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Improvement of the material supply system in health centres

A case study of Primary care within Västra Götalandsregionen

Master's thesis in Supply Chain Management

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SUMMARY

Today, healthcare is facing complex challenges. In five years, the number of inhabitants in Västra Götaland is expected to increase with 120 000 people. However, the healthcare sector is facing scarce resources, and there is no sign of increased financial resources. Within the healthcare region in western Sweden, healthcare workers are responsible for ordering material, and the process is time-consuming. The material supply system is handled manually, and the assortment of articles is wide which leads to excess inventories and increased inventory costs. Therefore, a material supply system called MiV 2.0 (Materialförsörjning i Vården 2.0) based on a Kanban system was developed. By introducing the MiV 2.0 concept, the service organisation within the regions is responsible for the material supply system, including the material handling, which in turn enables healthcare workers to spend time on clinical work instead. Today, the concept has been implemented at the Skaraborg's hospital in Skövde.

The purpose of this study is to investigate how the MiV concept can be applied at health centres within Primary care to create an efficient material flow, efficient use of competence as well as increased safety for patients. It is also crucial to investigate which potential benefits it will result in. In order to do that, the MiV 2.0 concept at hospitals was studied and relevant problems as well as potential improvements were identified. It also gave the authors an understanding of the concept. Potential hindrances for implementing a material supply system as MiV 2.0 into the healthcare context were also investigated.

The qualitative study is primarily based on interviews conducted with healthcare workers, both at Skaraborg's hospital in Skövde, and at eight health centres within the healthcare region in western Sweden. Relevant literature has been studied. The collected data were analysed and identified problems were categorised. By categorising problems and relating them to the literature, adaptations of the MiV 2.0 concept at hospitals were identified to improve the material flow at health centres.

Today, the material handling process at health centres is decentralised with limited coordination and control. No common standards regarding the assortment of articles exist, nor how the material handling process is managed. There are no common standards for how storages at health centres should be structured in order to be as efficient as possible. Therefore, the material supply system at health centres needs to be centralised. A standardised and common assortment of articles for all health centres is suggested. The coordination and control need to be more centralised compared to the decentralised approach today. In order to enable an efficient material flow, storages at health centres need to have a standardised structure where each article has its assigned place and quantities are predetermined. The implementation needs to be clearly established and supported by strong leadership in all parts of the organisation, which is an important factor to take into consideration, as this can be a reason why the implementation phase fails. The suggestions are in line with the MiV 2.0 concept.

Keywords: material supply system, material handling process, health centre, Lean healthcare

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This master thesis has been conducted at the department of Technology Management and Economics at Chalmers University of Technology. The researchers study at the master's program Supply Chain Management. The study was conducted on behalf of Regionservice and began in the middle of January 2021. The master thesis has provided the researchers with an opportunity to improve the material supply system at health centres within VGR and thereby increase the quality of patient care. This has been a motivation for the researcher during the whole study. Further, by getting the chance to apply the knowledge we have gained in practice has been valuable.

We want to express our gratitude to our Supervisor Hanna Co at Regionservice for helping us and guiding us in the right direction. It has been of great importance for the study and has provided us with the best opportunity to reach a conclusion of the study. We further want to thank the MiV Project group and everyone who has contributed to the study. We want to give further thanks to all healthcare workers who have given us their time and participated in interviews and workshops and shared their knowledge.

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Emma Forsman & Julia Nero
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1. INTRODUCTION

In the following section, the background of the study will be presented, as well as purpose, research questions and limitations which have been made.

1.1 Background

Today, healthcare is facing complex challenges. In five years, the number of inhabitants in Västra Götaland is expected to increase with 120 000 people, where the major increase is young people and elderly (Regionservice, 2021). Brandt (2013) implies the same scenario and discusses that even though the general health has improved, the need for care is growing. Brandt (2013) further discusses the ongoing political trend in Sweden where patients should have a bigger impact and be able to choose freely regarding type of care and where to receive it. This has created higher awareness among inhabitants in Sweden, which in turn has led to higher demands on the healthcare sector. However, the healthcare sector is still facing scarce resources, and there is no sign of increased financial resources. This implies that resources need to be used more efficiently. Therefore, it is crucial that the healthcare sector searches for inefficiencies in order to make improvements within processes and activities.

Landry and Philippe (2004) describe the complexity of a hospital's distribution network, which is often related to poor developed inventory management (Kritchanchai et al., 2018). Landry and Philippe (2004) further describe how workers at hospitals have to spend time managing logistics and material planning, which often leads to large inventory volumes and high inventory costs. According to Landry and Philippe (2004), it is estimated that nursing staff at a typical hospital spend 10 percent of their time on logistics activities instead of taking care of patients. It is also estimated that up to 46 percent of a hospital's total operating costs is spent on logistics activities (Landry & Philippe, 2004). Khlie et al. (2016) further discuss costs related to logistics within the healthcare sector which represent a large part of the total healthcare budget. The costs are estimated to range between 25 percent and 46 percent (Khile et al., 2016), which Landry and Philippe (2004) also discuss above. This shows how logistics within healthcare is a potential area for cost reductions. Khile et al. (2016) argue that American hospitals can save up to 48 percent in costs related to logistics by introducing new logistics management approaches.

Kritchanchai et al. (2018) discuss how problems related to logistics within healthcare in Asia often are related to inventory management and not having standardisations of data in the supply chain, which indicates large improvement potential related to logistics performances also in Asia (Kritchanchai et al., 2018). Kritchanchai et al. (2018) further discuss how one option to solve this is to increase the organisational efficiency by measuring the performance of the organisation. Therefore, the healthcare sector needs to develop an adapted information system (Kritchanchai et al., 2018). Khlie et al. (2016) further state the importance of information systems within healthcare organisations. The authors argue that in order to gain the benefits of

logistics management approaches, the healthcare sector needs to develop a performing information system to support the process by providing the right information at the right time. Persona et al. (2008) discuss the lack of management processes within healthcare. Even if there is a lot of documented evidence of benefits and competitive advantages when implementing logistics management approaches, the healthcare sector seems to adopt this approach slowly, despite the opportunity for cost reduction and efficient workflows (Persona et al., 2008).

In 2010, an analysis was done of the current situation within the healthcare region in western Sweden, further mentioned as VGR, in order to find inefficiencies. A number of consultants found potential for efficiency improvement within the material flow. Within healthcare, *healthcare workers*[1] are responsible for the *material handling process* [2]such as ordering and unpacking of material. The process of ordering material is carried out in the ordering portal called *Marknadsplatsen*[3], which is a time-consuming process. At the same time, surgeries are cancelled and there is a scarcity of trained workers. The material handling process is also fragmented and no standard for how to carry out the process is found. The process is done manually, and the assortment of articles is wide which leads to excess inventories. Therefore, the *MiV* [4]concept was initiated and an implementation plan was carried out. By introducing the MiV concept, the service organisation within VGR, further mentioned as Regionservice, is responsible for and handles the *material supply system*[5], which enables healthcare workers to spend more time on clinical work. The project has so far led to a 50 percent saving both in time and money (Regionservice, 2021).

However, the healthcare sector is constantly facing financial challenges and the project was paused for financial reasons. Within healthcare, larger improvement projects with the purpose of making processes more efficient often requires large investments. Nevertheless, decision makers within healthcare tend to search for solutions which require low investments. However, the concept of MiV has spread during the years and care units have implemented adapted versions of the concept. It has also been requested by Regionservice to take care of the material supply system within healthcare in order to enable healthcare workers to focus on clinical work instead of administrative work tasks. As a result, in 2020 the Regional executive committee

[1] *Healthcare workers consist of nurses and assistant. However, assistant nurses are in the most cases responsible for the material handling process and will be named nurses in the report.*

[2] *The material handling process is defined as the process of material ordering in Marknadsplatsen, inventory of materials, receiving material, unpacking of material and placing the material in the storages.*

[3] *Marknadsplatsen is the Swedish name for the common ordering portal for all employees within VGR.*

[4] *MiV is a shortening of Materialförsörjning i Vården in Swedish. Translates to Material supply system within Healthcare in English.*

[5] *The material supply system is defined as the whole process of supplying material.*

made a decision to prioritise MiV and the project was politically supported and called MiV 2.0. In 2020-2024, the goal is to implement the concept to 550 care units at hospitals within VGR. Today, Skaraborg's hospital located in Skövde, further mentioned as SkaS Skövde, is the first hospital which has implemented MiV 2.0 successfully. The implementation has led to a reduction in time used for the material supply system with 34 percent. This implies an annual cost saving of 33 MSEK. In 2020, an IT system was developed in order to support the standardised processes within MiV 2.0 and has today been implemented at SkaS Skövde. The IT system is expected to save further 3.4 MSEK. The primary goal of introducing MiV 2.0 is to make the material supply system more efficient from a time and resource perspective and to reduce purchasing costs. Space is also freed up at care units by reducing the space needed for storage (Regionservice, 2021).

In parallel with the implementation at care units at hospitals within VGR, Regionservice has initiated a project where the aim is to investigate how MiV 2.0 can be adapted and implemented at health centres within Primary care in VGR. The project is still in the start-up phase and is expected to proceed in Q4 2020-Q1 2021, with the primary goal of making the material supply system more efficient.

1.2 Purpose

The purpose of the master thesis is to analyse how MiV 2.0 can be adapted to make the material supply system more efficient and improve material handling processes at health centres within VGR. The purpose is further to investigate which advantages it may result in, and study factors affecting the implementation. The primary goal of MiV 2.0 is foremost to create an efficient material flow. Hopefully, it will lead to more efficient use of resources as well as increased safety for patients. Since MiV 2.0 reallocates resources, a higher degree of work satisfaction among healthcare workers will probably be achieved, as the concept will enable the healthcare workers to focus on patients instead of administrative tasks.

1.3 Research questions

In order to present a more efficient material handling process within Primary care, two research questions need to be answered:

1. How can the MiV 2.0 concept be adapted within Primary care to improve the material handling process at health centres?

In order to be able to improve the material supply system within the healthcare context, it is important to have an understanding and realisation of factors affecting an implementation of management principles in another context than industrial environments. Therefore, the following is investigated:

2. Which factors need to be taken into consideration when implementing a material supply system as MiV 2.0 adapted for industrial environments into the healthcare context?

1.4 Limitations

The study is limited to eight health centres within Primary care in Västra Götaland. Therefore, the study only considers the material supply system and material handling processes at these eight health centres and it is assumed that these are representative for all health centres within Primary care in Västra Götaland. The study will not include privately owned health centres within Västra Götaland.

The focus of the study is the material flow, which implies that the patients nor their experience is taken into consideration. However, patients may experience increased safety and quality due to higher material availability and more available time with healthcare workers.

The focus area of this study is the material supply system at health centres. It is assumed that material is supplied at the time needed. Therefore, the transportation network within VGR will not be studied for the purpose of change. However, it will be studied in order to provide the researchers with an overall understanding of the distribution network.

2. THEORETICAL FRAMEWORK

The following section aims to present theoretical concepts and methods which have been used in the study. First, a brief introduction is given of logistics within healthcare. Further, Lean management is brought up and described, where 5S and Kanban are central parts. An introduction of Lean management is given in order to provide the reader with an understanding of the Lean production philosophy. Centralised supply chain planning and factors related to the working environment are also described. Finally, relevant factors hindering an implementation of industrial management concepts into the healthcare context are highlighted.

2.1 Logistics within healthcare

According to Wang et al. (2015), inventory costs at hospitals account for approximately 30 to 40 percent of the total expenses for a hospital. The biggest problem hospitals face regarding the inventory is the large amounts of material, as it has to be in place at all times due to the variety of patients. In a hospital there is no possibility to predict the demand in the same way as in the manufacturing industry. The effect of this is hospitals having problems using efficient inventory management methods (Wang et al., 2015). As discussed by Wang et al. (2015), hospitals often organise inventories in different levels and have replenishment storages in care units as well as a large central storage. Inventory storages are often managed by the healthcare workers, who base material ordering on personal experience instead of what is actually needed based on actual usage (Persona et al., 2008) (Wang et al., 2015). One method often used for replenishment at hospitals is a reorder point system with a safety level. At hospitals, healthcare workers are often responsible for replenishment of material, and therefore set the safety levels after what is desirable for them, not what may be the optimal level (Wang et al., 2015). The core business of the healthcare sector is to deliver care to patients and the material supply system is a support function. However, an absence of the material needed at the right time can have consequences on the given care (Landry & Beaulieu, 2010).

2.2 Lean management

Lean management is a production philosophy and strategy based on the Toyota production system and the basic idea is to use methods for eliminating internal waste while maximising productivity (Tlapa et al., 2020). In order to accomplish productivity as well as to reduce waste, minimising buffers and having a high degree of standardisation are important methods to use in order to be successful within Lean management (Oudhuis & Tengblad, 2013). In Lean management, waste is seen as anything the customers do not consider as value-adding and are willing to pay for (Chiarini, 2012). The method also includes just-in-time production in order to maintain low stock balances to reduce waste. The basic idea is to produce the right amount of products requested by the customers in the right time (Chiarini, 2012). Lean management is developed within the manufacturing industry and the idea is to obtain a perfect balance between capacity and workload.

Lean management has also been applied outside the manufacturing industry and has been proven successful in another context as well (Persona et al., 2008). According to Oudhuis and Tengblad (2013), the use of standards is a necessary element in Lean management, as it can help the workers to take their responsibility as well as create a confidence for the workers to contribute to further improvements. It is according to Oudhuis and Tengblad (2013) important to consider that standardisation needs to be applied to processes which are easy to control, and to create standards for the core operations when implementing Lean management.

2.2.1 5S

One of the Lean management methods is called 5S, which stands for sort, straighten, shine, standardise and sustain (Abdallah, 2020). According to Chiarini (2012), 5S allows the workers to focus on their main tasks, which decreases the risk of failure. The method allows for increased productivity, better quality as well as increased safety and security by making problems in the organisation visible. Gupta and Chandna (2020) further discusses how 5S is flexible as it can easily be adopted to all types of organisations.

Sort means to choose the most useful activities and separate them from the less useful activities. This enables improved quality as well as increased productivity. Straighten implies that material and tools are cleaned which makes it possible to find the tools or materials easier. Thereafter comes shine which means to clean up the whole area. Standardising means to make the instruction of the process easy and simple to understand for everyone. It is important to maintain the area clean and tidy according to the steps before, and it has to be repeated in order to become a daily routine. The instructions further need to be visible and easy to find. Sustain means to ensure that the organisation maintains order and tidiness and to improve the steps if needed. The procedure also requires discipline in order to reach long-lasting results (Chiarini, 2012).

2.2.2 Kanban

Kanban was introduced to the Japanese manufacturing industry in the 1950s (Ahmad et al., 2013). It is a method for visualising the workflow using Kanban cards and the concept is closely related to just-in-time production (Jonsson & Mattson, 2009). Kanban is classified as a pull system since the rate of production is controlled by the demand. The demand is passed from the end customer upstream in the chain (Ahmad et al., 2013). The Kanban cards create a signal which will start the production or replenishment in the same way as in a reorder point system (Jonsson & Mattson, 2009). Kanban is not classified as an inventory control system, but it will visualise the work, create an even workflow, reduce waste and create maximum value for the customer (Corona & Pani, 2013). Kanban provides opportunities to easily communicate priorities and highlight bottlenecks (Ahmad et al., 2013). In addition, Kanban and 5S can be implemented simultaneously, as Kanban is a visual system which demands strict rules and awareness. These aspects can be connected to 5S (Chiarini, 2012).

The Kanban card contains information of the material including part number, a description of the material, quantity and location. The Kanban card is placed in the working area or where the material is located and is used to signal when material is running low and needs to be refilled (Ortiz, 2016). When an order is placed, a signal is sent to the first station downstream and then continues upstream through the stations until it comes to the last station in the chain (Tanhaie et al., 2017). Buffers are located between the stations, and when these buffers decrease to a predetermined limit, the Kanban card sends a signal to the station next in the chain to start producing based on the predefined production rate (Tanhaie et al., 2017). The information on the Kanban cards enables control of the system and to avoid overproduction (Jonsson & Mattson, 2009)(Tanhaie et al., 2017).

Two-bin Kanban system

The two-bin Kanban system is one of the most frequently used inventory management methods within the healthcare context and has been implemented in different countries around the world (Landry & Beaulieu, 2010). Landry and Beaulieu (2010) further describe a two-bin system where a label is used to signal need for material. The system consists of two bins, and when the first bin is empty, the label is put up on a wall-mounted rail to signal the need for refill. The system also has an IT system connected to enable easy transfer of the material order to the inventory management system. Colour labels can also be used to distinguish between different categories of material (Landry & Beaulieu, 2010).

