Seal, black	1	AU	AU117	KIT007	4950	DRGFI
FI01	2	EDC	0	2	3	4	31	1.5.21	JP00	Seal, blue	1	FI	FI14	KIT008	3000	FRK07
FI01	2	EDC	0	2	3	1	5	1.5.21	JP01	Rubber hose	1	FI	FI14	KIT008	3000	FRK07

FIGURE 15. Designed view of the sheet based on business needs

6.3.3 Source mapping

To provide the fields required, the next step is to determine where one can get all this information and where it should be available. Kalmar's ERP contains most of the needed information like the part description, plant locations, stock situation, and ROP. The rest is located in Cargotec Cloud, or it is used by IoT applications already. To have all this data together in one place, one needs to establish a connection between the sources. Therefore, whichever application or platform is used, it must be able to compute all the data together and be in such form that inventory planner can filter and alter it according to their needs. That leaves me to conclude that QlikSense would be the best platform to build the solution in. QlikSense is already receiving information from Cargotec Cloud, and it has data from Gateway and ERP on it. One can also scroll and filter it without affecting the visibility of other users who are checking the data at the same time. Kalmar central operations and front-line units already use QlikSense, so there is no need for training either. The new targeted solution would be an interactive sheet where all the needed information is in one place. After deciding the platform, began mapping of data sources and their connectivity. This map is presented in Figure 16 below.

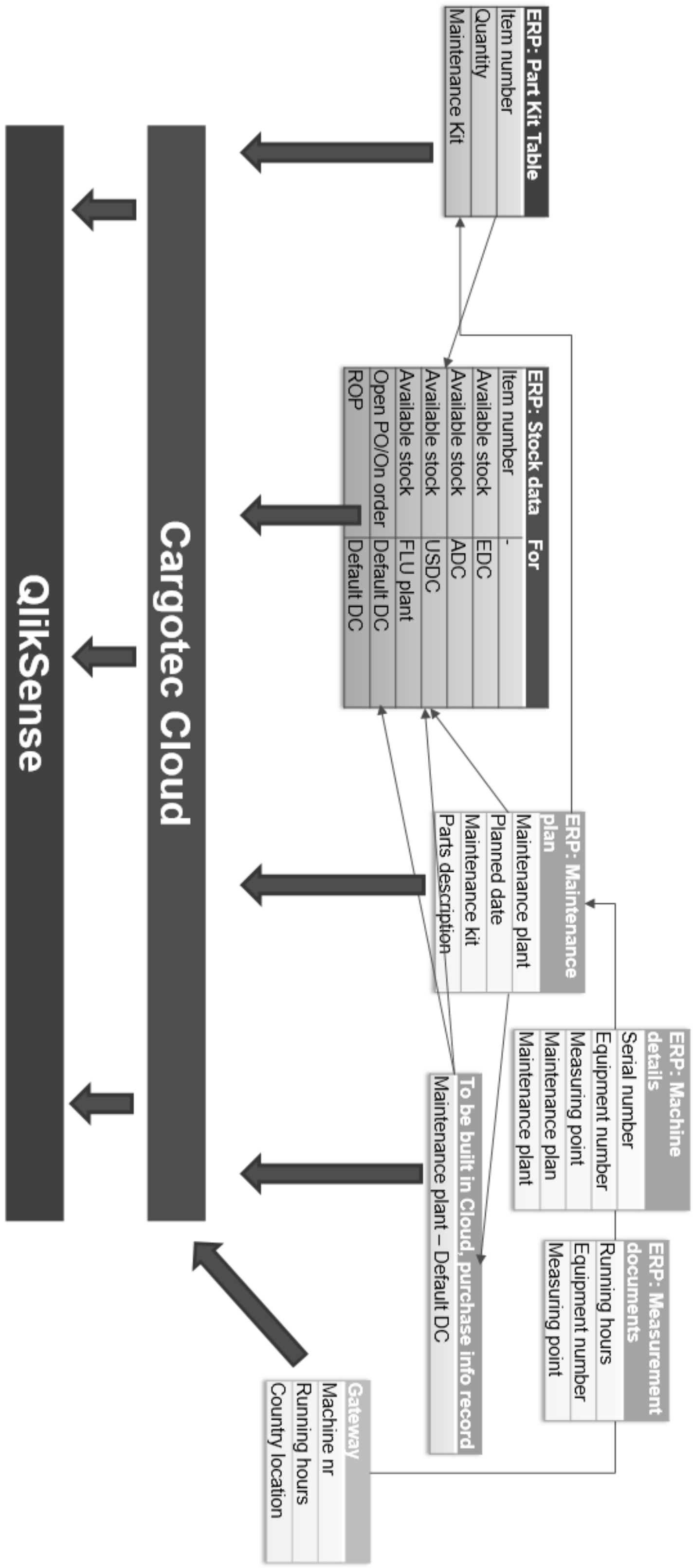

FIGURE 16. A map of sources for each data that is needed in the solution. Each ERP table represents a transaction in SAP where the data is extracted

