

# **Rational and Participative Task Allocation between the Nursing Staff and the Logistics Support Service Provider in Healthcare**

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## ***Abstract***

*This study aims to answer how rational task allocation between the nursing staff and the support service provider in the healthcare context can increase the positive outcome of the work system. The work system model is used as a theoretical framework, with resilience and cost as complementary concepts. This qualitative case study used action research and participatory design to develop the work system with the interplay of two parallel personnel groups in the healthcare environment. First, the case of an ongoing relationship between the target organisation's nursing staff and in-house logistics and material supply services was studied. The development process resulted in a variety of practical ideas to improve the co-operation between the personnel groups. In the second case, a prospective relationship between the nursing staff and an external logistics service provider was examined. This research's conceptual results identify the main characteristics of rational support services as comprehensive, resilient, reliable and easily accessible.*

## 1. Introduction

The ageing population and limited resources are posing challenges to healthcare systems globally. Furthermore, the variety of methods and techniques for treating progressively challenging medical conditions is increasing the use of healthcare services. This situation has correspondingly expanded the diversity of highly specialised medical supplies and instruments. Hence, healthcare providers have a growing need to find ways to improve patient processes, as well as support activities. The co-operation of the actors in these processes enables the complex system of healthcare to function cost efficiently and for the benefit of patients (Hollnagel et al. 2013). However, the design of such modern socio-technical systems is challenging because of their complexity – for example, many safety and risk management systems arising from traditional starting points are insufficient in this context (Qureshi et al. 2007). A macroergonomics aspect that takes into account physical, social and organisational contexts is needed (Carayon 2009).

The work system model (Carayon & Smith 2000; International Organization for Standardization [ISO] Standard 1981; Smith & Sainfort 1989) has been used to figure out the complex system of healthcare (Carayon et al. 2006, 2014; Gurses et al. 2009; Hignett et al. 2013; Holden 2012; Holden et al. 2013). However, until now, the co-operation between healthcare professionals and support service providers has gained less attention. In its basic form, the work system encompasses the person (employee), his or her tasks, the available tools and technology, and the work environment, as well as the organisation where the work is performed. The work can be perceived as consisting of processes that result in either positive or negative outcomes, depending on the input and the interrelation among the sections in the work system (Carayon & Smith 2000).

In this paper, the work system model is used with the complementary concepts of resilience and cost. The definition and the usage of the term *resilience* vary in different fields of study but share some common features (e.g., agility, responsiveness, visibility and flexibility), regardless of the

field (Herrera & Janczewski 2016; Ponomarov & Holcomb 2009). According to Hollnagel (2011), in the field of safety management, resilience can be perceived as “an intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions”. Resilience engineering argues that it is necessary to examine not only the failures, as has traditionally been done, but also the successes (Hollnagel 2011). The logistics and supply chain literature defines the phrase *supply management resilience* as a meta-capability that aims to resist damage and to quickly recover from disturbances (Eltantawy 2016). To maximise the pros and prevent the cons of task allocation in the complex context of healthcare, resilience offers a key to the management of the combination of the core process (i.e., nursing tasks) and the support process (i.e., support service tasks).

Regarding the other complementary concept used with the work system model, cost effectiveness in healthcare serves as both a driver for change (Kaplan & Porter 2011) and a positive outcome of a well-functioning work system (Carayon et al. 2006). Seamless operations, which aim to generate the best possible value for the customer in a cost-efficient manner, require an organisation to constantly develop its functions. The way that costs are managed plays an important role in organisational profitability and efficiency (McNair et al. 2006). Lower cost structures and higher service levels in healthcare are achieved in many cases by redesigning support services, such as material logistics (Poulin 2003).