Landry and Beaulieu (2010) further describe how a two-bin system is beneficial from a time perspective. Compared to a traditional material supply system where healthcare workers search and estimate quantities to order, the two-bin system is more efficient. A conducted study demonstrated that an order line took five to six seconds compared to 20 to 30 seconds with a traditional system. The two-bin system further enables visual control of the material flow as well as the system works as an anti-error system, i.e. that healthcare workers are hindered by the system to make an error. The two bins are placed in module cabinets, which creates space constraints. The space constraints thereby prevent healthcare workers from stocking up material since each article has a limited assigned space in the cabinets. The space is based on an established quota. Further benefits of a two-bin system are reduced surplus inventory, minimisation of staff movement and reduced staff involvement (Landry & Beaulieu, 2010).

2.3 Centralised supply chain planning

Centralised supply chain planning includes a standardised organisation, working methods and processes where IT systems are integrated and supported (Jonsson et al., 2013). The authors further describe how centralisation facilitates coordination and control and leads to increased performance and more transparent and visible demand patterns. By centralising planning processes, problems with overestimated demand can be solved by better matching demand and supply. Obstacles for implementing centralised supply chain planning include workers who do

not work according to the new standardised processes, knowledge deficiencies and lack of management support (Jonsson et al., 2013).

2.3.1 Standardised work

As discussed by Timmons et al. (2014) standardised work within centralised supply chain planning enables workers to create both a smooth workflow and to free up time. According to Drotz and Poksinska (2014), standardised work creates a more efficient workflow in organisations. By using standardisation, the time needed to perform a task is more predictable and constant. However, standardisation makes the process less dependent on the workers since the time required is reduced, which can create negative reactions (Drotz & Poksinska, 2014). Drotz and Poksinska (2014) further bring up how 5S can be used to standardise working routines. Within healthcare, the implementation of 5S led to doctors having a standardised examination trolley which was moved around. This solved the problem of occupied examination rooms. Before the implementation, there were more doctors than examination rooms which led to discussions about who should use which room. The doctors were part of designing the standardised trolley and the implementation led to savings both in cost and time (Drotz & Poksinska, 2014). The reason for failing with an implementation of standardised work is according to Abdallah (2020) bad leadership, no clear goal in advance and lack of training. The organisation needs to create an understanding of what the implementation will lead to (Abdallah, 2020).

2.4 Working environment

The effects of stress on humans can cause damages both mentally and physically. Stress is helpful when humans are in danger to escape threatening situations, but when individuals are exposed for too long, it will affect their health negatively. This can in turn lead to burnouts. The reaction of prolonged stress or burnouts can affect both work, relationships and health (Bickford, 2005). Stress tends to decrease the ability to focus, which can create a higher risk of making mistakes. Mistakes within healthcare often have a negative effect on the quality of patient care (Firth-Cozens & Greenhalgh, 1997). According to Johnson et al. (2005), some occupations face a higher risk of developing stress related to their work than other occupations, e.g healthcare workers and teachers, as they tend to have higher degree of emotional involvement.

According to Kahn (1993), nurses face a higher risk of suffering from fatigue because of the emotions needed to be put in their work. Cooper et al. (1999) also describe how healthcare workers have higher pressure on the emotional elements at work which causes more stress compared to workers in the industry. The sources of stress are high workload, long working hours, time pressure and insufficient free time. Within the healthcare sector, nurses are most vulnerable for stress, while managers reported low stress levels related to their work (Cooper et al., 1999). The effects of prolonged stress affect both the nurses' health and quality of life.

It will also affect the quality of patient care which indirectly affects the patient safety (Zaghini et al., 2020).

Jacobsson et al. (2007) emphasise the importance of giving attention to previously successful improvement projects in order to help drive the implementation forward. By doing that, work satisfaction as well as motivation increases among healthcare workers. It encourages the workers to reach the same result and at the same time to create a feeling of 'We can do this' (Jacobsson et al., 2007).

2.5 Factors hindering implementing industrial management concepts into the healthcare context

The healthcare sector shares several characteristics with the industrial sector, especially when it comes to inventory control and material supply systems. This implies that industrial management concepts would be possible to implement within the healthcare sector as well. However, the concepts are not as widespread within the healthcare context, implying that factors hindering the implementation of industrial management concepts in the healthcare context exist (Jarrett, 1998).

2.5.1 High inventory levels

The healthcare sector is traditionally managed by high inventory levels in order to prevent shortages from occurring. However, these high inventory levels are often not justified, and shortages of material rarely occur. Healthcare workers are often responsible for the excess inventory levels. Even though inventory levels are high, it still leads to lower quality of patient care since more time as well as space need to be utilised for material handling. Cost is also a factor (Persona et al., 2008). This in turn leads to lacking possibilities to implement material handling processes into the healthcare context (Jarrett, 1998).

Hoarding of material is also discussed by Landry and Beaulieu (2010). Due to the importance of always having the material needed at the right time to be able to provide care for patients, healthcare workers often hoard material to prevent stock outs from occurring. However, this behaviour is expensive as well as it leads to waste of space and a large amount of time being spent on searching for the right material (Landry & Beaulieu, 2010). Callender and Grasman (2010) connect hoarding of material to poorly implemented inventory management tools and describe how healthcare workers' personal judgement is used to determine stock levels instead of scientific methods. This is also emphasised by Nicholson et al. (2004), who state that inventory levels are based on healthcare workers' experience, rather than on data.

Saha and Ray (2019) discuss inventory levels within healthcare and state that stock outs need to be prevented in order for healthcare workers to have faith in the system. On the other hand, excess inventory creates high tied-up capital which otherwise could have been used for other purposes. Variations in demand are also hard to predict within the healthcare context, implying

that some inventory needs to be held (Saha & Ray, 2019). Therefore, the authors state that it is important to develop an inventory control policy which takes fluctuations in demand as well as uncertainties into consideration.

2.5.2 Strong hierarchies

The healthcare sector is characterised by traditional hierarchies which are difficult to break. Work routines are deeply rooted, and doctors, nurses and managers have different status (Jacobsson & Åhlström, 2010). The authors further describe how this leads to communication problems as well as uncoordinated work between departments. Hierarchies are also connected to doctors' high autonomy. Due to their specialist knowledge and core function within healthcare, they have high power, and thereby high influence, on which management processes are applied. It can therefore be difficult to implement solutions based on material handling processes. It is important to give doctors proof and to visualise that the new system will work according to what is promised (Jacobsson & Åhlström, 2010).

According to Akmal et al. (2020), silos are deeply rooted within healthcare. Silos within healthcare can be described as groups within the department or care unit which have created barriers to the other departments within the organisation (Alves & Meneses, 2018). Alves and Meneses (2018) further describes how these groups are working by themselves as an autonomous unit with low communication to the other departments.

Brandt (2013) discusses factors within the healthcare context which affect an implementation of material handling processes and focus on Lean management. If healthcare workers are not committed to implementing Lean management, it could hinder the implementation. He further connects this to the healthcare workers' fear of losing autonomy over their work. The healthcare sector is also managed by deeply rooted ways of working, which further may hinder an implementation (Brandt, 2013). Brandt (2013) further brings up hierarchies within healthcare and states how they rather are oriented towards their own group, i.e. doctors and nurses, rather than the leaders implementing Lean management. Brandt (2013) further discusses how managers located further away from the daily activities may have problems releasing the benefits with implementing Lean management. Therefore, a hindrance when implementing Lean management is that the material supply system is perceived as optimal by managers. As long as it works, the common perception is that change is not needed (Brandt, 2013).

2.5.3 Lack of management support

Lacking support from management could hinder the implementation of improvement projects into the healthcare context. In order to enable a successful implementation, support from management is a prerequisite (Brandt, 2013). Jacobsson and Åhlström (2010) further implies this and discuss lacking motivation among healthcare workers as a consequence of lacking management support. Personal characteristics of the manager further influence the implementation, where drive, ability to understand and explain as well as encouragement are

important (Jacobsson et al., 2007). Jacobsson and Åhlström (2010) further discuss a lack of knowledge regarding management processes within the healthcare sector. Even though the healthcare workers possess severe knowledge regarding medicine, knowledge regarding how to improve, plan and control patient flows is insufficient (Jacobsson & Åhlström, 2010). The lack of knowledge regarding material handling processes is also brought up by Jarrett (1998). The author emphasises lack of knowledge regarding how to maximise the value added, and at the same time achieve synergies in order to improve the overall performance of the supply chain. Jarrett (1998) further discusses the lack of adoption of new technologies as a factor hindering the implementation of material handling processes into healthcare, e.g. barcodes and systems for interchanging information electronically.

The lack of support from management in combination with knowledge deficiencies regarding continuous improvements may cause healthcare workers to return to their old working routines instead of following the new ones. The improvements may also be regarded as an extra burden (Jacobsson & Åhlström, 2010). Managers within the healthcare sector have historically been hired based on clinical knowledge, e.g. a doctor with specialist knowledge. This implies a lack of knowledge regarding management processes (Brandt, 2013). However, the author further argues that managers within healthcare are facing an increased demand for knowledge regarding management, implying that managers within healthcare are moving towards being more management oriented and less clinical.

Jacobsson and Åhlström (2007) discuss that improvement projects often are introduced from higher up in the organisation. If initiatives with the purpose of improving the efficiency are introduced from top management, or from any other instance with no direct link to the healthcare unit, it could lead to healthcare workers feeling pressured (Jacobsson & Åhlström, 2007). Therefore, the authors emphasise the importance of managers to inform healthcare workers of the project in advance. It is also beneficial to include healthcare workers who are motivated and engaged in the specific part where the improvement is going to be implemented (Jacobsson et al., 2007).

Managers further need to be careful using industrial terms. If industrial terms are used, healthcare workers tend to react negatively to implementing them. In order to manage industrial terms in a successful way, the content needs to be explained in a logical way and critical terms need to be rephrased. A reason for this might be that healthcare workers do not want to be compared with the manufacturing industry since it handles material and products and not humans, as in the healthcare sector (Jacobsson et al., 2007).

3. METHODOLOGY

In line with the clinical methodology discussed by Åhlström (1997), a qualitative approach was chosen. The methodology enabled the researchers to study changes within the organisation from the inside. The study takes its starting point in the MiV 2.0 concept and tests it against the empirical context. The background of the study is to make the material supply more efficient, which requires the theoretical concepts to be tested based on the specific context, i.e. health centres within VGR. Therefore, the theoretical concepts were in focus in the beginning of the study in order to gain an understanding of them.

3.1 Primary Data

To collect the primary data needed, interviews were the primary source of data. This is according to Alvehus (2016) an appropriate method when conducting a qualitative study due to the possibility of collecting data regarding how people feel, think and act. Wallén (2008) further states the same opinion and discusses that qualitative interviews are an essential method in order to map peoples' feelings and experiences. The interviews were complemented with observations, which according to Wallén (2008) is an appropriate complementary data collection method when conducting interviews. However, due to Covid-19, observations were made digitally. Three digital workshops were held at the end of study where relevant professions attended, see Table 2.

Bryman and Bell (2017) further discuss the importance of considering the Hawthorne effect. This is also emphasised by Kvale and Brinkman (2014). The Hawthorne effect is the effect the researcher has on the person being studied, which may create a bias in the data. The bias is created consciously or unconsciously by the researcher by expecting a certain outcome of the study which may affect the person being interviewed or observed (Bryman & Bell, 2017). This is important to have in mind when conducting a qualitative study, and the researchers have taken it into consideration during the study.

3.1.1 Interviews

The interviews were conducted digitally via Skype and Teams. If the interviewees did not have access to these platforms, the interview was held over telephone. The interviews were held with healthcare workers at SkaS Skövde, which has implemented MiV 2.0 at the majority of all care units and patient facilities. Interviews were further held with healthcare workers at the eight selected health centres, mainly nurses and assistant nurses. Interviews were also held with managers at the health centres. The purpose of interviewing healthcare workers at SkaS Skövde was to use and learn from the experience and exploit it at health centres. Complementary interviews were also held with functions connected to MiV 2.0 within Regionservice, e.g. a service developer within MiV 2.0. Interviews were also held with actors in the distribution network. This was done in order to have a deeper understanding of the MiV 2.0 concept and the material supply system. In Table 1, the title of the interviewees is stated as well as numbers of interviews held.

Trost (2014) emphasises the importance of social interactions, which other than words include body language and face expressions. Due to Covid-19, the interviews were held digitally, which may affect the outcome of the interview regarding this. However, Trost (2014) further discusses the importance of choosing a place for the interview where the interviewee can feel safe and comfortable. By doing the interview via Skype, Teams or telephone, it enabled the interviewee to choose location for the interview by themselves and thereby enabled them to conduct the interview in a location where they felt safe. Digital interviews were also more efficient from a time perspective, which is beneficial since the healthcare workers have scarce resources due to the pandemic.

Different types of interviews are suitable in different situations and generate various results and an interview can have different characteristics. Standardisation implies that all interview questions as well as situations are equal for all interviews. Structurisation on the other hand, describes how open the questions are and to what extent the interviewee can answer freely (Trost, 2014). An interview with open characteristics enables the interviewed person to describe which dimensions and perspectives that are relevant in the specific context (Lantz, 2015). This is also brought up by Bryman and Bell (2017), who call it an unstructured interview, where the researcher mainly uses short notes as a basis for the interview. The interviews in this study were open. This was assumed to be the most appropriate type since the researchers had limited knowledge about working methods at health centres within VGR. This is further validated by Lantz (2015), who states that open interviews are preferable if the aim of the study is to deepen the understanding of a specific model or context. Bryman and Bell (2017) also discuss the need for more open questions when conducting a qualitative study due to the desire to have the interviewed person's own perceptions and interpretations regarding the subject in mind. The authors further describe that in qualitative studies, there is a desire to let the interviewee control the direction of the interview in order to gain knowledge about what the person perceives as relevant.

The open questions were complemented with follow-up questions, which are enabled by qualitative interviews (Bryman & Bell, 2017). However, since a few of the interviewees wished to receive the questions beforehand, a list of relevant subjects was sent before the interview was conducted. Therefore, the interviews also had elements of being semi structured, which according to Bryman and Bell (2017) is characterised by the researcher having stated a number of themes that the interview will cover. All interviews were held by both researchers of the study, which according to Trost (2014) is beneficial if the interviewers work well together. During the interviews, one person was responsible for asking the questions and listening carefully to what interviewee answered while the other person was focused on taking notes. Since the two researchers in the study did all interviews together as well as the rest of the study, it is assumed that the interplay works in a good way. It is also essential to set aside enough time for the interview to have time to ask all questions as well as allowing the interviewee to answer the questions (Lantz, 2015). Trost (2014) further emphasises the time aspect and discusses that

90 minutes is too long for an interview; however, the author further describes how the time aspect is individual. The interviews during the study took approximately 60 minutes depending on the interviewees' availability. If needed, several interviews were held with the same person.

The interviews were not recorded or transcribed. Trost (2014) describes it as time-consuming to listen to recorded interviews, as well as it can make the interviewed person feel uncomfortable and thereby limited when answering the questions. A high number of interviews also results in an even higher number of transcribed interviews. This is further time-consuming to go through and analyse (Trost, 2014). Lantz (2015) has the same opinion regarding recording of interviews and argues that it can affect the result of the interview negatively since the interviewee may be more reticent. However, notes were taken during the interviews in order to facilitate the data analysis and to ensure that nothing was missed. After the interview, the notes were complemented with further notes. This is according to Trost (2014) an appropriate method when conducting qualitative interviews.

Table 1. An overview of the interviews held.

Title	Interviews
Assistant nurse health centre	6
Assistant nurse SkaS Skövde	4
Nurse	1
Health centre manager	4
MiV team	2
Purchasing coordinator within Primary care	1
Service developer	2
Service manager Regiontransport	1
Logistics leader Regiontransport	1
Logistics coordinator Tvätteriet Alingsås	1
Marknadsplatsen worker	3
Delivery coordinator Sisjödepån	1
Total	**27**

An assortment analysis was carried together with the healthcare workers in order to see potential benefits with reducing the assortment of articles at health centres. The assortment of articles was reviewed using an Excel file based on data from Regionservice. In order to sort the data generated by the Excel file, two workshops were held with the healthcare workers responsible for the assortment of articles at the health centres. The sorting parameters used were based on the workshops held.