To set up the sheet operable in practice, one must establish connections from one source to another. Planning the connection was formulated by using key attributes, and through that, a source listing came together that can be used when the solution is implemented. In Table 6 below are key attributes of each source. This design facilitates future changes and requirements as one can retrieve more data from the chosen sources or connect others to it by using any key attribute.

TABLE 6. List of key attributes born during mapping

Source	**Key attribute**
Gateway	Equipment number
ERP: Measurement documents	Equipment number, measuring point
ERP: Machine details	Maintenance plan, Equipment number
ERP: Maintenance plan	Maintenance plan, Maintenance kit
ERP: Stock data	Default Distribution Centre, Item number
ERP: Part Kit Table	Maintenance kit, Item number

At this stage, the design is ready, and the case organisation can begin development to production. In the research, the next step is to analyse and evaluate the design. Analysing was possible for not only research purposes but also business-wise since the outcome was approved by Kalmar as well.

7 RESULTS

Results are analysed based on the two hypotheses. "Implementing a single IoT step will decrease human effort" and "Implementing a single IoT step will decrease the number of IT solutions needed". The first one will indicate whether the solution has had or will have a social effect, and the second one will be a technical evaluation of the two processes. The second one will measure whether the solution was able to limit the number of IT applications, systems, and communication through different solutions. Other indicators to analyse the design are business need, literature, and future use of the solution, which are incorporated into each hypothesis chapter. Future use of solution was one of the criteria that also Sein et al. (2011) highlighted in the ADR method.

7.1 The first hypothesis, social aspect analysis

At first, analysis of solution's social aspect is summarised. Both interviewees felt that the old process was not productive and should be replaced. Both were aware and, to some extent, familiar with IoT cloud and knew about the possibilities it could offer. Once the new design was ready and sent for approval, it managed to cut the first individual, the analyser, completely out of the process and restored their working time to other tasks. The analyser felt that the new design met their requirements. As for the planner, they gave their input with the design in order to detail it to fit their tasks in this process. The solution means for planning that they are responsible for steps one and four in the previous process (Figure 9) but in a new way. Email communication and other steps were not necessary anymore, and decisions were possible with real-time data instead of double-checking ROPs twice (sending the email and adjusting when requested). The social aspect of the study was evaluated mainly by emails, and both parties gave their input in the desired process. It was their request that roles are diminished as much as possible and that IoT is used as Kalmar already had most of the information and data available. Based on the changes that had taken place on the social side, a Table 7 was created with the adjustments.

TABLE 7. Comparison of demand planning process from social aspect

Role	Before	After	Before	After	Before	After
	Time invested quarterly		Steps involved in, ref. Figure 9 and ref. Figure 14		Role description	
Analyser	Estimation: 8 hours	0h	1-3	0	Analyse, email, compare, suggest adjustments	No role
Planner	Estimation: 2-8 hours	Estimation: 1h less	2-4	2	Send ROP lists, wait for suggestions, alter ROPs	Compare real-time data and adjust ROPs

The literature part (see Section 2.4) discussed the practical and human challenges of IoT. PwC's (2018) report indicated seven different areas where one should pay attention while implementing IoT. Next, the case process is analysed against these seven areas.