Support services in healthcare can be defined as all services and tasks that enable the nursing work but are not nursing functions themselves. While nursing work comprises both direct and indirect care and guidance of patients or their relatives, support services cover tasks such as material logistics, meal services, cleaning and laundry services, maintenance and technical services, and so on (see, e.g., Kotavaara et al. 2017; Peltokorpi et al. 2009; Pohjosenperä et al. 2017). The necessary support services to enable the functioning of healthcare can be organised in

a variety of ways. Traditionally, support service functions have been organised by an internal operator in a hospital. However, recent findings question the efficiency of internally produced services (Kriegel et al. 2013). In practice, it is common for certain services to be outsourced to external operators, while others are produced in-house. Both internal and external methods of providing support services have their challenges, which are discussed, among other aspects, in the Results section.

The tasks of healthcare are to take care of patients and to perform operations on them to provide prerequisites for their health and well-being. Patients are the customers of the nursing staff and thus of the whole healthcare organisation. On the other hand, in the case of healthcare support services, the nursing staff can be regarded as the customer of the support service provider. However, when viewing the entire healthcare system on a large scale, the patient is the end customer. The support service providers in healthcare bear a resemblance to the suppliers in an industrial network (Väyrynen et al. 2016). The concept of an inter-organisational shared workplace that is common in industry might be applied to healthcare, where several support services are needed to enable patient treatment and care by the nursing staff. Social sustainability, as well as a high and consistent level of service quality, can be promoted through specialised tools such as the Health, Safety, Environment, Quality (HSEQ) Assessment Procedure presented by Väyrynen et al. (2016), as well as through participatory design and development and employee empowerment in organisational development projects from a broader perspective. Overall, in demanding and skilled jobs with high risks such as healthcare, with its shared workplace situation of nursing and support tasks, the shared work system approach is actually also necessary. Meticulous and integrated management based on a detailed work system and wide, consistent HSEQ-style coverage of quality are prerequisites for smooth collaboration and desired outcomes.

In this regard, the study aims to answer how rational task allocation between the nursing staff and the support service provider in the healthcare context can increase the positive or the desired

outcome of the work system. This is done in practice by seeking new solutions and courses of action for the task allocation to increase employee's well-being and productivity at work. The positive outcomes of the rational task allocation and performance of the support service system contain both monetary and non-monetary elements. The empirical part of this study consists of two cases with different setups for the support service system. In Case 1, the system is organised by an in-house service provider. Previously, Paananen et al. (2011) conducted research on the work of both the nursing staff and the support service staff in the same healthcare organisation studied in Case 1. This earlier study focused on employee empowerment and personnel participation in the development projects carried out in many areas, among which were task allocation and support services. Case 2 deals with a prospective relationship between the hospital and an external logistics service provider (LSP). These two cases are compared in terms of the relationships between the nursing staff and the support service providers to find new solutions and courses of action for organising the support service functions.

The research was carried out on two levels. On a practical level, real-life development ideas were generated and implemented in the target organisation by using a participatory design in Case 1. On a more theoretical level, the roles of the support service personnel and the nursing staff were contemplated in Cases 1 and 2. The theoretical concepts are presented in the next section.

## **2. Theory**

### ***2.1. Work system and task allocation***

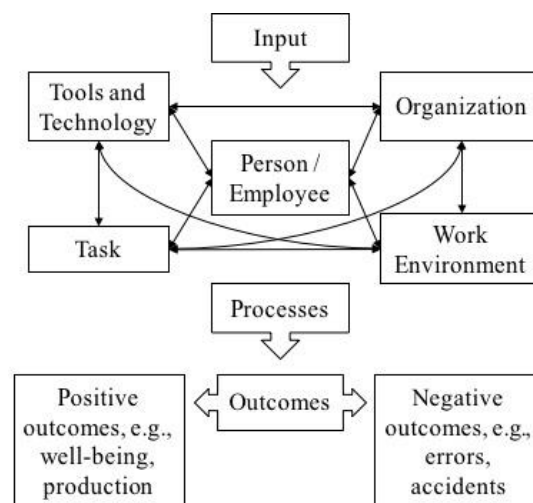
The work system, often presented in the form illustrated in Figure 1, serves as the basis for this study's theoretical framework (Carayon & Smith 2000; ISO Standard 1981; Smith & Sainfort 1989). The work system consists of the person or the employee, his or her task, the tools and