In addition to the interviews held, three workshops were held at the end of the study with the Project leader and Subproject leader for MiV 2.0 as well as complementary professions who work with MiV 2.0 on a daily basis. At one of the workshops, representatives from the health centres were present. The workshops were done in order to validate the results of the study and to test the solutions against the research questions.

Table 2. An overview of workshops held. The number in parentheses represent the number of participants.

Workshop	Participants	Time duration (h)
Assortment analysis	Assistant nurse (2),Subproject leader MiV 2.0	2
Deeper assortment analysis	Assistant nurse, Subproject leader MiV 2.0	1.5
MiV 2.0 Project development day	MiV 2.0 Project group (17)	3
MiV 2.0 Workshop	Health centre manager (3), Assistant nurse (4), Subproject leader MiV 2.0, Project leader MiV 2.0, Purchasing coordinator within Primary care, Coordinator Primary care	3
MiV 2.0 Project development day	MiV 2.0 Project group (17)	4
Result presentation	Subproject leader MiV 2.0, Project leader MiV 2.0, Development manager within Logistics, Supervisor Chalmers	1

3.1.2 Observations

Since the study took place in the real world, direct observation is an appropriate method (Yin, 2018). In order to map the current material flow at health centres and have an understanding of working methods and which activities the material flow consists of, the interviews were complemented with observations. This is emphasised by Yin (2018), who states that observations may add new dimensions to the understanding of the subject, e.g. technologies being used or problems studied. It might also add dimensions that can be noticed only by an outsider (Yin, 2018).

Due to Covid-19, there were no opportunities to have on-site visits at health centres to make interviews and to analyse the material handling process. In order to have a better understanding and knowledge of the material handling process at the health centres, healthcare workers were asked to take pictures and mark on a map over the facility, the storage location and where material is received. This enabled the researchers to make an analysis of the current material flow at health centres.

3.1.3 Selection of interviewees

The selection of interviewees was done in collaboration with the Subproject leader for MiV 2.0. The selection of health centres was predetermined by Regionservice. Contact information to managers at eight health centres within Primary care were received at the beginning of the study and the researchers contacted the managers to schedule interviews with healthcare workers and managers at the health centre. Both nurses and assistant nurses were included in the selection. In addition, the supervisor led the researchers to a Service developer at the hospital using MiV 2.0 today, SkaS Skövde, and to a purchasing coordinator within Primary care.

The Service developer was also the first person in the Convenience selection process at SkaS Skövde, which according to Trost (2014) is a method in order to make strategic choices regarding the selection of interviewees. A variant of the method is The Snowball method, where the first interview person refers to the next one, the next one refers to another person and so forth (Trost, 2014). This method is also discussed by Alvehus (2016) who put an emphasis on the effectiveness of the method. However, he also discusses the risk of getting stuck within a network of people and thereby receiving the same perspective during the interviews. This was something the researchers had in mind during the selection.

3.2 Secondary data

The secondary data was collected from a shared portal within the VGR-network where the majority of the material regarding the theoretical parts of the MiV 2.0 concept is presented. There were also two presentations with the Subproject leader for MiV 2.0 where the MiV 2.0 concept was described and explained further. This enabled the researchers to have a deeper knowledge and thereby be able to describe the concept better when conducting the study. Data of the generated effects of using MiV 2.0 at SkaS Skövde was used to analyse which potential effects an implementation of MiV 2.0 at health centres may result in. Ordering data was also collected and used in order to make an assortment analysis. The ordering data was generated from the ordering portal within VGR, Marknadsplatsen.

3.3 Analysis of the collected data

Alvehus (2016) emphasises the importance of analysing the empirical data in a clear and systematic way when conducting a qualitative study. The author further divides the analysis process into three different parts: sorting, reducing and argumentation. First, the empirical data is sorted into categories and subcategories depending on its nature. Second, the material is reduced, and interesting parts are highlighted. In the last step, the analysis is used to support the conclusion of the study (Alvehus, 2016). In order to analyse the collected data, the researchers wrote down notes from the interviews of the most important and relevant parts.

Open questions were used to capture various aspects of the study. Notes from the interviews were then written down in a shared document while conducting the interviews. The shared

document was then complemented with further notes after the interviews. At the same time, the researchers identified and highlighted relevant problems brought up during the interviews. After all interviews were conducted, the problems were written down in short sentences on post-it notes which then were put up on a whiteboard. The problems were then grouped based on its characteristics. A selection was made of the most significant problems within the scope of the study. Relationships between the group of problems were also highlighted in order to find causality, i.e. a connection between cause and effect. The problems were further decomposed in order to be able to analyse them thoroughly and find solutions to the problems supported by literature. This was done after recommendations from the supervisor at Chalmers.

The analysis of data when conducting a qualitative study can be extensive due to the large amount of data it can evolve. In order to manage this in an efficient way, the analysis of the collected data was conducted in parallel with the problem and solution discussion as well as the conclusion of the study. This is in line with Bryman (2002). According to Barley (1990), it is a challenge to create structure and analyse large amounts of data at the same time. The analysis is done continuously and repeatedly during the data collection when doing a qualitative study. This may be a challenge since the qualitative analysis is not structured (Miles, 1979) (Åhlström & Karlsson, 2009). The conclusion of the study is based on relevant literature, empirical data as well as the analysis. The conclusion of the study was reached by decomposing the collected data in order to better be able to analyse the data and compare it to existing literature (Bryman, 2002).

3.4 Collection of information and literature

In order to collect the information and data needed, relevant literature and information were collected. In this section, a description of how this was done is given. The use of source criticism is also discussed. Finally, reliability, validity, generalisability and the ethical parts of the study are discussed.

3.4.1 Approach of collecting data

The focus at the beginning of the study was to have a deeper understanding of the MiV 2.0 concept as well as how it is operated today at SkaS Skövde. This was done in accordance with recommendations from the supervisor at Chalmers. Therefore, the MiV 2.0 concept was presented and explained by the Subproject leader for MiV 2.0 within the first weeks of the study. Interviews with healthcare workers at SkaS Skövde using MiV 2.0 were also conducted early in the study. Eriksson and Widersheim-Paul (2014) describe the importance of identifying the problems as it will enable access to the right information related to the chosen topic. It will further lead to time savings when searching for information related to the topic (Eriksson and Widersheim-Paul, 2014). Since MiV 2.0 is developed within VGR, the majority of the collected secondary data were gathered from VGR's data platform. Based on the increased understanding of MiV 2.0, the research questions were formulated. When the research questions were formulated, the researchers were able to start searching for relevant literature. Some key words

used were lean, kanban, material supply system and logistics in healthcare. Databases used were Google Scholar and Chalmers library.

3.4.2 Source criticism

During the literature study, a critical review of the collected data was carried out. Using a critical review while conducting a literature search is according to Eriksson and Wiedersheim-Paul (2014) relevant in order to answer the questions in a right and credible way. The critical review is questioning the study's validity and reliability in scientific contexts (Eriksson & Wiedersheim-Paul, 2014). The sources chosen for the study were carefully examined in order to use the most trustworthy and credible sources. Some of the books and articles used did not have to be examined as thoroughly as the authors were considered trustworthy. Examples of authors are Bryman and Bell (2017), Alvehus (2016) and Yin (2018).

3.5 Reliability

Reliability implies that the results of a study are similar regardless of who performs it and how many times the same study is conducted (Yin, 2018). This is further discussed by Alveus (2016). The author refers to reliability in terms of repeatability, which implies that the study can be repeated and generate the same result independently. According to Bryman and Bell (2017), the human factor may affect the reliability due to the difficulties for an individual to give the exact same answer to a specific question multiple times (Bryman & Bell, 2017).

By having interviews conducted in the form of a personal meeting, reliability is increased as it enables the researchers to take tone of voice, body language and facial expressions into account (Justesen & Mik-Meyer, 2012). Due to the Covid-19 pandemic, the reliability will be lower in the study as interviews were conducted through Skype, Teams or telephone. In order to cope with problems regarding reliability, Yin (2018) suggests that the researchers conduct the study as explicitly as possible in all approaches during the research. One further factor affected by the Covid-19 pandemic was the possibility to contact healthcare workers as they have limited access to technology, e.g. Teams and e-mail. It also led to some technical problems for the healthcare workers due to lack of technology skills.

According to Trost (2010), reliability is difficult to achieve in qualitative studies. Reliability requires the author to ask the interviewee the exact same questions and thereby receive a standardised answer. However, this is not the intention when conducting a qualitative study (Trost, 2010). Interviews in the study were therefore unstructured and open which enabled the interviewees to speak freely. It further enabled the interviewer to open up for relevant follow-up questions (Trost, 2010). Kvale and Brinkman (2014) discuss this further and emphasise the importance of the interviewer to use an improvised approach while interviewing as it may open up for creativity and variation in the answers. If the researchers focus on creating a high reliability, it can create the opposite effect on creativity and variation in the study (Kvale &

Brinkman, 2014). However, since reliability is difficult to achieve in qualitative studies, the focus of the study has mainly been to increase the validity of the study.

3.6 Validity

As stated by Alvehus (2016), validity is a measure to assess the quality of the study and implies that the study measures what is intended to be measured. This is further discussed by Wallén (2008) who emphasises the importance of planning the execution of the study carefully to ensure validity. Kvale and Brinkman (2014) discuss validity in terms of qualitative interviews, which was one of the major data collection methods in the study. Therefore, it is important to have this in mind when planning and executing interviews. Trost (2010) states how high validity is achieved by formulating interview questions well with thoughtful questions to follow up with. However, since the interview questions were open in order to make room for the interviewee to speak freely, the possibility to plan and prepare the interview fully was limited. Therefore, the researchers guided the interview in the right direction if the interviewee deviated from the subject. Kvale and Brinkman (2014) also stress the importance of validation throughout the whole research period. Therefore, the researchers had this in mind during the whole study in order to ensure validity.

Due to the Covid-19 pandemic, the possibility to make observations was limited and the researchers had to find complementing methods, e.g. observations via pictures. This may cause concerns regarding the validity since the researchers had limited ability to affect what was being observed. However, high validity can hopefully be ensured since the healthcare workers who provided the researchers with pictures work with the material handling process on a daily basis.

Bryman and Bell (2017) make a distinction between internal and external validity. Internal validity means that observations made by the researcher should correspond to the theoretical ideas that result from the study. External validity refers to the ability to apply the results to other contexts as well (Bryman & Bell, 2017). The authors further connect external validity to the limited selection researchers tend to use in studies. This can be connected to the limitations done in this study regarding which health centres to study. A limitation was made to study eight different health centres and assume that these were relevant and represented a cross-section of all health centres within Primary care in VGR. This may affect the validity and is something the researchers had in mind while conducting the study.

3.7 Generalisability

According to Eriksson and Wiedersheim-Paul (2014), generalisation implies how the results of a study can be applied to other contexts as well and is not limited to the selection where the study is conducted. Bryman and Bell (2017) further discuss that the size of the selection should be representative in order to be able to generalise. Since it is not within the limits of the study to investigate all health centres within Västra Götaland, limitations were set in order to receive

a representative outcome of the study. The chosen health centres have a high number of listed patients which implies a large distribution of both patients and material used. Therefore, the chosen selection of health centres was assumed to be representative for the majority of all health centres within Västra Götaland. This type of generalisation is according to Yin (2018) called statistical generalisation and implies how the results can be used in another context outside the scope of the study.

However, it is important to be aware of factors distinguishing health centres and thereby limit the generalisability, e.g. distribution of patients and location of the health centre. Therefore, each specific case needs to be investigated in order to be adapted to the specific health centre.

3.8 Ethics

An important aspect when conducting a study is ethics and to respect the integrity of the participants, e.g. to not violate personal integrity (Wallén, 2008). Therefore, it was important to not conduct the interviews against any of the participants' will, implying voluntary participation in the interviews (Trost, 2010). The participants were also anonymous, and the interviews were not recorded. These prerequisites are also emphasised by Trost (2010).

4. DESCRIPTION OF MiV 2.0

The following chapter provides a description of the MiV 2.0 concept developed for hospitals within VGR. The chapter includes a description of the Tom/Full principle which is the inventory management process used in MiV 2.0. An IT support system is part of the concept and will be described further in the chapter as well as hierarchies within Regionservice and perceived effects of implementing MiV 2.0.

4.1 MiV 2.0

Regionservice is an internal service organisation within VGR with the purpose of coordinating and standardising support activities and processes within the healthcare sector in order to free up time and resources for healthcare workers. The services provided by Regionservice are divided into three areas: health related services, logistics and administration. Examples of activities are cleaning services, material supply, transportation of material and food services. By handling activities centrally, an efficient and standardised service offering is enabled as well as increased quality (Regionservice, 2020). The purpose of MiV 2.0 is to standardise and make the material supply system more efficient. The concept is initiated by Regionservice and includes strategies for handling, purchasing and transportation of material. By implementing MiV 2.0, the ownership of the material supply system is transferred to Regionservice from healthcare. MiV 2.0 is implemented at the majority of the care units at SkaS Skövde. However, the plan is to implement the concept at hospitals in VGR 2020-2024, starting with a newly built Children's Hospital at Östra Sjukhuset, located in Gothenburg. The MiV 2.0 concept is based on five principles, see Figure 1.

	MiV 2.0 Basic principles
1	**Standardised assortment**: The assortment of articles is predetermined and based on actual demand.
2	**Standardised material handling locations**: Each hospital consists of an unpacking room, a transit hall, Unit storage rooms and Local storage rooms.
3	**Efficient inventory management**: Inventory levels are based on what is actually used. The Tom/Full method enables visual management. The material supply system is owned by Regionservice which is responsible for all storages. The healthcare workers only pay for what is used.
4	**Standardised processes, roles and responsibilities**: The system is based on standardised processes for inventory control, management and improvements of processes.
5	**IT support**: An IT system is used to support the material supply system. The IT system enables visible inventory levels as well as easier follow-up of consumption.

Figure 1. The basic principles of MiV 2.0.

4.1.1 Standardised material handling locations

The concept MiV 2.0 is designed in accordance with the layout of hospitals within VGR. Each hospital consists of a number of standardised material handling locations to make the material flow more efficient, see Figure 2. A transit hall and an unpacking room is located close to the

goods reception, which are further connected to Unit storage rooms and Local storage rooms located at each care unit at the hospital. A care ward consists of one Unit storage room and a number of Local storage rooms, which are located in direct connection outside each patient room. Care receptions consist of one Unit storage room and one Local storage room.

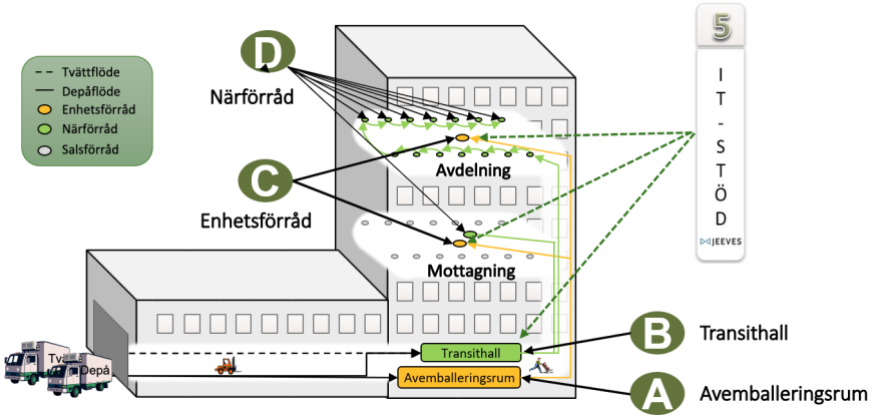

Figure 2. An overview of material handling locations at a hospital. Text in Swedish. Source: Regionservice (2021).

The unpacking room enables material arriving from *Sisjödepån*[6] to be unpacked and further distributed within the hospital. Packaging from transportation is removed and the material is repacked into clean transport carriages, which is beneficial from a hygienic perspective. The carriages are transported and unpacked by the *MiV team*[7] into the Unit storage room at care units. Care units are supplied with material on predetermined days one to three times a week. Deliveries are packed and delivered separately to care units at the hospital.