The 1st challenge, the lack of IoT strategy, was solved by designing the new process in a way that the case company already utilises IoT. QlikSense is using IoT data, and Cargotec Cloud holds data from various sources; therefore, this solution is within their IoT network and fits in an already existing model. Kalmar built the cloud in 2016 to enable IoT solutions (Cargotec, 2021), and this research supports that business strategy. As for security hazards (2nd challenge), all cloud data is protected by VPN and Cargotec firewalls. When there is no new environment, the security aspect is already taken care of. With the 3rd challenge, PwC (2018) noted interoperability within platforms. That is something that the new design can additionally avoid. As the outcome is placed within an existing platform where cloud data is proven to work, interoperability is not an issue. Scaling (4th challenge) is performed by providing a comprehensive plan for the development team, which consists of a detailed description of what is needed, what is not, and what is the data needed for. Scaling for the right purpose on large companies is essential when the development teams serve multiple units with varying business needs. The solution must serve its original need and not spread to multipurpose use as it might decrease the quality. Scaling is one way to prove IoT's benefits. When IoT projects are large, it is difficult to track the origin of each improvement. Role defining (5th challenge) was a simple task for a project this size. In the IoT ecosystem, one could have an external partner, but in this case, IoT was designed, tested, and built by Cargotec employees or close partners. It will be supported and used by them as well. Therefore, the role was clear, and there were no miscommunications on what each individual should work on. The next (6th) challenge, communicating IoT to users to enable monetising was quite easily faced, as this process is limited to very few users, and they could see the benefits directly. That could encourage others to try streamlining. The last (7th) challenge, organisational issues due to lack of skills, innovation, and governance, was avoided throughout the study as it became clear that Kalmar has the team for this kind of implementation and users are already familiar with the platform. It was clear that improvements through IoT are welcome and supported by the case company, and there are skills to implement this.

Other challenges that were introduced in section 2.4 are handled to various extents by already existing security measures, and data flow is constantly followed. One possible issue remains; the accuracy of the data from sources remains the same. Whether there will be faulty data coming from gateways or there are security breaches, that is not in the scope of this information science solution to study but are noted as possible weak links. Faulty and inaccurate data could cause the solution to seem less attractive for the end-users and therefore decrease satisfaction of the process. Naturally, the accuracy of the data is crucial for the case company as business decisions rely on it.

Yerpude and Singhal (2017) listed (section 2.5) five benefits that were agility, strategic advantage, revenue growth, cost savings, and accuracy and relevancy. From their list, Kalmar benefitted as following. Planning can now be executed based on real-time data, and that gives the advantage of preparing stock where demand is foreseeable. The solution also brought proactive responsiveness and eliminated delays from communication. The new speed of information and access to interactive sheet enabled Kalmar to free an unnecessary data processing and analysing role completely. If one evaluates the social solution against the results, it can be said that the listed advantages of IoT are true.

Farahani et al. (2015) mentioned in the same chapter many aspects of IoT that are important to supply chain management. Especially increased cooperation, visibility, and improved service were noted from the outcome by the end-users in the analysis phase.

In conclusion, the hypothesis “Implementing a single IoT step will decrease human effort” was confirmed in this business case. People involved felt that their tasks became easier than before, or their roles were eliminated. The challenges that were presented in the literature part were used in the design phase to avoid common mistakes as much as possible, and benefits from the literature were used to evaluate the outcome. As for Sein et al.’s method (2011), end-users were happy to provide access to their tools and felt that they could save time and effort when the researcher tried out their tasks. There was no need to explain every aspect, and the researcher could easily identify the key issues in the process. The ADR method was also efficient in designing when one could present options and solutions to users, and they could comment on those fast and provide feedback. Working projects were visible to them the entire time in a shared cloud, and the study got pleasant feedback for the possibility to see the result throughout the development. End-users gave instant comments like “I added some fields we need” and “This looks really good”. Socially this was interactive and aligned with employees’ needs.

7.2 The second hypothesis, technical aspect analysis

To find out if the second hypothesis, “Implementing a single IoT step will decrease the number of IT solutions needed”, is true, quantity of IT solutions between the original and the targeted process was calculated. In the original process, there were six different IT-related steps. To begin, the analyser needed the ROP list from the planner, who used SAP to get it (1. & 2.). Then the analyser checked it against information in QlikSense (3.). Then they send it back to planning if parts needed adjusting (4.) The planner then used Servigistics (5.) to adjust the ROPs accordingly. Finally, they confirmed via email or another communication forum (6.) that changes were completed. In the new process, the planner checks from QlikSense the new sheet and changes the data in Servigistics, if adjustments are needed. All changes reflect in QlikSense, and interested parties can see them there directly without extra email communication. The results are listed in the table below.