technology used in the work, the physical environment and the organisation where the work is performed. The work that is carried out in different processes normally leads to both positive (i.e., desired) and negative (i.e., undesired) outcomes that depend on the input and the interrelation among the elements of the work system. Examples of positive or desired outcomes are employee productivity, health and well-being, while negative or undesired outcomes include stress, accidents, discomfort, absence from work and loss of time. The work system provides a model for describing all of the elements present in work, encompassing psychosocial, cognitive and physical aspects (Carayon 2009). Earlier, Smith and Sainfort (1989) formulated the balance theory to set the principles of the work system design. The various issues related to the different elements of the work system influence the employee. Since it would be impossible to eliminate all the negative aspects present in the work system, the proper balance should be sought by compensating for the adverse factors with positive ones, so the outcomes would be optimal performance, low stress, good health, and safety and well-being of the employee (Carayon 2009).

The concept of the work system has been widely applied in the field of healthcare (Carayon et al. 2006, 2014; Gurses et al. 2009; Hignett et al. 2013; Holden 2012; Holden et al. 2013). A model that takes the original work system further is the Systems Engineering Initiative for Patient Safety (SEIPS) created by Carayon et al. (2006) and reformed as SEIPS 2.0 by Holden et al. (2013). The model's aim is patient safety through human factors in healthcare. In the SEIPS model, the person(s) in the work system can be a healthcare professional(s), the patient and/or his or her family members or other actors in the healthcare processes. In terms of the physical setting, the SEIPS 2.0 model also covers the organisation's external environment. The processes can be professional work, patient work or collaborative professional–patient work; correspondingly, the outcomes are divided into professional, organisational and patient categories. Feedback from the processes and the outcomes is included in the work system, which aims at continuous adaptation (Holden et al. 2013).

Practical issues that have arisen in earlier research related to the task allocation of the nursing staff include obstacles experienced by intensive care unit nurses, such as patient transport tasks inside the hospital, disorders in nursing instruments and material warehouses, and delays in medicine transports from the hospital pharmacists. All of these issues take time off from patient work. By minimising these obstacles, a more functional work system can be attained, resulting in positive outcomes, such as improved quality of patient work, patient safety and working life of the nursing staff (Gurses et al. 2009).

A systems approach to the healthcare work system was also suggested by Hignett et al. (2013), who studied the present state and the future challenges of healthcare issues, such as occupational ergonomics for the nursing staff, planning for patient safety, operation safety and organisational and socio-technical systems in a framework of human factors and ergonomics. According to the cited study's results, comprehensive co-operation among ergonomics professionals, healthcare personnel and decision makers is needed to build a better functioning healthcare work system.



**Figure 1. The work system, input and processes leading to positive (desired) or negative (undesired) outcomes (adapted from Carayon & Smith 2000).**

## **2.2. Cost effectiveness**

In the process of achieving positive outcomes such as cost efficiency, the work system encounters challenges in producing services efficiently. In the accounting literature, services can be enhanced by eliminating non-value producing functions and constantly seeking to develop functions through which capacity can be generated (Maskell & Kennedy 2007). Organisations face the decision of operating with either internal or external actors. An internal customer's value is based on the interfaces among different functions in the production chain, which are among the focus areas of this paper. The various functions of the organisation can be regarded as one another's customers, in which case, good work community skills are particularly appreciated. The organisation's core functions are not usually outsourced, whereas the purpose of outsourcing support functions is to devote more time to core functions (Schulz & Brenner 2010). In this way, the professional skills of the organisation's own employees can be utilised in more demanding tasks, due to the work time released from them. Producing services at minor costs and providing services quickly increase customer value from the viewpoints of both internal and external customers (Braun & Tietz 2015). Everybody will benefit from a maximally efficient, value-generating process, which can be attained by constantly improving functions (Olesen et al. 2015).