The Unit storage rooms consist of consumable material from Sisjödepån, e.g. needles, coffee, gloves and bandages. It is located centrally in the care unit and consists of module cabinets as well as shelves for bulky material. When MiV 2.0 is implemented at a care unit, Regionservice and the healthcare workers at the care unit review the assortment in order to reduce unnecessary articles, called an assortment analysis. The total number of consumable articles in the MiV 2.0 assortment at Sisjödepån is approximately 3000. Each care unit then has a selection of this assortment, depending on which type of articles the specific care unit requires. In order for an article to be included in the MiV 2.0 assortment at care units, it shall meet a number of requirements. The article must be a consumable article or an article delivered from *Tvätteriet*

[6] *Sisjödepån is VGR's central warehouse for consumable material. The warehouse supplies 5000 customers within VGR.*

[7] *The MiV team consist of service workers from Regionservice who are responsible for ordering and delivering material to care units within MiV 2.0.*

Alingsås[8]. It should also be possible to have in stock at Sisjödepån. The consumption of the article should be continuous and repeatable during a year, with a predictable demand. Finally, it must have been ordered more than once the previous year and been consumed at least once a month during a period of six consecutive months.

The transit hall is a central distribution point for frequently used textiles supplied to Local storage rooms at the hospital. Articles arrive at the transit hall from Tvätteriet Alingsås. The transit hall receives goods in bulk and enables smaller quantities to be sent to the Local storage rooms at care units. Both the unpacking room and transit hall are located at the bottom floor close to the goods reception. It is also beneficial if the rooms are located centrally at the hospital, e.g. close to an elevator. This enables efficient transports to care units at the hospital.

The Local storage room is located close to the patients and consists of the 20-25 most frequently used textile articles from Tvätteriet Alingsås, e.g. bedding material and patient clothes. Totally, the care unit can choose its assortment out of approximately 50 articles and all Local storage rooms at the care unit consist of the same articles. The Local storage rooms are supplied based on a reorder point system where the MiV team is responsible for ordering material and filling up inventories to a maximum point. The MiV team picks and consolidates articles from the transit hall and packs it to a transport carriage before bringing it to the Local storage room. In addition, the MiV team uses an IT system to register when a withdrawal is made by the MiV team in connection to picking and consolidating articles from the transit hall. At patient facilities, where the Local storage room is limited due to space restrictions and frequent patient flow the MiV team has no access to Local storage rooms which are placed inside patient rooms. Therefore, all articles are stored in the Unit storage room and the healthcare workers are responsible for filling up the Local storage rooms when possible. Regionservice owns and is responsible for the material until it is picked out from the cabinets by the healthcare workers. Therefore, each care unit only pays for its actual consumption.

4.1.2 The Tom/Full principle

The *Tom/Full* [9] principle is an inventory management process enabling a pull-based material supply system, where the healthcare's actual consumption is a basis for new material ordering. This implies that no more material than what is used is ordered. The method is also known as a Kanban system. In the Unit storage rooms, the Tom/Full principle is applied in the module cabinets where each article is assigned two bins: one picking bin and one buffer bin. The

[8] *Tvätteriet Alingsås is the actor responsible for the textile supply process and provides the healthcare within VGR with laundry, textiles and sterile articles.*

[9] *Tom/Full is the Swedish name for a system based on the Kanban methodology. Translates in English into Empty/Full.*

healthcare workers pick material from the picking bin, and when the picking bin is empty, the healthcare workers are responsible for filling up the picking bin from the buffer bin. An ordering card is also used to signal demand. The ordering card is removed from the picking bin and put up on the door to signal demand for a specific article, see Figure 3. This is done by the healthcare workers. The MiV team is then responsible for ordering and delivering the articles by scanning the ordering cards put up on the door. When the articles have arrived at the hospital, they are unpacked in the unpacking room and delivered to the module cabinet in the Unit storage room by the MiV team who unpack the material in the buffer bin.

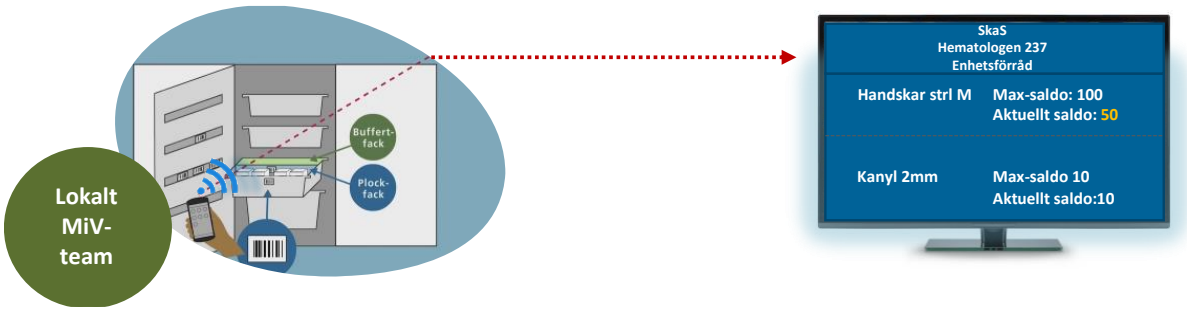

Figure 3. The figure shows the module cabinet with picking bin and buffer bin. The MiV team uses a PDA to scan the ordering cards put up on the door. The PDA is connected to an IT system which enables visible inventory levels. Source: Regionservice (2021).

4.1.3 IT system

In 2020, an IT system was developed in order to support the standardised processes within MiV 2.0. The IT system is connected to MiV 2.0's own assortment of articles at Sisjödepån, and each material withdrawal is registered by the IT system which enables increased control and follow-up of consumption, see Figure 3. This in turn gives both hospitals and Regionservice increased knowledge about actual demand. Resources can therefore be allocated in a more efficient way since inventory levels are registered and monitored. The IT system further works proactively and prevents deviations. By making inventory levels visible, care units are enabled to borrow material from each other if a shortage occurs, instead of placing an express order. This has decreased the number of express orders. In addition, inventory worth 65 MSEK is distributed within hospitals today, which is made visible through the IT system. This is in turn presented as an asset in the balance sheet.

In order to increase control, a Personal Digital Assistant (PDA), is used by the MiV team to register the ordering cards put up by the healthcare workers. The PDA is connected to Sisjödepån and enables updated stock balances both at the hospital and at Sisjödepån. However, it is not possible to control or change the assortment of articles in the PDA, nor the number in stock. This is handled centrally.

4.1.4 Hierarchy

The Central Purchasing Department, Koncerninköp, within VGR consists of material consultants and contract managers, who often consist of financial officers or experienced

nurses with knowledge regarding the purchased articles. In addition, there is an Operating Purchasing Department at Regionservice which is responsible for purchasing of material as well as having continuous contact with suppliers in order to secure and handle disturbances that might occur in the delivery process to the central storage, Sisjödepån. Regionservice's responsibility is limited to supplying healthcare with material and has no mandate to make decisions regarding which articles are purchased. When an article is changed due to an expired agreement and the material consultants have negotiated a new contract with a supplier, the contract managers are responsible for informing Regionservice which article has been changed, and which article it replaces. The articles have the same function; however, the new article receives a new article number in Marknadsplatsen.

When the Central Purchasing Department has finished a negotiation and a supplier has won the bidding, the supplier owns the article data, and is in most cases responsible for sending the information to Marknadsplatsen in an Excel-file in order to have an approval. It is stated in the agreement with the supplier that pictures and a description of the new article is required in order to facilitate for healthcare workers to know which article the new article replaces. However, there is no standard way to monitor that the requirements are followed by the supplier.

Today, the Operating Purchasing Department at Regionservice and the Central Purchasing Department are two separate units who mainly work independently of each other. One goal of implementing MiV 2.0 is to increase the collaboration between the two units and enable them to work together in order to create a seamless experience for the healthcare workers. If an article is changed in the assortment, a close collaboration and clear communication would enable Regionservice to work proactively and change it in the MiV 2.0 system without the healthcare workers noticing any disruptions.

Regionservice is a part of harmonising and reducing the assortment of articles at care units when implementing MiV 2.0. When a decision has been made to implement MiV 2.0 at a care unit, a part of the implementation is to reduce the assortment of articles the care unit has in storage. Since there is no standardised way for ordering and handling of material today, different healthcare workers often use different variants of the same article, implying that the assortment stored at care units is wide. Regionservice therefore acts as a link between hospitals and the Central Purchasing Function.

4.2 Perceived effects of implementing MiV 2.0

By implementing MiV 2.0 into the healthcare context, the responsibility for the material supply system is transferred to Regionservice, which thereby is responsible for supplying the hospital with material. The healthcare workers are responsible for consuming the material and signalling when there is a need for refill of material. The purpose of introducing MiV 2.0 is to reduce the time needed for the material supply system by making it more efficient. MiV 2.0

offers hospitals the opportunity to focus on their core business, as Regionservice's teams will manage the material flow, e.g. order material, unpack material and refill material in storages.

The primary goal of MiV 2.0 is to free up time for healthcare workers and reallocate resources in order to use the right competence at the right place. By handling the material supply system centrally, it makes the process more efficient and thereby reduces costs. MiV 2.0 is also expected to lower purchasing costs by a standardised assortment and standardised material handling locations. By reducing the assortment, an annual cost saving of approximately six percent is expected. A similar reduction of the assortment was done of office material, which led to a nine percent annual cost saving. The increased control of the material flow is also anticipated to lower waste with one percent. By introducing standardised material handling locations and rebuilding the storage layout, space will also be freed up. A 50 percent space reduction is anticipated.

5. ANALYSIS

The data presented in the chapter below is mainly based on interviews with nurses at SkaS Skövde and nurses and managers at health centres. Interviews have also been conducted with relevant functions connected to MiV 2.0. First, MiV 2.0 at SkaS Skövde is described, followed by a description of the material handling processes at health centres. The distribution network within VGR is further brought up. The ordering portal Marknadsplatsen is described in the following section. The last section describes identified gaps between MiV 2.0 at SkaS Skövde and the material handling process at health centres.

5.1 MiV 2.0 SkaS Skövde

MiV 2.0 is currently used and implemented at most of the care units at SkaS Skövde. First, MiV 2.0 in practice is described and important parts are highlighted. Second, effects from the implementation are described, followed by a description of experienced problems connected to MiV 2.0.

5.1.1 MiV 2.0 in practice

Below a description of MiV 2.0 in practice at SkaS Skövde is given. The description is divided into assortment of articles, MiV team and storage structure.

Assortment of articles

The assortment of articles is standardised and adapted to each care unit. When MiV 2.0 was implemented, healthcare workers were a part of deciding the assortment and inventory levels. The articles included in the MiV 2.0 assortment are articles with high frequency which are used on a regular basis by the healthcare workers. If an article not included in the MiV 2.0 assortment is needed, the healthcare workers can order the article in Marknadsplatsen, e.g. patient specific articles. However, these articles arrive at the same time and are delivered to the care unit by the MiV team. A few care units have assigned places for the additional articles in the Unit storage room.

The healthcare workers have the possibility to put up a note ‘x2’ on the ordering card in order to receive double the amount of material, alternatively order the excess amount from Marknadsplatsen. Some care units also order from Marknadsplatsen if they want to test a new article. If the care unit wants the article in the assortment, it may be included in the MiV 2.0 assortment. If a demand for a specific article occurs unexpectedly or if a shortage occurs, all care units have the possibility to make an order with express delivery. If the article is in stock at Sisjödepån, the cost is 100 SEK and if it is not in stock, it costs 1000 SEK. The care units can also borrow material from each other. In that case, the MiV team is responsible for finding another care unit with the article in stock, picking up the material and delivering it to the care unit.

MiV team

The MiV team at SkaS Skövde consists of six service workers who rotate on an eight-week schedule. Information about who is supposed to be at each care unit at what time is provided both to the MiV team, but also to the care units in order to facilitate for the healthcare workers. This enables healthcare workers to know when the MiV team will arrive and be available for e.g. questions. The healthcare workers describe the possibility to receive help from the MiV team as easy and accessible. The communication between the care unit and the MiV team is also well-functioning. If healthcare workers need help or have a problem, they have the possibility to call the MiV team and receive help.

The worker from the MiV team who is responsible for the care unit handles the whole material flow, from goods arriving at the goods reception until the material is packed up at the care unit. The material flow is separate for articles to Local storage rooms and Unit storage rooms. However, the Local storage room material flow is not as vulnerable due to a storage of articles being stored at the hospital. This is not the case with consumable articles arriving from Sisjödepån. The MiV team usually fills up the storages two or three times a week. In the Local storage room, each article is filled up according to a reorder point system and the MiV team puts the oldest article on top in order to have circulation of the material. The picking bin and the buffer bin in the Unit storage rooms have also lowered waste due to higher visibility and circulation of material.

Storage structure

The Unit storage rooms are often located centrally at the care unit and are provided with a balance lock. This has enabled more material to be stored in the Local storage room since some articles need to be stored in locked spaces, e.g. needles. It has also reduced the risk for patients to mistake the room for e.g. the bathroom. In the Local storage room, each module cabinet has a list provided at the cabinet door where all articles are listed. This reduces the time needed for looking for material. The Tom/Full system in the module cabinets is also described as easy to learn and it is according to the healthcare workers difficult to make a mistake, see Figure 4. The standardised way of working with MiV 2.0 has also facilitated for healthcare workers when rotating job location from one care unit to another.

Figure 4. The figure shows the Tom/Full method at SkaS Skövde. To the left, the buffer and picking bin are seen and to the right, an ordering card put up on the door is shown.

5.1.2 Perceived effects of MiV 2.0

The MiV 2.0 concept is seen as a valuable asset by the healthcare workers, and it has facilitated the material handling process as well as freed up time. This time is now spent on patients instead. It has also led to reduced stress levels which in turn has created a better working environment for the healthcare workers. Before MiV 2.0 was implemented, nurses often got disrupted while ordering material, which further created stress.

MiV 2.0 has increased the number of delivery days from one to two or three every week. Before MiV 2.0 was implemented, the nurses responsible for the material handling process spent several hours a week on checking material availability, ordering and unpacking material. When material arrived in carriages at the care unit, it was often placed in hallways and thereby causing space problems. Cardboard waste was also a problem since the healthcare workers were responsible for unpacking the material. At the Haematology ward, patients are susceptible to infections and cardboards are not appropriate to handle nearby. The implementation of MiV 2.0 has thereby improved the hygiene and reduced the risk for infections for these patients. It has also lowered waste at the Haematology ward. Earlier, material was stored in the patient rooms and if there was an outbreak of e.g. stomach flu, all material in the room had to be discarded and thereby wasted. This is not the case anymore since no material is stored in the patient rooms. The MiV team is also responsible for structuring and cleaning the storages on a regular basis which further increases hygiene and frees up time for healthcare workers.

It is further described how the material handling process sometimes caused irritation and disagreements among the healthcare workers, e.g. if someone missed to order an article, or problems with Marknadsplatsen accidently led to 5000 articles being delivered instead of five. It is further described how MiV 2.0 has made the distribution of material more equal during the Covid-19 pandemic since it has enabled increased control and visibility of material. The system disables hiding of material and care units cannot stock up with e.g. 1000 masks and thereby leave another care unit without masks.

One further benefit from the MiV 2.0 implementation is that healthcare workers do not need to keep track of which articles are withdrawn or changed in Marknadsplatsen. Before MiV 2.0, a large amount of time was spent on searching for new articles in Marknadsplatsen. This is now handled by the MiV team. If an article is changed, the MiV team changes the label in the module cabinet and the administrative IT parts are handled centrally by Regionservice. During the Covid-19 pandemic, the change of articles has increased. However, normally the number of times articles change is approximately once a month.

5.1.3 Identified problems at SkaS Skövde

While interviewing healthcare workers at SkaS Skövde, the majority expressed a positive attitude towards MiV 2.0. However, some problems were identified. The problems are described below and categorised into implementation phase, assortments of articles, group dynamic and ordering cards.

Implementation phase

The implementation phase at SkaS Skövde included an assortment analysis. The MiV team in collaboration with the healthcare workers at each care unit analysed the material consumed in the previous year. This was done in order to be able to reduce the number of articles and standardise the MiV 2.0 assortment. The analysis was complemented with a computer analysis which calculated the optimal inventory levels based on the ordering data. The computer program often resulted in a lower number than the healthcare workers requested, and the inventory level was often set to a number in between. The majority of the care units realised that they did not need as high inventory levels as they previously thought. However, the Paediatric ward experienced some problems when the assortment was decided in the implementation phase. The problems were related to the large age distribution of their patients, and the need for different sizes and types of articles was thereby larger than an average care unit. Therefore, the healthcare workers experienced communication problems with the MiV teams in the implementation phase. The healthcare workers felt that they had to argue why they needed more articles than the average care unit. Some concerns also occurred in the beginning among the healthcare workers due to the lower inventory levels as well as the reduced assortment.