TABLE 8. Comparison of IT solutions needed, the technical aspect

<table>
<tr><th>Needed tools originally</th><th>Needed tools with the new solution</th></tr>
<tr><td>1. Email</td><td rowspan="3">1. QlikSense</td></tr>
<tr><td>2. SAP</td></tr>
<tr><td>3. QlikSense</td></tr>
<tr><td>4. Email</td><td rowspan="3">2. Servigistics</td></tr>
<tr><td>5. Servigistics</td></tr>
<tr><td>6. Email</td></tr>
</table>

IoT based solution enabled the use of big data. That empowered a cloud solution where all data is gathered in one place, and therefore the need for different applications decreased. Big data has three attributes: velocity, volume, and variety (Marjani et al., 2017). This hypothesis was proven using them. The data that is needed in this process can be picked from various sources and be tailored to fit business needs. It can also be drawn without overwhelming the report with all the data that the sources offer. Data is further updated automatically and has no requirement for manual adjusting. Overall, the benefits of big data meant in this case study that all the data that Kalmar has; is shaped into a form that is beneficial to them. Obstacles with utilising big data are in data, knowledge discovery, and processing (Marjani et al., 2017). Those issues were tackled with the data map, (Figure 16), so extracting information would be easier. In addition to volume, velocity, and variety, Mao and Liu (2014) introduced the fourth "v" = value as a big data attribute. Data that varies comes in big scales and is quickly available can have value if one can utilise it (Chen et al., 2014).

During the designing phase, the study also had to take into account demand planning needs. According to previously introduced literature, Section 3.4, the industry's revolution enabled machine-to-machine communication and other technological advancements usable for consumers and companies. Therefore, technology can be used for proactive planning instead of a reactive one. In the case study, this meant that the planner who will alter the ROPs finds the solution and the platform fitting their needs, so they can operate with proactive planning. As for the struggles with supply chain visibility and transparency, the technical solution opened the process for all who use QlikSense and especially the maintenance sheets in it. Before, the process was handled only by two individuals who had an active role. In addition, it was not visible for others to see what kind of stock situation the parts had. Getting that information would have required a lot of copy-pasting from different sources, and it would not have been in real-time. Now everyone with access to maintenance sites can see the situation themselves and contact the planning department with their concerns if they have any. That also reduces barriers and opens the discussion. ITU (2012) wrote that IoT is expected to advance networking and decision-making. Those effects came along when the initial issue was solved. Those benefits are not only social but also technical when the data is located in one place and the need for multiple sources decreases. If the old process and extra email communication were still in place, it would be difficult to include other people in the process. Therefore, one can conclude that the technical aspect was a success in multiple ways and contributed to the social benefits as well.

Baskerville and Myers (2004) stated that information science researchers have difficulty establishing their research practically relevant. Based on the two evaluation aspects that were formulated for this study, one can state that the outcome was proven to bring practical change, and it had a concrete solution that could be utilised. As mentioned before, ITU (2012) wrote that IoT has technological and societal effects. When those were used as a measurement type, both of them changed for the better. The results inspired a new IoT process model that this research had an opportunity to test in the case company. The next project has already begun to adopt and test the process model. This process model is presented in the next section.

7.3 New IoT process model

Baskerville and Myers (2004) have stated that the outcome from AR researches should create a class solution for similar cases. Based on the findings of this study, a process model was established based on the ADR method for individual IoT tasks, which worked in the study well. The model could be used as a baseline in the case company and possibly in other companies to study tasks that are linked to utilising IoT with cloud data. After this study, the researcher is involved in further similar projects at the same organisation that are giving them the possibility to test whether the new IoT process can become a practical model for this organisation.

The proposed streamlined IoT process is divided into seven phases. Phases are listed with concrete actions in Table 9. The first phase (1) is finding out the main subjects of the issue and researching those. In this case study, subjects were IoT and demand planning, but for other cases, they could be IoT and purchasing. The second phase (2) studies the compatibility of subjects; what is known about their benefits combined? Then at phase three (3), using the tools and IT solutions in practice as an end-user to understand the context of the issues. That would include interviewing current users. After this, one can determine how to evaluate the outcome. Fourth point (4) stresses scoping the current platforms and (cloud) data to see whether those can be utilised. Phase five (5) is designing a realistic option that fits organisation’s needs. The next phase (6) is to test the design in practice to verify that the original issues are not present any longer and to continuously share its development versions with end-users and altering the design iteratively (as in the ADR method). In the final phase (7), the results are measured in a similar method as in this study.