In developing operational processes, efficiency is achieved by eliminating waste, for example, which consists of defects, overproduction, waiting, not utilising people's full potential, transportation, inventory, movement and excessive processing (Braun & Tietz 2015). Eliminating waste makes it possible to increase productivity and efficiency, reduce costs and increase the net results (Yu-Lee 2011). Therefore, it allows moving resources to the necessary functions, which improves quality and reduces the time spent on the use of services (Braun & Tietz 2015). In addition to eliminating waste, employees should pay attention to everyday functions and work methods that would make the operation more efficient and prevent the generation of waste (Olesen et al. 2015). From the perspective of the smooth flow and efficiency of the operation processes, it is important that the organisation's employees and work groups observe the incomplete operation of processes and know how to solve the resulting problems. Thus, both the



management and the employees benefit from and can be satisfied with the operation of the organisation and the decisions made in it (Jones et al. 2013).

### ***2.3. Resilience***

The concept of resilience has been widely used in many disciplines, originating in the development theory of social psychology. Thus, the definitions vary (Ponomarov & Holcomb 2009). According to the British Standard (BS 65000 2014), organisational resilience is the ability to anticipate, prepare for, respond and adapt to events – both sudden shocks and gradual change. It means being adaptable, competitive, agile and robust. The United Nations International Strategy for Disaster Reduction (2004) provided this definition: “Resilience is the capacity of the system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure”. According to Hollnagel (2014), a resilient organisation possesses certain features, such as the ability to respond to changes, errors and possibilities. Such an organisation monitors its actions and environment to identify the changes that may affect its possibilities. It also learns from experiences and anticipates its evolution and the consequences that are not yet visible in everyday life.

Within logistics services, resilience has also been defined in various ways over time. The concept has been under discussion over the past few years, and there is no universal, widely accepted definition for it. Nevertheless, the definitions have similarities, highlighting readiness, response, recovery and growth (Hohenstein et al. 2015). According to Eltantawy (2016), supply management resilience is a meta-capability that helps the buyer resist damage and quickly recover from disturbances to reach performance goals. Christopher and Peck (2004) defined supply chain resilience as “the ability of a system to return to its original state or move to a new, more desirable state after being disturbed”. Implicit in this definition is the notion of flexibility, and given that the desired state may be different from the original one, ‘adaptability’ earns a place in our thinking too. Based on the social, psychological and economic standpoints of resilience, Ponomarov and

Holcomb (2009) developed from the supply chain risk-management perspective the concept of supply chain resilience. They defined the concept as “the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function”.

Being a resilient service provider requires dynamic capabilities (Eltantawy 2016; Pettit et al. 2010), enabling it to adapt to changes or threats and be competitive, flexible, agile and robust (Ponomarov & Holcomb 2009). Herrera and Janczewski (2016) summarised the aspects of supply chain resilience as agility, responsiveness, visibility, flexibility, redundancy, structure and knowledge, reduction of uncertainty, complexity, reengineering, collaboration, integration, operation capabilities and transparency.

It has been recognised that maximum safety, high performance and strong resilience do not necessarily go together very well because of the natural trade-off between standardisation and supervision to optimise safety and a culture of innovation and personalisation by and autonomy of individuals and groups that are required for adaptivity. In healthcare, performance, safety and resilience have traditionally been developed in separate silos. Resilience is needed, especially in cases where the complexity and the variety of the medical system dominate; at the same time, less resilience should be applied to the standard cases to ensure safety (Amalberti 2013).

In healthcare, different kinds of medical, nursing and support service personnel perform a broad range of both caring and support roles. The case studies by Braithwaite et al. (2013) show the importance of an improvised, responsive approach to the task of producing safe care in the context of unpredictability that is inherent in healthcare, as well as the interaction among staff members from different occupations, departments and organisations. The gaps between the different departments and professional groups (doctors, nurses, support service personnel, etc.) lead to the

lack of awareness of the actors in one unit about the work of others. These manifold gaps pose a threat to the resilience of the healthcare system (Braithwaite et al. 2013).