When the IT support system was first implemented, some issues occurred. The MiV team had not learnt how the IT system and the PDA worked, which created issues with some orders. Due

to the number of functions which the MiV team needs to learn, time is required in order to learn and fully understand the IT system. In addition, the MiV team receives training. The problem can to some extent be connected to age and technical knowledge. Older people with less experience of technology have more problems with understanding the system, while young people tend to learn faster due to a trial-and-error mentality.

The service developer responsible for the operational parts of the MiV 2.0 implementation at SkaS Skövde further experienced problems with the assortment analysis. As requested by top management at SkaS Skövde, the service developer was tough when negotiating with the healthcare workers and only allowed articles meeting the MiV 2.0 assortment requirements. This led to discussions with the healthcare workers. If an article only is ordered once a year, there is no need for the care unit to have it in the MiV 2.0 assortment, nor if no other care unit within VGR has the article in stock. Instead, the care unit should order the article when a demand occurs. The service developer further described how healthcare workers have a tendency to stock up material. If the healthcare workers are not pleased with the MiV 2.0 assortment and want to have another article than offered in the MiV 2.0 assortment, they have a possibility to order it via Marknadsplatsen. However, it is described by the service developer that this is not the MiV 2.0 project group's responsibility, it is top management's. The service developer further described how managers at care units have not been involved in the MiV 2.0 implementation. However, the manager at the care unit can attest healthcare workers' orders outside MiV 2.0 and thereby facilitate for them to order the articles they were not allowed to have in the MiV 2.0 assortment. Nevertheless, this is not something the MiV 2.0 project group can do anything about.

When interviewing the service developer responsible for the MiV 2.0 implementation at SkaS Skövde, the need for a central and coordinating function was emphasised. If the assortment of articles and working methods are standardised, similar to the MiV 2.0 concept, the service developer's perception is that it will not be consistent over time if no central and coordinating function exists. Eventually, the healthcare workers will go back to their old working routines.

Assortment of articles

The healthcare workers at SkaS Skövde also brought up problems regarding the assortment of articles. The MiV 2.0 assortment implies a reduced number of different articles as well as a lower number of each article stored in the module cabinets. While the majority is positive towards the reduced number of different articles, others want to have a larger assortment of articles, i.e. more articles to choose between. A few healthcare workers expressed concerns regarding inventory levels and want to have higher levels of material in the storages in order to ensure that shortages do not occur.

The MiV team is responsible for finding and borrowing material from other care units if a shortage occurs. Nevertheless, this responsibility is often put over on the healthcare workers, who need to call care units to find the material needed. Further issues brought up is how the

MiV team is not able to break all packages of material. If a care unit needs to have two of a specific article in the module cabinet, it may not be possible due to a package size of 10 distributed by Sisjödepån. Thereby, the care unit needs to have 10 articles in the module cabinet.

Since the majority of the MiV 2.0 assortment consists of standard articles which are used frequently, the healthcare workers need to order articles which are used less frequently on Marknadsplatsen. However, everyone using Marknadsplatsen describe the system as difficult and confusing to use. Keywords used when searching for material need to be very accurate and the article descriptions are hard to understand and interpret. Neither are pictures available for all articles, which sometimes leads to problems and wrong articles being ordered and delivered to the care unit.

Group dynamic at care units

At the Haematology ward, the nurse responsible for material is positive regarding MiV 2.0 and works towards having a well-functioning material handling process at the care unit. At this care unit, MiV 2.0 works well and has resulted in positive effects. At other care units, the attitude towards MiV 2.0 is not as positive and a feeling of competition between the MiV team and the healthcare workers exists. The healthcare workers who previously had a greater responsibility for the material handling process feel that the MiV team has taken their job. These healthcare workers have not accepted that the material handling process no longer is their responsibility and are still interfering with the structure and way of working. This can be connected to a lack of anchoring of the project at the specific care unit. During the interviews, the importance of involving the whole organisation when implementing a new way of working was discussed. In the interviews, one of the interviewees from the MiV team described that if the whole organisation is not involved in the process, it can create a feeling of rivalry.

Ordering cards

The majority of the care units experience problems with the ordering cards. When the last article is picked from the picking bin, the healthcare workers are supposed to put up the ordering card on the cabinet door. However, this is sometimes missed which in turns leads to material not being ordered and delivered in time by the MiV team. The MiV team does not look for missing ordering cards in the module cabinets since it is not within their responsibility. According to some healthcare workers, this is done due to stress, forgetfulness or laziness. Lack of knowledge is also described as a reason. Nevertheless, the system is also described as easy to understand and it takes one second to put up the ordering card on the cabinet door. At some of the care units, these problems have been brought up and discussed. However, it has had limited effect and one nurse states how everyone says that they put up the ordering cards, however, the ordering cards are not put up.

At some care units, routines have been implemented in order to prevent this. Healthcare workers who work the shift prior to the MiV team scanning the ordering cards, search through

the cabinet for missing ordering cards. The healthcare workers have thus designed and implemented their own systems for how to prevent this from happening. This has made it possible to prevent shortages of material due to ordering cards not put up in time. However, according to the healthcare workers who are responsible for material, the problem of missing ordering cards still exists, but the routine has prevented shortages of material from occurring.

One further problem with the ordering cards is that they do not state the number of articles in the picking and buffer bin, and the healthcare workers need to log into Marknadsplatsen in order to see the inventory levels in the Unit storage room. The MiV team can see inventory levels in the PDA. One further issue regarding the ordering cards is the name of the article which is stated. For some articles, the name is hard to understand and connect to the specific article. This often creates problems in the beginning when MiV 2.0 is implemented. However, after a while the healthcare workers learn and understand which article the name correlates to.

5.2 Health centres

Below a description of the current material handling process at eight health centres within VGR is given. The description is followed by identified problems and a description of the assortment analysis which has been carried out at health centres.

5.2.1 Current material flow

The material handling process at health centres is managed and controlled by nurses and material is ordered once a week. An overview of the material handling process at health centres can be seen in Figure 5. Before ordering material, the nurse does an inventory of needs in the storages in order to identify which articles to order. The material handling process is done by hand and the nurse uses a pen and a paper to write down the material needed. In some cases, a pen and a paper are located in the storage and everyone consuming material can write down which articles to order. At other health centres, a common praxis is that everyone should report to the responsible nurse when the last package of an article is opened. At other health centres, the nurses do everything by themself and keep track of what needs to be ordered every week. A notice board is used at some health centres where healthcare workers can note when material is needed. Therefore, it can be concluded that each health centre has their own way of signalling demand and there is no standardised way for how to handle it.

The following step is to order the material from Marknadsplatsen. The nurses enter the data in Marknadsplatsen and search for material. The process is time-consuming as the portal often lacks both pictures and information about the article. Nurses can use templates in Marknadsplatsen in order to facilitate the material ordering. However, in most cases this is not used as the nurses do not feel comfortable using it due to lacking technology skills. After the order is placed, it is sometimes complemented up to five times before the deadline. When the data is entered in Marknadsplatsen and the order is complete, the order is automatically sent to the health centre manager who approves it. When the order is approved, it is sent to Sisjödepån

and delivered to the health centre within two days. If material is ordered from an external supplier, the lead time is usually longer.

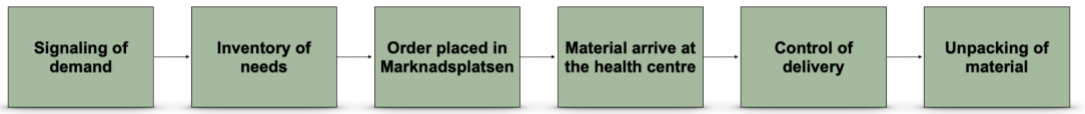

Figure 5. The material handling process at health centres within VGR.

Nurses have two to three hours per week set off for the material handling process. The type of articles ordered sometimes vary and depends on the preferences of the nurse ordering material. When the order is delivered, the nurses unpack the material and check if the delivery matches the original order. If material is missing, it is marked with a marking pen and placed in a folder with information about deliveries. However, this process is not standard at all health centres. The material is delivered to the same location every week and does not have to be received in person. In some cases, material is transported inside the building to reach the delivery location. Health centres have between three to five storage locations. The unpacking of material is performed at the health centres and the material is placed in the storages. Shortage of material rarely occurs, and if it happens, health centres can borrow material from other health centres or place an emergency order. If health centres have material that is out of date or in other contexts not usable, the material is sent to help organisations.

Before holidays, material is stocked up as there are no deliveries on holidays nor authorised healthcare workers available at the health centre. This increases inventory levels at the health centres. The health centres are also responsible for ordering material for nursing homes located in the area and receive their material orders by fax or by paper.

5.2.2 Storage structures

Health centres are often located in the same buildings as other care units e.g. child health centres, dentists and nursing homes. The majority of the storages are relatively small and scattered around the health centre. The structure of the storages is sometimes based on the area of use of the material, e.g. office supplies are located in one storage and lab material in another. This enables nurses to easily know where to find the material. However, the majority of the storages are not divided based on usage and different types of material are mixed, e.g. dressing material together with toilet paper. The health centres use a first in first out system, i.e. new material is placed behind older material, which is used first. In figure 6 and 7, examples of storage structures can be seen at different health centres.

Inventory levels at health centres vary, which leads to varying structure in storages. At some health centres, material is placed in order to make it easy to access, while some have placed material both in front and on top of other material. In some storages, the structure is built up by compartments and shelves where material is placed. However, the majority lack a

description of which type of material is stored and quantities of each material. The material is often stored in the packaging it arrived in. Due to lack of space in some storages, material is placed on the floor or above cabinets.

Figure 6. Pictures of storages at two different health centres within VGR. In the first storage, a mix of material is stored in one storage. In the second, office supplies are stored together in one storage.

Figure 7. In the picture, it can be seen how lab material is stored in connection to the usage point, i.e. in the lab.

5.2.3 Managers' perception of the material handling process

While interviewing managers at health centres, it became clear how the common perception is that the material handling process is well-functioning. However, some problems were brought

up. One manager states that the nurses at the health centre sometimes think long-term when ordering material. The manager further describes how the nurses are encouraged to trust their own ability and how much material is needed. At another health centre, the manager describes how material is ordered to last for three to four weeks. Problems regarding limited storage space are further brought up. Even though the health centre is newly built, storage space has not been prioritised.

At one health centre, the health centre manager described how nurses spend one hour a week on ordering material. Therefore, the manager has problems seeing which benefits a system like MiV 2.0 would result for the health centre from a time perspective. The manager further referred to an Emergency ward at Sahlgrenska university hospital where a system similar to MiV 2.0 led to shortages of material.

However, at some health centres, managers had a different view on the material ordering process and could see the potential benefits with improving the material handling process. At one health centre, the manager had previously been responsible for ordering material and therefore knew which problems that often occurred. The manager was positive towards MiV 2.0 and could see the potential benefits with making the material handling process more efficient at the health centre. The nurses working at the health centre also expressed a positive attitude towards implementing MiV 2.0 and further described how changes in the organisation usually are received in a good way among the workers.

It is further described by managers how healthcare workers can be sceptical when implementing new working methods. An aspect brought up is the potential resistance which may occur when doing a reduction of the assortment at health centres. The reason is that the healthcare workers often have personal preferences regarding which material to use, e.g. which type of needle to use on which patient. One manager therefore pinpoints the importance of visualising the effects of the implementation.

5.2.4 Nurses' perception of the material handling process

The majority of the interviewed nurses state how most of the material ordered is consumable articles ordered continuously, and several of the nurses think relatively long-term when ordering material, e.g. that material is ordered to cover a month of consumption. Another nurse orders material for a period of three to four weeks in order to prevent stock-outs, to reduce the risk of not being able to treat patients. One nurse describes how the time perspective depends on which type of article is ordered and which area it is used for. The article's durability is also taken into consideration. If the article is used frequently, larger quantities are ordered since these articles most likely will be consumed, e.g. test tubes used in the lab. At another health centre, material is bunkered due to the risk of not being able to order material the next week as a result of stress or lack of time.

A nurse at one health centre states concerns regarding how a system like MiV 2.0 would imply that the material supply will be dependent on a third party. The nurse is further concerned about what would happen if the MiV team does not arrive in time and how this can lead to shortages of material.

5.2.5 Identified problems at health centres

The main problem brought up at interviews by both nurses and managers is Marknadsplatsen. The main problems with Marknadsplatsen are the search function, lack of pictures and inadequate information regarding the article and delivery costs.

Nurses at health centres further describe how mistakes sometimes occur and that articles are missed when checking the inventory before placing an order. Potential risks with missing articles are to not be able to treat patients. Worst case scenario is that patients have to be sent to Sahlgrenska university hospital in order to be able to receive the right treatment. However, the majority of the health centres state that this is not a common problem. In most cases, the healthcare workers can use an equivalent article and still be able to treat the patient.

One further problem brought up by the healthcare workers is that some articles are distributed by Sisjödepån in large packages, which leads to material being wasted as well as high inventory levels. Sisjödepån is not able to split packages since the provided quantity is dependent on the agreement negotiated by the Central Purchasing Department. One further aspect is that some articles are sterile, and therefore the package cannot be split.

In addition, health centres need to have a number of articles in stock owing to regulations within emergency care. These articles have limited durability and are rarely used. Therefore, the majority of the material is wasted. The articles are often provided in large packages, leading to an excess inventory of the specific articles. Further, the articles are sterile which makes it difficult to split packages. One nurse brought up an example of an article which has never been used during the nurse's 30 years within Primary care. The article is available to order in a package size of 10, implying that large quantities are wasted every year. The nurse further described how they have talked about the possibility of splitting a package with other health centres, but they have not reached an adequate solution due to logistical challenges.

One further issue brought up is how nurses miss to signal when the last package of an article is opened, which makes the nurse responsible for ordering material unable to work proactively and order new material before a shortage occurs. Several nurses also brought up the vulnerability of the system, since only one nurse is responsible for the material ordering in most cases. A few of the nurses working at health centres further described how they did not have time to structure and clean storages.

5.2.6 Assortment analysis at health centres

When analysing ordering data from two health centres within VGR, it can be noted that the assortment of articles is 505 respectively 458, while a typical care unit at a hospital has around twice as much. Therefore, health centres do not have a too wide assortment in order to implement MiV 2.0. Purchasing costs range between 382 000-423 000 SEK annually. Among the assortment of articles, 60 percent are articles which only are ordered once a year, and quantities of these one-time orders range from one up to thousands of articles. These 60 percent represent approximately 10 percent of the total volume.

Today, Health centre A and Health centre B have approximately 30 percent of their assortment of articles in common. When harmonising the assortment of articles within the category office supplies at Health centre A together with a nurse, the assortment of different articles was reduced by 37 percent. External suppliers were eliminated, and articles distributed from Sisjödepån were chosen instead. The price aspect was also taken into consideration, and if possible, an article from the MiV 2.0 assortment was chosen. This led to reduced purchasing costs by four percent.

Even though articles have the same function, it can be noted that the price differs depending on which article is ordered. When analysing the assortment of articles within office supplies, some examples were found. Health centre A ordered 500 pieces of copy paper at a cost of 5 SEK, while Health centre B ordered 500 pieces for 196 SEK. The price thereby differs by 97 percent. For two equivalent pens, the price is 10.4 SEK respectively 0.79 SEK, implying a cost saving of 95 percent in purchasing cost if the inexpensive pen is chosen. In addition to the direct purchasing costs, it can be assumed that indirect costs also are saved, e.g. delivery costs and hidden costs. While performing the assortment analysis, healthcare workers at both Health centre A and Health centre B realised that they often order articles in larger quantities than necessary, which leads to high inventory levels.

In order to be able to relate cost saving to a wider perspective, purchasing costs from three further health centres was collected. The average purchasing cost for a health centre within VGR is assumed to be therefore 530 000 SEK. If it is assumed that a four percent reduction in purchasing costs can be achieved, the total potential cost saving is 21 000 SEK per year. Within VGR, there are 104 health centres, implying a total cost saving of 2.2 million a year.

5.3 Marknadsplatsen

Marknadsplatsen is the common ordering portal for material used within VGR. There are around 300 000 different articles in the portal today, whereas 50 000 different articles are ordered in a year via Marknadsplatsen. The 26 000 most frequently used articles are distributed via Sisjödepån, however, only 7000 articles are stocked at Sisjödepån. A central part during the study has been Marknadsplatsen, and healthcare workers have described how they experience different types of problems with Marknadsplatsen in their daily work. The problems

have been further emphasised by the MiV 2.0 project group. Below a description of the problems from the healthcare workers' perspective is given more thoroughly. The problems are further described by workers at Marknadsplatsen.