TABLE 9. New IoT process model by the author that will be tested in the following IoT projects

Phase	Concrete action
1	Research the main topics (IoT + the relevant subject to be studied)
2	Study of subjects’ compatibility and previous findings
3	End-use practising and interviewing. What are end-users actually interested in changing → find measurements on both the social and technical side
4	Scope what data is already collected and whether it can be used
5	Design a realistic option that solves end-user issues

6	Test continuously and allow access to end-users to see the design and alter it accordingly
7	Measure social and technical results as applicable

7.4 Limitations

Ellis et al. noted in 2015 that the Internet of Thing's success could vary depending on the implementation. If end-users are not familiar with the limitations and capabilities of such a system, benefits may not be seen to the full extent. In this case, there still might be aspects that could be utilised with the cloud data, but each of those has to be researched individually. Ellis et al. (2015) point out that to evaluate the success of the implementation, one needs to look not only short-term, but also long-term solutions. In the study, one is not able to measure long-term effects, but this process was quite straightforward re-processing, and benefits were meant to fix a single procedure in order to save working hours, reduce IT solutions, and form a path for future projects, not to bring long-term unexpected advantages or disadvantages. If long-term effects appear later on, it might be difficult to trace them back to this IoT project. Who is to say whether they outweigh the negative sides of the past process? Therefore, one has to acknowledge that tracking those requires active follow-up.

Some limitations are related to working with a single case company. As this study was realised with a specific organisation with certain equipment and database, it might be that different outcome would have been born from different inputs and connections that were established in the system. There is to note additionally that in this research, information from enterprise resource planning (ERP) is assumed correct and truthful. It may or may not consist of information that is incomplete or has errors, but those are acceptable within this study. Such error could be that once a solution is implemented and it relies on ERP, it contains false ROPs to some parts that are human or system errors. Abnormal figures were scoped by two individuals in the original process, but in case of incorrect data, the reliability of the outcome can create distrust in users.

Any ethical or moral questions were not present in the study process and the solution does not demand access to anyone's private information. Therefore, global laws on privacy, like GDPR, are not required to acknowledge. The data itself is owned by the case organization and customers who have granted access to it. This alone changes the requirements compared to projects related to human resources or salaries.

7.5 Further research

As for further researches in this area, there are multiple departments where to test implementing IoT but the individual differentiations in their business processes can bring results that are not present in this study. Supply chain is one of those fields that is keen to utilise IoT, but similar interest and help in other internal processes could vary. In the case study, the researcher also works in supply chain management themselves, which provides deep understanding to the problems that were present. Doing similar researcher outside the industry might affect the outcome.

The study does not either determine what kind of measurements in social and technical sides are optimal for each field or each case company. Therefore, in future cases there is a possibility to create a mapping for measureable outcomes that ADR researchers can use while looking for concrete outcomes. This case study had working time and IT solution quantity, but another case might benefit from employee satisfaction rate or the cost of IT licences after the fact.

Another future topic could be to test if personnel is more willing to accept major implementations of IoT if they see a smaller scale projects bringing results to colleagues.

8 CONCLUSION

Both hypotheses, “Implementing a single IoT step will decrease human effort” and “Implementing a single IoT step will decrease the number of IT solutions needed”, were true with the selected measuring methods. As analysed in chapter 7, the case study showed that IoT and IoT platforms are possible tools even in smaller projects when it comes to reducing manual labour and the number of IT solutions used. It is important to build solutions to fit business needs and to take stakeholders into the design phase so that end-users benefit from the outcome and their previously existing obstacles are truly solved.

In practice, this study managed to erase the current issues in the process and proved that IoT implementations could be task-targeted and give results. It additionally showed that issues companies struggle with could be solved with the data that they already have. As for working with the method with interviews, end-user practising, and organisational familiarity, that is supported by organisations.

What is the value of this study for the scientific community? This research demonstrated that design studies have concrete and practical outcomes that are possible to measure. Outcomes affect both social and technical aspects, as one cannot operate without the other. The study also indicated that focusing on individual processes gives the opportunity for the researcher to gather detailed and deep feedback that is not possible in large projects. Focusing on end-users point of view gave productive results and feelings of being heard. Would a project with large-scale production bring such results?

The follow-ups could focus on either social or technical effects that were not noted in this research. Those could be the employees’ personal experiences on refocused tasks and productivity measurements after the fact. Did they feel heard or revealed with the change? With technical aspects, the follow-up could include cost savings from technical licences. Further studies could research any of the mentioned and see how the model (Table 9) works in different settings.

Positive results from the case leave one to conclude that there is a possibility to create a streamlined process to follow in smaller IoT projects with specific interests. Technology and services for it are globally accessible. As stated in the Harvard Business Review, utilising big data and IoT is not a question of technology, as much it is about management (Redman, 2017). That statement is endorsed in this case as access to the technical side and end-user interface helped to stay on track and helped to avoid designing an application that is useless to those who need it. The way of management at the case company and their willingness to give full access enabled that.

In the end, the solution itself was about building a bridge for end-users, data sources, and designing a platform where the data can be accessed in a suitable format.

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