#### ***2.4. Action research and participatory design***

Action research both studies and changes predominant practices. It can be defined as a collective self-reflective inquiry carried out by the participants in a social situation or an organisation in order to improve the rationality of their own social or educational practices (Masters 1995). Independent of the emphasis of the stated definition, action research features the acquisition of knowledge, empowerment of participants, collaboration through participation, and social change. Action research can also be viewed as a spiral process that consists of four elements: planning, acting, observing and reflecting (Masters 1995).

Knowledge can be acquired in many ways, one of which is observation. Observing the behaviour and the actions of the subject under study makes it possible to obtain direct and in some cases, more objective information than interviewing the subject, for example. Ethnography is a broad research strategy, which concentrates on participating in and observing the relevant processes of the studied system (Flick 2007). Ethnography-based observation techniques can be used in action research.

Participatory design and development is a natural companion of action research (Spinuzzi 2005). Early on, it was shown that employees' even-handed involvement in the development of work processes was connected to work satisfaction, work ethic and productivity (Coch & French 1948). Currently, participatory ergonomic interventions can be considered effective tools for reducing the burden of employees' work-related symptoms (Driessen et al. 2010; van Eerd et al. 2010). However, the way that the participatory approach is implemented and adapted in the workplace has a significant effect on the success of the intervention (van Eerd et al. 2010; Vink et al. 2006).

In participatory organisational development projects, intra-organisational human-centred communication skills also play a major role (Rajala & Väyrynen 2013; Väyrynen et al. 2014).

### ***2.5. Holistic perspective on the development of the work system by participation***

As mentioned earlier, performance, safety and resilience in healthcare have traditionally been developed in separate silos (Amalberti 2013). However, in recent decades, the benefits of the integrated management of organisational performance, including multiple facets (e.g., health and safety, quality and environmental issues), have been identified (Häkkinen 2015). The separate management of these areas has become too complex to be efficient; thus, several businesses and researchers have acknowledged the positive effect of integrated management systems on organisational success. The increasing demands for cost effectiveness and productivity also speak for the integrated management systems (Koivupalo et al. 2015). The role of resilience as a necessary feature to conform to the changing environment has also been identified (Hollnagel 2011). Sustainability and sustainable development of the organisation call for the proper balance among economic, ecological and social factors (Koivupalo et al. 2015).

Work system through which work is examined in this study is a framework that combines the elements of work and thus promotes its holistic management. The employees' participation in the development of their own work can both create tangible improvements and contribute to the employees' engagement in their work and organisation. Altogether, the integration of these separate concepts aids in establishing a holistic view on the development of work in a complex setting, such as the co-operation between the nursing staff and the healthcare support service personnel.

## **3. Characteristics of the cases**

Cases 1 and 2 share many common traits. Both cases' settings are public hospitals under the Finnish healthcare system in northern Finland. On the other hand, the two cases differ significantly in another aspect. In Case 1, the support services are operated by an in-house service provider. In Case 2, the use of an external LSP is studied. The features of the cases are presented in this section.

### ***3.1. Case 1: The regional central hospital***

The location of Case 1 is a regional central hospital. This hospital provides special healthcare services to 120,000 inhabitants in the area and is a part of the special responsibility area of the university hospital studied in Case 2. Case 1 concentrates on an ongoing "business" relationship between the obstetrics and gynaecology ward and the logistics and material supply services of the hospital. The obstetrics and gynaecology ward employs 60 nurses working round-the-clock shifts, for example, handling the approximately 1200 births in the hospital annually.

In terms of support services, the case focuses on the logistics and material services, which are provided by an in-house operator that offers purchasing and material logistics, as well as stock refill and shelving services to units inside the hospital and to other healthcare customers in the area outside the hospital. The stock refill service maintains the medical material and instrument assortment in the ward warehouse by handling the purchasing and shelving operations in the wards using the service. The logistics services cover the material delivery inside the hospital, as well as internal laundry, waste disposal, food delivery, medical instrument and pharmacy transportation.