5.3.1 Healthcare workers' perspective

The main problem brought up by healthcare workers both at SkaS Skövde and at health centres is the search function in Marknadsplatsen. In Marknadsplatsen, the name of an article is often not related to the function of the article, which has created difficulties to find the right material for the healthcare workers. The process of ordering material in Marknadsplatsen is therefore time consuming. In most cases, the process takes a few hours. However, if healthcare workers have problems finding the right article, the process may take days, up to weeks before it is found in Marknadsplatsen at some health centres. The article information uploaded on Marknadsplatsen is operated by the suppliers, who are required to upload pictures and a description of the article to facilitate for the healthcare workers. However, since there is no standard way to monitor this, the information provided for healthcare workers is often lacking, which creates problems when ordering material.

When an article is replaced or expired in Marknadsplatsen, it receives a new article number. This results in problems when ordering material and the healthcare workers need to spend time finding the replaced article. Today, there is no standardised way to inform healthcare workers of exchanged articles in Marknadsplatsen. Further problems brought up is the lack of pictures and descriptions of the article, and information regarding extra delivery cost. A few articles have a minimum order value which results in extra costs if the order value is below the limit. However, this information is lacking and is therefore often missed by the healthcare workers, which results in extra costs. If the minimum order value is 300 SEK and material is ordered for 20 SEK, the health centre has to pay 280 SEK extra. If the healthcare workers need help to search for material or have other questions regarding Marknadsplatsen, they can call the service desk. According to the interviewees, the quality of the help depends on the person answering the call.

In Marknadsplatsen, healthcare workers can use templates in order to facilitate the material ordering process. However, when articles are expired or replaced, the templates need to be modified or the user has to create a new one. Therefore, templates are used to a limited extent by healthcare workers. Technology skills and education level further influence the use of templates.

5.3.2 Marknadsplatsen's perspective

Workers at Marknadsplatsen describe how healthcare workers can perform training and education in order to learn how to navigate and use Marknadsplatsen in their daily work. However, the interviewees at Marknadsplatsen state how the main problem is that healthcare workers do not perform the training and education available. The education on how to use Marknadsplatsen could help the healthcare workers with the experienced problems. Workers

at Marknadsplatsen further state that around 70 percent of the articles have pictures. The workers at Marknadsplatsen are to some extent sceptical towards MiV 2.0, as a result of not being involved in the process of developing the system. This has resulted in a wide range of different PDAs used after implementing MiV 2.0, where Marknadsplatsen uses one PDA while MiV 2.0 uses another. These are not connected to the same platform.

5.4 The distribution network within VGR

The distribution network within VGR consists of three departments: Sisjödepån, Tvätteriet Alingsås and Regiontransport. Sisjödepån distributes all material to hospitals and health centres within VGR and Tvätteriet Alingsås distributes all types of textiles used in healthcare, e.g clothes and towels. Regiontransport is responsible for picking up and delivering tests from the lab at health centres to the hospitals. Regiontransport also delivers medication to health centres in Västra Götaland. Regiontransport is also responsible for picking up and delivering mail to hospitals and health centres. Regiontransport visits health centres on a daily basis in order for healthcare workers to have lab results back in time. Regiontransport have small vehicles and can therefore help deliver material to health centres and hospitals within VGR, where Sisjödepån's and Tvätteriet Alingsås' larger trucks have problems reaching. Regiontransport has a number of central hubs within Västra Götaland and uses these as nodes in the distribution network. At the central hubs, Regiontransport's trucks are parked. The delivery of medication and material are distributed to the central hubs and are thereafter delivered to the right location. Regiontransport's transportation routes are manually planned in order to maximise the number of visits at health centres per truck each day and are thereby vulnerable for change in the network. Therefore, Regiontransport is not flexible for change today.

Sisjödepån and Tvätteriet Alingsås coordinate and co-transport their deliveries to hospitals within Västra Götaland. The hospitals within VGR have material delivered every day and therefore operate as nodes in the distribution network. The distribution area around each hospital is divided into different parts which are supplied once a week. Each day, the transportation route starts at the hospital and thereafter continues the route to all health centres, child health centres and dentists in one area. Each health centre thereby has one fixed delivery day each week. The distribution network is based on fixed delivery times in order to be able to cover all customers within the area. The transportation route is therefore planned in the most efficient way based on the geographical location. This makes it hard to change the transportation routes.

5.5 Identified gaps SkaS between Skövde and health centres

While studying the material handling process, several gaps between health centres and MiV 2.0 were noticed. Today, the unpacking of material at health centres is done by healthcare workers while the material is packed up in storages. This is a difference compared to SkaS Skövde, where this is done in an unpacking room located at the bottom floor by the MiV team. During the study, it also became clear how health centres do not have the physical prerequisites

for implementing an unpacking room. The transit hall at hospitals is used for distributing textiles from Tvätteriet Alingsås. At health centres, textiles are not as frequently used, and the assortment is smaller. The majority is working clothes for healthcare workers which are not included in the MiV 2.0 service provided by Regionservice. All textiles are delivered together with the material from Sisjödepån. As stated above regarding the unpacking room, physical prerequisites hinder having a transit hall at health centres. The limited use of textiles is also a factor to take into consideration.

At hospitals within VGR, Regionservice workers are located at the hospital, handling e.g. material supply, food services and cleaning. This is not the case at health centres where Regionservice workers only visit health centres at predetermined times, e.g. to collect lab samples or deliver material. There is also a geographical distance between health centres. At hospitals, all care units are placed in connected buildings, which enables a MiV team to easily travel between different care units and to have a centralised hub where they are based. Health centres on the other hand, are geographically dispersed, especially in the countryside, which complicates having a central MiV team.

It has also been noticed that health centres are less coordinated with less communication between different units. Health centres therefore operate in a decentralised way. The material supply is handled locally and there is a lack of communication and coordination between different units and the way the material handling process is handled. One health centre describes how they plan to invest in the same type of EKG machine as a health centre nearby in order to be able to borrow EKG material from each other. This agreement has been made locally and no central coordination or control has been a part of the decision. If health centres need to borrow material from each other, this is something that is handled locally by the health centres. They need to call health centres nearby to check availability and travel to pick up the material.

Today, hospitals within VGR are supplied with material daily, both from Tvätteriet Alingsås and Sisjödepån. This was the case before MiV 2.0 was implemented as well. Health centres on the other hand, receive material once a week. According to the interviewees at Tvätteriet Alingsås and Sisjödepån, it is difficult to change transportation routes, both in terms of frequency and number of delivery days. One further gap identified is the assortment of articles. At SkaS Skövde, the assortment has been reduced by approximately 50 percent when implementing MiV 2.0. However, the number of different articles at health centres were approximately equal to the MiV 2.0 assortment at SkaS Skövde, implying a narrower assortment of articles at health centres.

6. PROBLEM DISCUSSION

Below a discussion of the identified problems during the study is given. The problems are related to relevant literature brought up in the theoretical framework. In some cases, additional literature has been brought up in this chapter.

6.1 Lack of management support

Lacking support from management may be a hindrance when introducing improvement projects within the healthcare sector (Brandt, 2013). Jacobsson and Åhlström (2010) also discuss lack of management support as a hindrance when implementing material handling processes into the healthcare context, which is a problem that has been noticed during the study. The material handling process is handled by nurses who are responsible for ensuring material availability. While interviewing managers at health centres, the majority described the material handling process as well-functioning with few problems. The nurses have time set off for ordering material every week, which according to the managers works in a good way. One manager described how the majority of the material ordered is consumable articles which are ordered continuously every week by the nurses. Therefore, the manager did not see the purpose of introducing a new system for consumable articles since it works today. However, while talking to the nurses, the process was described as time consuming, and they experienced different problems connected to the material handling process.

The lack of understanding as well as support from management might be a hindrance when improving the material supply system at health centres. While interviewing managers at health centres, it was noted how the common perception regarding the material handling process is that it is well-functioning with limited need for improvement. This in turn may lead to a lacking support regarding the implementation since managers do not see the potential benefits. This can be further connected to what Brandt (2013) discusses. He describes how the common perception within healthcare is that change is not needed as long as processes and systems work. Brandt (2013) further pinpoints how managers located further away from the daily activities may have problems realising the benefits. This is also emphasised by Jacobsson and Åhlström (2010), who further describe how lacking support may cause lacking motivation among healthcare workers.

However, at some health centres, managers were positive towards improving the material flow. At these health centres, nurses were also positive and described how changes in the organisation usually are received in a good way among workers. This further reinforces what Jacobsson and Åhlström (2010) as well as Brandt (2013) discuss about support from top management and its effects on employee motivation. If the manager is motivated and supports the implementation, the workers are motivated too. This is in line with Jacobsson et al. (2007) who state the importance of personal characteristics in managers and leaders. If managers have a personal drive and are able to understand and explain problems and possible solutions, an improvement project is more likely to succeed.

According to Erlingsdottir et al. (2018), the leadership style influences the outcome when a new way of working is implemented. To cope with change when implementing new ways of working, Brandt (2013) emphasises the importance of operating with an understanding and engagement. The lack of engagement and understanding might be a reason why healthcare workers face the problem with missed ordering cards brought up during the interviews. According to Iqbal et al. (2015), an effective leadership will empower the performance of the workers by guidance and shared knowledge. It can further decrease stress levels and increase quality of patient care (Gooraki et al., 2013). If the leadership is not performed properly, it will affect the performance as a result of lack of direction and guidance (Iqbal et al., 2015). This might be a reason why the healthcare workers do not consequently follow the instructions of the ordering cards. It is important to be aware that the leadership could affect the performance of a new implemented system (Brandt, 2013).

6.2 Lack of competence in material handling processes

Lacking competence may also be a hindrance when implementing a material supply system similar to MiV 2.0. As discussed by Jacobsson and Åhlström (2010), healthcare workers usually have limited knowledge regarding material handling processes and its possibility to improve the material supply system within the healthcare context. At health centres, lack of knowledge has been noticed both regarding material handling processes, but also lacking technology skills, which Jarrett (1998) discusses. The nurses who order material possess severe skills within medicine and clinical work. However, they are not educated within the area of material handling processes, nor are they the ones with the highest educational level. This has led to problems occurring regarding e.g. Marknadsplatsen.

Lacking competence regarding material handling processes is also an aspect to consider among managers. As stated by Jarrett (1998), managers often lack competence regarding how to maximize the value added for processes, and at the same time achieve synergies to improve the overall performance. This has been noticed during the study and can be connected to the lack of incentives for implementing MiV 2.0. Managers at health centres do not always see the potential benefits and value added by improving the material flow from an overall perspective, e.g. how lower inventory levels leads to freed up space and reduced material costs, as well as economies of scale for the whole organisation. It further increases the quality of patient care. Even though managers are aware of e.g. waste, they might not see the full implications of it. As described by Jacobsson and Åhlström (2010), lacking support from management as well as limited knowledge regarding material handling processes may lead to healthcare workers returning to their old working routines. If a new material supply system is implemented, and healthcare workers as well as managers do not see the benefits of using the new system, there is a risk that they return to ordering all material from Marknadsplatsen. The new system may be seen as an extra burden instead of a value-adding system which improves the overall performance of the health centre, as emphasised by Jacobsson and Åhlström (2010).

As stated by Jacobsson et al. (2007), researchers need to be careful when using industrial terms when interacting with healthcare workers, as well as reconsider rephrasing critical terms. This was noticed during the study. When interviewing healthcare workers both at SkaS Skövde and at health centres, industrial terms were avoided, and concepts and terms connected to material supply systems were instead explained to the interviewees using other words. Examples of avoided terms were Lean and Kanban. The Kanban method which MiV 2.0 is based on is rephrased and mentioned as the Tom/Full method. Even though the principles of the method can be directly linked to Kanban and Lean, the terms are never mentioned in documents or by workers involved in the MiV 2.0 implementation.

6.3 Assortment analysis at health centres

While interviewing nurses responsible for the material handling process at health centres, it was clear that their perception is that the majority of the material ordered is consumable articles which are ordered continuously. However, a review of the ordering data from March 2019 to February 2020 at health centres showed how approximately 60 percent of the articles are only ordered once a year. These 60 percent represent approximately 10 percent of the total volume, implying that healthcare workers spend a large part of their time on a small part of the material used. It can further be assumed how nurses' perception of their ordering patterns are deficient. In interviews, nurses describe how articles which are ordered less frequently take more time to search and find in Marknadsplatsen. This further implies how a large part of the time is spent on articles ordered and used less frequently.

The review of the ordering data within the category office supplies further showed how health centres order articles with a higher purchasing cost, even if there were similar articles with a lower price. A reason for choosing these articles can be the search function in Marknadsplatsen, as the name and information do not correspond to the function of the article. The healthcare workers have limited time set off for the material handling process, and therefore have limited possibilities to find the most beneficial articles in Marknadsplatsen from a price perspective. This leads to higher purchasing costs. After the harmonisation of the assortment of articles, some of the expensive articles could be replaced by articles with the same function, but to a lower price. A total cost reduction of around four percent was achieved within office supplies. This implies further possibilities to reduce purchasing costs at health centres.

While reviewing the assortment of articles at Health centre A and Health centre B, it was seen that the majority of the articles used are different, i.e. 70 percent. The analysis of the ordering data further showed how material is not ordered continuously. Order sizes differ which creates an uneven flow of material. This may create problems higher up in the organisation since routes and truck capacity cannot be planned efficiently. While reviewing material within office supplies together with the healthcare workers at Health centre A and Health centre B, the healthcare workers realised how articles often were ordered in large quantities, which led to high inventory levels. It can therefore be discussed if the uneven flow of material is connected

to an uneven demand of patient care or if healthcare workers tend to order material in a non-continuous way.

6.4 Healthcare workers' ordering and consumption patterns

As discussed by Persona et al. (2008), the healthcare sector is traditionally managed by high inventory levels in order to prevent shortages from occurring. When conducting the study, it was clear that healthcare workers have a tendency to stock up material. Several of the interviewees stated how the fear of not having the material needed led to more material being ordered than what is actually consumed. This is reflected in storages at health centres. Jarrett (1998) states the same opinion and discusses how this mindset may hinder the implementation of material handling processes into the healthcare context. The mindset can be seen both at SkaS Skövde and at health centres within VGR. At SkaS Skövde, the MiV 2.0 implementation phase was characterised by healthcare workers trying to increase inventory levels and widen the assortment of articles to ensure material availability. Managers at health centres further described how nurses responsible for ordering material have a tendency to order more material than actually consumed, which leads to excess inventory.

At health centres, nurses described how they think long-term when ordering material in order for the material to last longer, e.g. that material should last for a month. This long-term ordering implies high inventory levels. The behaviour of thinking long-term when ordering material is brought up by Callender and Grasman (2010). The authors describe how healthcare workers' personal judgement often is the basis for material ordering, rather than more scientific methods. This is further emphasised by Wang et al. (2015). At one health centre, the nurse stated that material is bunkered because of the risk of not being able to order material next week, caused by stress, lack of time or lack of resources. However, when analysing the ordering data, it can be noted how material is ordered every week at this specific health centre. It can therefore be discussed if healthcare workers lack knowledge and understanding regarding their ordering behaviours. Callender and Grasman (2010) as well as Nicholson et al. (2004) state how it is problematic to have a material ordering based on personal experience rather than on data.

Hoarding of material is further discussed by Landry and Beaulieu (2010), who describe how hoarding of material is an expensive behaviour which in the end does not lead to better care for patients, rather the opposite. This is further discussed by Persona et al. (2008). The excess inventory of material implies waste of space as well healthcare workers being forced to spend more time searching for material. This is interesting to note since the reason for healthcare workers stocking up material is to be able to provide better care for patients, even though an excess inventory of material affects patient care in a negative way (Landry & Beaulieu, 2010). However, as stated by Saha and Ray (2019), demands within healthcare are fluctuating, i.e. random variation, as discussed by (Jonsson & Mattson, 2009), and stock outs may lead to healthcare workers losing faith in the material supply system. Therefore, too low inventory levels may cause stock outs which could make healthcare workers feel uncomfortable with the new material supply system.

The tendency to stock up material has also led to some healthcare workers having a hard time letting go of their work tasks connected to the material handling process. Healthcare workers at SkaS Skövde were still trying to change the structure of the storages and the way of working regarding MiV 2.0. Therefore, a rivalry was noted between the healthcare workers and the MiV team. This can be connected to hierarchies between the healthcare workers and those who implement, as discussed by Brandt (2013). Brandt (2013) further brings up fear of losing autonomy. At SkaS Skövde, the healthcare workers felt that the MiV team took their job, which led to healthcare workers interfering with the MiV team's work tasks. By introducing MiV 2.0, the responsibility for the material supply system is transferred from the healthcare workers to Regionservice, implying that the healthcare workers have no duties or responsibilities left and old working structures are changed. At health centres, nurses were anxious of becoming too dependent on a third party handling the material supply system, and concerns were brought up regarding what would happen if material did not arrive in time and how this can lead to shortages of material. This is similar to the issue SkaS Skövde faced regarding the feeling of losing autonomy of work tasks connected to the material handling process.

6.5 Decentralised material ordering

Today, the material handling process within Primary care is decentralised, i.e. it is handled and controlled locally at each health centre. The decentralised approach leads to a lack of coordination and control between health centres and different functions within VGR. Each health centre orders different articles, even though the articles have the same function, implying a wide assortment of articles. Which quantities each article is available in depends on the agreements negotiated by the Central Purchasing Department. However, as stated by nurses at health centres, quantities are often large which results in high inventory levels and wasted material. One further problem is that material withdrawals made by the healthcare workers in storages are not registered, nor wasted material. Therefore, it can be assumed that there is a lack of knowledge regarding how much material is wasted as well as how large quantities that are actually needed by the healthcare workers. This is further emphasised by Persona et al. (2008).

Activities related to the material handling process are decentralised and handled differently at health centres. Each health centre has its own working methods, and routines are not followed consequently. The nurses responsible for the material handling process describe how healthcare workers do not consequently follow the routine of signalling demand, e.g. to note when the last package is opened or write on a board which material is needed. In addition, a lot of responsibility lies with the nurse responsible for material ordering.

The decentralised approach may also be a hindrance for implementing a concept similar to MiV 2.0 at health centres. It can be noted how the decentralised approach leads to problems realising potential effects higher up in the organisation. The health centres are focused on local benefits at their specific health centre and thereby overlook potential benefits from an overall

perspective. Today, the health centre only pays for the nurse's salary, without social fees which are paid higher up in the organisation. Therefore, it may be more beneficial from an economic point of view to have a nurse order material than invest time and money into a concept similar to MiV 2.0, seen from the health centre's perspective. The local health centre may also have difficulties realising the benefits from a time perspective. Today, a nurse spends on average two to three hours on material ordering each week. Therefore, health centres may not see the benefits as big enough in order to invest time and resources into a new system, i.e. the incentives are not strong enough for improving the material supply system. This is also emphasised by Jacobsson and Åhlström (2010).

6.6 Working environment

A problem that occurred with MiV 2.0 at SkaS Skövde, is the instructions of the ordering cards. The ordering cards signal demand for material, but the healthcare workers tend to miss to put up the ordering cards in time. According to the healthcare workers, the main reason for this is forgetfulness or stress. As discussed in Brennan et al. (2016), human error is a common factor for making mistakes both by people and in organisations. Stress and tiredness are two examples of human factors that could cause these kinds of mistakes (Brennan et al., 2016). Therefore, the human factor could be the reason why the healthcare workers at SkaS Skövde do not consequently put up the ordering cards in time. The nurses at SkaS Skövde responsible for the storage also discuss if this behaviour could be related to laziness.

According to Johnson et al. (2005), healthcare workers face a higher risk of developing stress related to their work. This is according to Cooper et al. (1999) related to the high pressure healthcare workers have on their emotional elements. Firth-Cozens and Greenhalgh (1997) further describe how humans who are exposed to prolonged stress are more likely to make mistakes. Firth-Cozens and Greenhalgh (1997) argue that if the workers feel less stressed, it can increase their well-being and create better focus. Zaghini et al. (2020) further discuss how nurses often are exposed to stress and that prolonged stress can affect both their well-being as well as the quality of patient care. After implementing MiV 2.0 at SkaS Skövde, the nurses described how they felt less stressed and, according to them, MiV 2.0 has increased the time for patient care. MiV 2.0 has also reduced the stress and led to less irritation regarding the material handling process for the healthcare workers, and it has created a more harmonised working environment at the different care units at SkaS Skövde.

Marknadsplatsen has been a central problem during the study, and it is according to the healthcare workers the most time-consuming task in the material handling process. The time put on both Marknadsplatsen and other activities related to the material handling process is time the healthcare workers otherwise could have used for patient care. This phenomenon is according to Landry and Beaulieu (2010) common for nurses in the healthcare sector, as they often are assigned to non-clinical tasks, which results in less time with patients. This was also the case at SkaS Skövde before implementing MiV 2.0. The process of ordering material in

Marknadsplatsen was stressful as the healthcare workers often got disrupted when ordering material.

6.7 Storage structure

It can be seen in pictures and maps over the selected health centres that storages at most of the health centres are scattered. A few health centres have structured storages where articles have assigned places, while others have not. In some cases, storages are divided based on its content. The healthcare workers describe how they have good structure in storages, but from pictures, it can be concluded that they often lack structure and have high inventory levels. The structure is varying in all health centres and there is no common standard for how to structure the storages. It is thereby up to each health centre to organise their storages. Persona et al. (2008) further describe that material within healthcare often is stored in an unstructured way. This unstructured way of storing material will both create inadequate space at hospitals, as well as insufficient rotation of material. Persona et al. (2008) describe how this often leads to expired material, which has been brought up as a problem by healthcare workers. Persona et al. (2008) further state the importance of structure in hospital environments, as space is important and should not be occupied by unused or unnecessary material.

7. SOLUTION DISCUSSION

In the following chapter, the first research question will be answered: 'How can the MiV 2.0 concept be adapted within Primary care to improve the material handling process at health centres?'. Based on the identified problems in the previous chapter, adaptations needed of the MiV 2.0 concept are discussed and presented. A discussion of how to overcome potential hindrances when implementing material handling processes into the healthcare context is also provided, followed by potential effects.

7.1 Centralised material handling

Today, the material handling process at health centres is decentralised. In order to fill gaps and solve the problems identified, a centralised approach is suggested. According to Jonsson et al. (2013), centralised supply chain planning includes standardised working methods and processes as well as it facilitates coordination and control. It can further solve problems with overestimated demand (Jonsson et al., 2013). Therefore, a standardised assortment, standardised structures in storages, standardised working methods and increased coordination and control are suggested in order to fill gaps and solve problems identified at health centres. In Figure 8, an overview of which problem is solved by which of the following solutions can be seen. Below a description of each solution is given.

7.1.1 Standardised assortment

Today, the assortment of articles at health centres is decentralised. No common standard exists for which articles to use or have in stock which results in a wide number of articles with the same function used at health centres within VGR. In order to make the material handling process at health centres more efficient, the assortment of articles needs to be overviewed and harmonised. Instead of health centres locally deciding on which articles to order and use, a centralised approach regarding the assortment is suggested. The assortment of articles should be standardised and common at all health centres.

By harmonising the assortment, the number of different articles can be reduced. By making an analysis of the assortment together with the healthcare workers, the health centres can agree upon which articles to use and have in their common assortment. Expensive articles can be eliminated and replaced with less expensive articles stocked at Sisjödepån or used in the MiV 2.0 assortment today. External suppliers can also be excluded in order to reduce delivery costs and hidden costs. As a result, a common and standardised assortment of articles can be agreed upon at all health centres within VGR, where the number of different articles are reduced, and the most beneficial articles are ordered. This will result in lowered purchasing costs, reduced tied up capital as well as economies of scale. By using a reduced and common assortment of articles where articles from Sisjödepån are used, it further enables the economies of scale available today to be exploited. The lead time will also be shorter if articles from Sisjödepån are chosen instead of external suppliers.

As stated by healthcare workers at health centres, the most time-consuming part in the material handling process is Marknadsplatsen. A standardised assortment at all health centres will reduce the time in Marknadsplatsen and thereby facilitate the process of ordering material. In the long term, a standardised assortment will further lead to more efficient inventory management at Sisjödepån. As stated by Persona et al. (2008) the cost of inventory is high, and by a standardised and common assortment, the number of different articles stored at Sisjödepån can decrease. This will in turn lower inventory costs in the organisation.

7.1.2 Standardised structures in storages

Today, storages at health centres lack a standardised storage structure. The storage space is limited which leads to unstructured storages where material is stocked in piles, both at shelves and on the floor. Therefore, storages should be structured, standardised and common at all health centres within VGR. This is enabled by a standardised assortment of articles. Shelves should be marked with the article's name in order to keep the storage organised and enable healthcare workers to more easily find material (Gupta and Chandana, 2020). The most frequently used articles should be placed in an easy and accessible way (Heisler, 2015). The Lean management method 5S can be used as guidance and help in order to structure storages, which is emphasised by Chiarini (2012). Quantities of each article should be predetermined and based on ordering and consumption data, rather than the healthcare workers' perception of how much material is needed. As stated by Persona et al. (2008), healthcare workers have a tendency to stock up material, and by calculating and constraining the space for each article, healthcare workers are disabled to order more material than actually needed. This is further brought up by Landry and Beaulieu (2010), who mainly discuss module cabinets similar to the cabinets used in the MiV 2.0 concept. In addition, by reducing stocking up of material made by the healthcare workers, inventory levels are decreased. Changes in the physical structure is also a way to sustain an improvement project (Ament et al., 2014). With re-structured storages, it is more likely that the improvement will sustain and that healthcare workers will follow the new ways of working.

Increased knowledge and awareness can also create a continuous flow of material at health centres by basing the material ordering on actual consumption instead of personal judgement, as discussed by Callender and Grasman (2010). Today, material is ordered in large quantities with the purpose of lasting for weeks up to months. By reducing order quantities as well as increasing the order frequency of an article, inventory levels can be lowered. This will lead to a balanced demand and supply (Jonsson & Mattson, 2009). A structured and well-organised storage will according to Gupta and Chandana (2020) enable healthcare workers to find material and create better space in storages more easily. The limited space available for storing material at health centres is thereby used in an efficient way, which according to Persona et al. (2008) is important since the scarce storage space available within healthcare should not be occupied by unused or unnecessary material. Structured storages may further make the process of creating demand easier. The structure could help healthcare workers to see which material to order and when, as the structure creates better visualisation of the material. The time to

unpack material will further be reduced as well as the time needed to search for articles in Marknadsplatsen.

At SkaS Skövde, the implementation of MiV 2.0 has facilitated the material handling process, and is according to the healthcare workers a valuable asset which has increased the time with patients. It has reallocated resources and enabled an efficient use of competence. Care units have a standardised assortment and use common articles which have reduced inventory levels as well as inventory costs. Material supply systems similar to MiV 2.0 which have been implemented within healthcare have resulted in reduced time, costs and tied up capital (Landstinget i Värmland, 2016). At SkaS Skövde, one Unit storage room is located centrally at the care units. However, at health centres, storages are small and scattered, and no need for one big central storage has been identified. Therefore, consumable articles can be further stored in a number of smaller storages located at the health centres. The Local storage room used at SkaS Skövde should not be implemented either due to the limited use of textile articles at health centres.

7.1.3 Standardised way of working

Today, health centres operate in a decentralised way. The material ordering process is handled locally and different at all health centres and routines are sometimes unstructured and not followed consequently. Therefore, a need for standardised and structured working methods related to the material handling process has been identified. As stated by Timmons et al. (2004), standardised work enables the workers to create a smooth workflow as well as to free up time. Problems related to signalling need for material were highlighted during the study. By implementing a standardised assortment and structures in storages, a standardised way for how to signal the need for material is enabled. The process of checking inventory is also scattered, implying that a standard for how to do this is also needed at health centres. Assigned places for each article as well as predetermined quantities enable the healthcare workers to systematically search through the storage for articles which need to be ordered. Material can also be ordered based on the predetermined quantities for each article. This decreases the time needed for the material handling process. In order to successfully implement standardised ways of working, Oudhuis and Tengblad (2013) emphasise the importance of involving the workers. By involving the workers in developing standards of the process, they feel responsible and have a feeling of ownership.

7.1.4 Increased coordination and control

At SkaS Skövde, a MiV team is located at the hospital which enables close and central handling of material to all care units. Health centres on the other hand, are more geographically dispersed than care units at a hospital, implying a longer distance between health centres. Health centres also operate in a decentralised way today with their own methods and working structures, which in turn has led to difficulties regarding governance and control. Therefore, increased coordination and control between the actors involved in the material handling process are needed.

When standardising the material handling process at health centres and making changes in the daily work for healthcare workers, there is always a risk that healthcare workers go back to their old working routines. This is emphasised by Jacobsson and Åhlström (2010). Therefore, there is a need for a central and coordinating function which has an overall control and ensures that the new routines are followed. This is further discussed by Ament et al. (2014) who bring up strategies for sustaining improvements within the healthcare context. One of the strategies brought up is to have a central coordinator. The authors further emphasise the importance of investing in workers who have responsibility for sustaining the improvement and making sure that the new ways of working are being followed. Since the material handling process at health centres today is decentralised, increased coordination and control between functions in the organisation are needed when the material handling process is centralised. The Service Developer at SkaS Skövde also emphasises the importance of having a central and coordinating function in order for the implementation to be consistent over time and prevent healthcare workers from returning to their old working routines.

Increased coordination and control in the organisation are also a prerequisite for having a standardised assortment of articles at health centres. The coordinating function can make it easier for health centres to borrow material from each other. Today, if health centres need to borrow material as a result of e.g. shortage of material, healthcare workers are required to call and check if any other health centre has the material in stock. By having a coordinating function, this can be handled centrally and thereby save time for the healthcare workers. Increased coordination and control in the organisation may also help reduce waste by solving the problem of large packages distributed from Sisjödepån. A common assortment of articles as well as a coordinating function enables smaller quantities to be sent to health centres and thereby reduce the risk of material being wasted due to articles being expired. However, the problem of large packages is mainly dependent on which agreements the Central Purchasing Department negotiates. However, by centralising the material handling process at health centres, all 104 health centres within VGR can join forces and thereby become one stronger unit.

The need for an IT system was also discovered during the study, as this would enable visible inventory levels as well as increased control and coordination, both at health centres but also within VGR. The IT system would also enable easier follow-up of material ordering and consumption which in turn prevents stock outs (Heisler, 2015). This can according to Chan et al. (2014) enable healthcare workers to reduce the workload and increase efficiency. It is also beneficial from a time perspective, and it will in turn enable healthcare workers to spend more time on patient care (Chan et al, 2014). The IT system also enables tracking of waste, which may further point at the importance of being able to split packages. At SkaS Skövde, the healthcare workers are not required to keep track of which articles are withdrawn or changed in Marknadsplatsen. A central and coordinating function could enable this at health centres in order to facilitate for healthcare workers. At SkaS Skövde, the IT system has enabled a more

equal material distribution, e.g. in the Covid-19 pandemic. Therefore, it can be assumed that an IT system at health centres would imply increased visibility and control, and thereby a more equal material distribution in times of a crisis. It would further imply increased patient safety and preparedness.

Problem	Solution	Difficulty level to implement
• High purchasing costs • Wide assortment of articles • Problems in Marknadsplatsen	Standardised assortment	Low
• Stock up of material • High inventory levels • Material not ordered continuously	Standardised structures in storages	Low
• Routines and working methods not followed • Articles are missed when ordering	Standardised way of working	Medium
• Prevent return to old working routines • Decentralised material ordering • Lack of control and visible inventory	Increased coordination and control	High

Figure 8. An overview of the identified problems and potential solutions. Difficulty level of implementing each solution is further stated from low to high.

7.2 Implementation factors to take into consideration

The following section answers the second research question: 'Which factors need to be taken into consideration when implementing a material supply system as MiV 2.0 adapted for industrial environments into the healthcare context?'. Relevant parts and problems will be brought up and factors to take into consideration will be discussed further. The factors have been divided into four different parts.

7.2.1 Management support

As discussed by Jacobsson and Åhlström (2010) as well as Brandt (2013), support from top management is a prerequisite when implementing a material supply system into the healthcare context. Therefore, it is crucial that the implementation is established in the whole organisation, including both managers and healthcare workers. This is also emphasised by Abdallah (2020), who further points at the importance of good leadership in order to succeed. However, as stressed by Jacobsson and Åhlström (2007), improvement projects are often introduced from top management, leading to healthcare workers feeling pressured. This points at the importance of involving the healthcare workers in the implementation in order to ensure that the implementation is established and successful. A starting point for this is to include motivated and engaged workers in the implementation and take advantage of their drive (Jacobsson & Åhlström, 2007). By establishing the project among all workers and taking advantage of motivated workers, the risk that the project is seen as an extra burden is also reduced. Moreover, Brandt (2013) states the importance of involving healthcare workers since they are the ones who perform the tasks. Jackson (2001) also describes the importance of involvement in decisions regarding the implementation as well as being clear of the reason why the

implementation is done. It is also crucial to have a clear goal of the process, as this creates motivation for the healthcare workers (Brandt, 2013).