### ***3.2. Case 2: The university hospital***

The setting of Case 2 is a university hospital that is one of the five university hospitals in Finland. The hospital is in charge of providing specialised and demanding healthcare services for approximately 741,000 patients in its responsibility area, covering more than half of the country's

geographical area. This research focuses on the hospital's surgical ward, which represents the largest cost centre and division at the hospital, accounting for approximately one-third of the costs in the annual budget. In the ward, 10,000 operations are performed annually on average. The operational-level actors at the university hospital in this case represent both anaesthesiology and surgery professionals. Their units employ approximately 100 staff members each. Furthermore, the material flow in the surgery ward is larger compared to other units in the hospital.

The in-house logistics operator handles the hospital's material logistics, called the warehouse service, which is managed by the procurement office. The pre-study conducted for this research reported some challenges of the warehouse service in meeting the needs of the surgical ward. The ward representatives held initial unofficial discussions with an external LSP about the possibilities of having new logistics services used in supporting the care processes, but no concrete steps have been taken in this relationship. This prospective LSP is a large state-owned service provider that focuses mainly on producing courier, logistics and financial services to corporate customers in 11 countries. The courier services include the delivery of letters, parcels and additional postal services, while the logistics services offer the customer diverse solutions covering cargo, warehousing and other third-party logistics arrangements.

#### **4. Methods**

This research comprises both work science and logistics disciplines. The data collection methods also vary per case. However, overall, this paper adopts a qualitative case approach that is recommended when issues are complex and in cases where alternating between the empirical field and different theoretical frameworks can be useful for generating additional insights (Orton 1997; Yin 2003). This study aims to answer how rational task allocation between the nursing staff and the support service provider in the healthcare context can increase the positive or the desired

outcome of the work system. On a practical level, action research and participatory design are used to generate and implement real-life development ideas. On a more theoretical level, the roles of the support service provider and the nursing staff are also contemplated.

Principles of participatory design and development (Spinuzzi 2005) are used to find new solutions and courses of action and to obtain information on the current state, as well as on the employees' views on the characteristics of a well-functioning relationship between the nursing staff and the support service providers in the target organisations. One of the methods often used in participatory design is the focus group discussion, where the participants in a group setting can engage in conversation about a subject or a theme introduced by the facilitator (Langford & McDonagh 2003). Focus groups are useful in identifying important qualifiers or contingencies that may be associated with an answer to a structured question. Furthermore, focus groups offer an opportunity for feedback from other participants and responses to their comments (Stewart & Shamdasani 2014).

As presented in the previous section, Cases 1 and 2 are partly different. This distinction is also reflected in the research and development processes presented in Figure 2 and thoroughly described in the following paragraphs. The researchers from different fields worked closely on the same research project between 2014 and 2016. However, after planning and initial discussions with the hospital representatives, the cases were formed by the target hospitals and researchers from different fields. Case 1 began with observations, followed by the identification of needs and challenges that were presented to focus groups to find solutions by discussing the issues. The resulting 12 practical development ideas were implemented by the hospital. Simultaneously, in Case 2, the researchers conducted pre-interviews and visits to identify the challenges in the surgery ward. These challenges were later brought up in focus group discussions to find new solutions with the LSP. The results of Cases 1 and 2 were presented to and commented on by the representatives of both case organisations in a joint project session. The initial results of the