It is important that managers state roles and responsibilities for everyone involved in the process. This is emphasised by the MiV team at SkaS Skövde, who describe how rivalry between the MiV team and the healthcare workers may occur otherwise. At SkaS Skövde, healthcare workers had problems letting go of responsibilities connected to the material handling process, and therefore interfere with the new way of working. It is important to note that MiV 2.0 does not remove work from the healthcare workers, it only reallocates resources. This in turn enables healthcare workers to focus on their main task, which is taking care of patients, while the MiV team is responsible for the material handling process. Therefore, it is important to clearly establish the implementation in the whole organisation to avoid that the new roles and responsibilities at health centres are not followed. It is also important in order to avoid strong hierarchies between working groups, as discussed by Brandt (2013).

7.2.2 Lack of competence

During the study, healthcare workers have expressed lacking technology skills, where the main problem is Marknadsplatsen. Therefore, it is crucial that the new standardised processes are easy to understand and do not require any advanced technology skills. At SkaS Skövde, the problem was solved by introducing the MiV 2.0 concept, which lowered the time in Marknadsplatsen for the healthcare workers. It can therefore be assumed that similar results would be gained by improving the material handling process at health centres.

Lacking competence as well as lacking management support has also been noticed as reasons why healthcare workers return to their old working routines (Jacobsson & Åhlström, 2010). Therefore, it is important to visualise benefits and show healthcare workers and managers which potential benefits the new system will result in, e.g. show data on perceived effects. Healthcare workers at health centres can also talk to workers at SkaS Skövde who already practice MiV 2.0 in their daily work. This is emphasised by Jacobsson et al. (2017) who describe increased motivation as a result of visualising previously successful implementations. It can also give the workers a feeling of: 'We can do this' (Jacobsson et al., 2017). It is further beneficial in order to ensure that healthcare workers understand the value added by the new ways of working instead of considering it an extra burden (Jacobsson & Åhlström, 2010).

The central coordinating and controlling role can also prevent healthcare workers from returning to their old working routines, e.g. similar to the MiV team at SkaS Skövde. At SkaS Skövde, the healthcare workers are no longer responsible for which material is ordered, nor in which quantities. If a similar concept is introduced at health centres with a central and coordinating role, the risk of healthcare workers returning to order material as previously is decreased. The role may also function as support if top management and managers at health centres are not supporting the implementation.

One further factor to take into consideration when implementing material handling processes into the healthcare context is to be careful with using industrial terms, such as Lean and Kanban. Instead, critical terms should be rephrased and explained in order to avoid that the terms negatively affect the implementation (Jacobsson et al., 2007).

7.2.3 Healthcare workers' ordering and consumption patterns

As stated by Persona et al. (2008), healthcare workers have a tendency to stock up material, implying high inventory levels as well as difficulties to improve the efficiency. The behaviour of stocking up material is rooted in a concern for not being able to provide patients with the care needed due to a lack of material (Persona et al., 2008). Therefore, actions need to be taken in order to show and assure healthcare workers that a standardised assortment of articles as well as reduced inventory levels will not lead to shortages of material, nor decreased patient safety.

Standardisation makes processes less dependent on the workers as the time to perform the task is reduced, which can create negative reactions since healthcare workers usually have high autonomy (Drotz & Poksinska, 2014). This can be related to the fear of having to rely on a third party to take care of the material handling process, as brought up by the healthcare workers at health centres. As stated by Jacobsson and Åhlström (2010), it is important to give healthcare workers proof and visualise that the new system will work according to what is promised. It is further important to explain to healthcare workers how the clinical work is not the scope of the improvement project when standardising working methods. The standards are only applied to supportive work tasks. Therefore, the healthcare workers will not lose autonomy of the clinical work, nor the contact with patients. The improvement work rather enables the healthcare workers to increase the time spent on patient care, which is brought up by Drotz and Poksinska (2014).

The assortment analysis further visualised the healthcare workers' ordering patterns, which enables healthcare workers to base the material ordering on actual demand from data and scientific methods rather than their own personal judgement. This is discussed by Callender and Grasman (2010). The IT system will further enable visualisation of consumption, which creates an even flow of material as well as lower inventory levels. The IT system enables visualisation of demand, which can prevent the behaviour of stocking up material. It will also increase safety for patients, as inventory levels can be tracked with the IT system. It will further enable healthcare workers to spend less time on the material handling process, and more time on patient care.

By designing the storage structure based on predetermined quantities of each article as well as assigned places in the storage, the structure and limited storage space may prevent healthcare workers from stocking up material. Thereby, the physical constraints prevent the stock up of material in storages.

7.2.4 Decentralised material ordering

It is also important to note that the decentralised approach at health centres may be a hindrance when implementing material handling processes. Since health centres operate locally, incentives may not be strong enough to improve the material handling process. The process is only seen from the health centre's perspective, not from the overall supply chain. Akmal et al. (2020) further discuss how silos are rooted in healthcare practices, which often makes it difficult to implement a system based on the opposite. This can be related to the problem with rivalry between the MiV team and the healthcare workers which occurred when MiV 2.0 was implemented at SkaS Skövde.

It is further important to take organisational benefits into consideration, and that improvements in the material handling process may result in benefits upstream in the organisation as well. If material is ordered continuously in an even flow, route planning as well as truck capacity can be planned better. Today, material is randomly ordered in large quantities some weeks and in small quantities other weeks, and material is ordered to cover more than one week's consumption. Therefore, by utilising that material is delivered weekly and only order material for the upcoming week's demand, the material flow will be evenly distributed. This will result in benefits both at an organisational level, but also locally at the health centre.

7.3 Potential effects with improving the material supply system

The potential effects by improving the material supply system at health centres can be divided into quantifiable and non-quantifiable effects. Below a description of these effects is given.

7.3.1 Quantifiable effects

It is important to note that different health centres most likely will experience different effects depending on their current situation regarding the material handling process. Health centres with a structured and well-developed routine for ordering and unpacking of material will most likely not experience as big effects as a health centre with a less structured material handling process. One further aspect to take into consideration is the resource perspective. In order to improve the material supply system at health centres and make it more efficient, resources need to be invested. If Regionservice takes over the responsibility of the material supply system at health centres, it must be done more efficiently and with less resources. Therefore, it has to be investigated which resources that are profitable to invest in. An example is to investigate if a central MiV team is needed or not. Thereby, it is important to take into consideration that it may not be beneficial to implement MiV 2.0 in the same way as at hospitals since it needs to be worth it from an overall perspective. This is also emphasised by Roberts (2001), who states that the basic premise of outsourcing within healthcare is that the external actor is able to provide the service more efficiently than if it was performed internally in the organisation.

Reduced time needed for the material handling process

VGR (n.d.) states that 40 percent of healthcare workers' time is used for searching and gathering of material. By structuring and standardising storages, this time can be reduced to 10 percent (VGR, n.d.). By improving the material handling process at health centres, the time needed for the material handling process is expected to decrease. By decreasing the number of articles ordered in Marknadsplatsen, less time is required by nurses to look and search for material. Today, nurses at health centres use approximately two to three hours for material ordering each week. By reducing the assortment of articles with 37 percent and reducing the number of low-frequent articles, a time saving can be assumed. At SkaS Skövde, the implementation of MiV 2.0 has led to a time saving of 34 percent, implying that similar results can be expected at health centres.

Freed up space

At SkaS Skövde, the implementation of MiV 2.0 has reduced the space needed for storing material by 50 percent. By structuring storages at health centres and reducing inventory levels as well as the assortment width, space will be freed up. According to Heisler (2015), by reducing inventory, space is freed up. This will enable storages to be used in a more efficient way (Heisler, 2015). This in turn leads to increased space for patient care at health centres.

Lower inventory levels

The limited storage space will prevent healthcare workers from bunker material, which leads to lower inventory levels. The storage structure will be based on predetermined quantities calculated from actual consumption. By implementing structured and standardised storages at health centres, the stocking up of material can thereby be prevented by these space constraints. The IT system further enables visualisation of consumptions and demand which creates an even flow of material as well as monitoring of inventory levels.

Reduced costs

A standardised assortment of articles implies reduced costs, both locally at health centres but also in the VGR organisation. Purchasing costs could be lowered and health centres can reduce the number of articles purchased from external suppliers. This would result in a reduction of purchasing costs by four percent. For all health centres within VGR, this implies an annual cost saving of 2.2 million. At a hospital located in the middle of Sweden, purchasing costs were lowered by seven percent by reducing the assortment of articles (Landstinget i Värmland, 2016). The Central Purchasing Department can also negotiate better agreements with suppliers due to higher volumes, which results in economies of scale. Costs can also be reduced upstream in the organisation. By an even and continuous flow of material, truck capacity can be optimised, and routes can be planned in a more efficient way.

Today, healthcare workers sometimes order wrong article as a result of problems in Marknadsplatsen. Costs related to these wrongly ordered articles will be reduced. By reducing both the number of different articles as well as inventory levels, tied up capital will be

decreased. At SkaS Skövde, the tied-up capital has reduced by 50 percent when implementing MiV 2.0, implying that a similar outcome is possible at health centres.

Reduced assortment width

After harmonising the assortment of articles, purchasing costs were reduced by four percent. The assortment of office supplies was reduced by 37 percent, which indicates potential effects for cost reduction as well as reducing the number of articles at health centres by doing an assortment analysis. After reviewing the assortment of articles at Health centre A and Health centre B, it was identified that they had 30 percent common articles. This implies a possibility to create an even more common and standardised assortment. The harmonising of the assortment was made on four percent of the total assortment of articles, which made it possible to reduce the assortment width as well as purchasing costs. This implies a possibility to scale up the harmonising to more health centres within VGR and to reach the same outcome.

7.3.2 Non-quantifiable effects

The non-quantifiable effects can be divided into stress related effects, improved work satisfaction and increased patient safety. A description of each of these effects is given below.

Reduced stress

Stress related to the material handling process is brought up by both healthcare workers at health centres and at SkaS Skövde. Before MiV 2.0 was implemented at SkaS Skövde, healthcare workers described how they felt stress related to the material handling process. By improving the material supply system at health centres, time will be released for healthcare workers to focus on patient care. This further implies a possibility to reduce stress levels as well as stress related mistakes. According to Firth-Cozens and Greenhalgh (1997), decreased stress levels create better focus, which in turn lower the possibilities of making mistakes. If stress levels at health centres are reduced, it may also prevent burnouts, which is often the outcome of prolonged stress (Bickford, 2005).

Improved work satisfaction

Decreased stress levels also create a better working environment (Firth-Cozens & Greenhalgh, 1997). MiV 2.0 has contributed to a better working environment for healthcare workers at SkaS Skövde as it has enabled a more efficient material handling process as well as reallocation of resources. Improved structure in storages further creates a better working environment, which has been the outcome after implementing MiV 2.0 at SkaS Skövde.

An improved material supply system can further contribute to freed up time for healthcare workers, which makes it possible to reallocate the time to patient care. The possible outcome of increased time for more patient care is higher work satisfaction, in the same way as MiV 2.0 created a better working environment at SkaS Skövde. This combined with a well-functioning leadership will according to Hargett et al. (2017) improve both quality of patient care as well as work satisfaction.

Increased patient safety

When decreasing stress levels, it will at the same time decrease the possibility of making mistakes, which in turn increases patient safety. As stated by Firth-Cozens and Greenhalgh (1997), decreased stress levels further lead to higher quality of care. Kekkonen et al. (2018) further describe how an increased service level in healthcare can be achieved by redesigning the material handling process.

8. CONCLUSION

Today, the material handling process at health centres is decentralised, compared to MiV 2.0 at hospitals which is handled centrally. The assortment of articles at health centres are wide and there is no common standard for which material to order. The structure in storages is not standardised, and in combination with a wide assortment of articles as well as long-term ordering, it leads to an inefficient use of storage space. The decentralised approach also implies a lack of standardised working methods. Today, healthcare workers at health centres spend a large part of their time on the material handling process, where the most time-consuming part is Marknadsplatsen. No structured coordination or regular control between health centres within VGR exist either.

To solve the problems identified and improve the material handling process at health centres in order to adapt it towards MiV 2.0, several actions need to be taken. This answer the first research question: 'How can the MiV 2.0 concept be adapted within Primary care to improve the material handling process at health centres?'. A centralised approach is suggested, where the material handling process is standardised and all health centres within VGR have a common and standardised assortment of articles. This approach will decrease the time needed in Marknadsplatsen. To further enable an efficient material handling process, storages at health centres need to have a standardised structure where all articles respectively have their assigned places and quantities are predetermined. A standardised assortment and structure in storages further enable standardised working methods to be implemented at health centres. Increased coordination and control are further identified as a prerequisite in order for the improvement to be consistent over time and to prevent healthcare workers from returning to their old working routines. A harmonisation of the assortment at Health centre A resulted in reduced purchasing costs by four percent, and the assortment of articles within office supplies was reduced by 37 percent. This implies a potential saving of 2.2 million SEK in purchasing costs for all health centres within VGR. At SkaS Skövde, the implementation of MiV 2.0 has resulted in similar outcomes.

To successfully improve the material supply system within the healthcare context, several factors need to be taken into consideration. This answers research question two: 'Which factors need to be taken into consideration when implementing a material supply system as MiV 2.0 adapted for industrial environments into the healthcare context?'. The implementation needs to be clearly established among both managers and healthcare workers, and management support is a crucial factor. At health centres, managers play an important role, and it is crucial that they support the implementation. A starting point is to include motivated and engaged workers in the implementation and take advantage of their drive. Furthermore, it is important that managers at health centres have support from higher up in the organisation. Roles and responsibilities also need to be clear in order to successfully implement material handling processes into the healthcare context.

Lack of competence has been noted during the study. Lacking technology skills has been brought up by healthcare workers, which points at the importance of creating a system that is easy to understand. In order to prevent healthcare workers from returning to their old working routines, potential benefits with the new system need to be visualised clearly. The implementation of MiV 2.0 at SkaS Skövde can be used as a good example. The tendency among healthcare workers to stock up material may also be a factor hindering the use of a standardised material handling process. This can be solved by basing the material ordering on actual demand from ordering data and scientific methods instead of healthcare workers' personal judgement. The healthcare workers' fear of losing autonomy can be solved by visualising that the new standardised improvements only are applied to supportive work tasks. Therefore, the healthcare workers will not lose autonomy of the clinical work. Physical constraints in storages further prevent healthcare workers from stocking up material. The decentralised approach may also be a hindrance when implementing material handling processes into the healthcare context. Today, health centres operate locally which can lead to problems realising benefits higher up in the organisation. Therefore, incentives may not be strong enough.

The suggested solution is in line with the fundamental principles of MiV 2.0. Among several goals, the principles of MiV 2.0 are to create a standardised and common assortment in order to reduce purchasing costs and create a more efficient material handling process. Inventory levels are based on actual demand, processes are standardised, and roles and responsibilities are defined in order to improve the overall process. This enables improved processes and better inventory control as well as a more harmonised working environment. An IT-support system further enables visible inventory level as well as simplified follow-up of the consumption. It can be concluded that the majority of the solution of this study is in line with the principles of MiV 2.0. It should therefore be investigated further if an adapted version of MiV 2.0 could improve the material supply system at health centres within Primary care and achieve similar outcomes as SkaS Skövde after implementing MiV 2.0.

9. MANAGERIAL IMPLICATIONS

A few of the problems identified in the study need to be further investigated in order to find an appropriate solution. The purpose of the study was to investigate and highlight potential improvement areas and gaps between MiV 2.0. Therefore, deeper investigation of how to implement the solution in practice at health centres needs to be conducted.

A potential area for investigation is if the existing structures and distribution network within VGR can be used and utilised for improving the material supply system. Today, Regiontransport distributes material to all hospitals within VGR and thereafter health centres in the surrounding area. Therefore, it can be further investigated if this existing distribution network can be used and expanded to include a central MiV team. The central MiV team could use the hospitals as nodes and visit health centres in the same way as Regiontransport, and thereby assist healthcare workers with the material handling process. Marknadsplatsen has been a central problem brought up by all healthcare workers. However, improvements of Marknadsplatsen are outside the scope of this study. Therefore, Marknadsplatsen is a potential improvement area in order to facilitate the material handling process for healthcare workers.

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