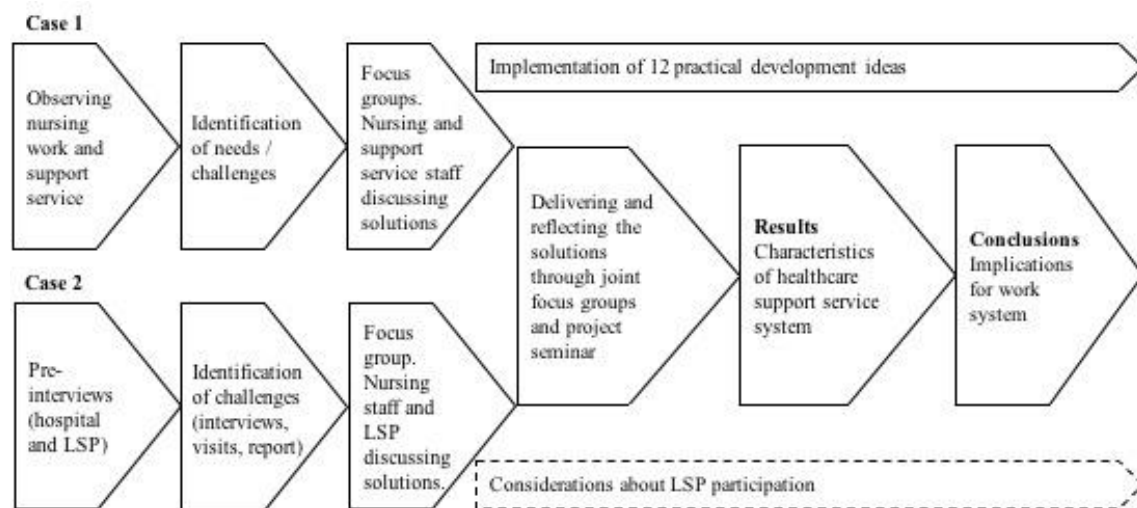
research were reported and presented to groups of experts, including the hospital representatives who participated in the focus group discussions. Subsequently, the final seminar of the research project offered the 45 attendees the possibility to comment on the results. In these documented discussions, the results were both validated and refined to meet the features of the novel context of healthcare. The joint results are further discussed in the Results and the Conclusions sections of this paper.

In Case 1, the data used in this study was collected through the action research carried out in the target ward and the support service provider. The research concentrated on the field of work science, with a focus on employee productivity and well-being. The development process began in January 2015 with the observations of the work of the nursing staff and the logistics and material supply services to find coinciding nodes in their work. The tasks of both of these personnel groups (later called *parties* due to their role as participating parties in the development process) within the work system were observed for 2.5 working days. The observer's role was to basically monitor the tasks of the employees and ask for clarification on the ways of performing the tasks, as well as the context of the work when needed. Based on the observations, the solutions were discussed in three participatory design workshops which were held as focus group sessions. In the workshops, the employees discussed about finding ways to improve the material supply and logistics services to match the nursing staff's needs and solve the challenges faced by the employees of both parties. Each workshop's participants comprised two nursing staff members (nurse and practical nurse), two material supply service staff members and the researcher. Additionally, the superior of the logistics and material supply services participated in one workshop. The researcher's role was to act as the facilitator, who raised questions when needed and enabled the discussion in an approving environment.

The research field in Case 2 is logistics. Thus, before this particular research, a pre-study was conducted in 2012 to gain an understanding of the healthcare context. The primary data for Case



2 was collected in three ways. First, semi-structured interviews were conducted between August 2014 and January 2015 with five interviews with the LSP, one with the hospital purchasing office and two with the nursing staff in the surgery ward. The interviews were carried out to obtain background information about the actors. The interviewees came from both strategic and operational levels of the organisations to gain a broad understanding of the organisations and their services. Furthermore, visits to the support service facilities and the surgery ward were arranged to obtain an overview of the services. The findings, including mostly the noted challenges in task allocation, were reported to the hospital and the LSP. In February 2015, a focus group discussion with the surgery ward personnel and an LSP representative was arranged to discuss about solutions to the reported challenges. The focus group discussion had no official purpose of starting a new business relationship but discussing LSP possibilities on behalf of the research project and providing new insights for the hospital management and the LSP. The researcher's role in the focus group discussion was similar to that in Case 1.

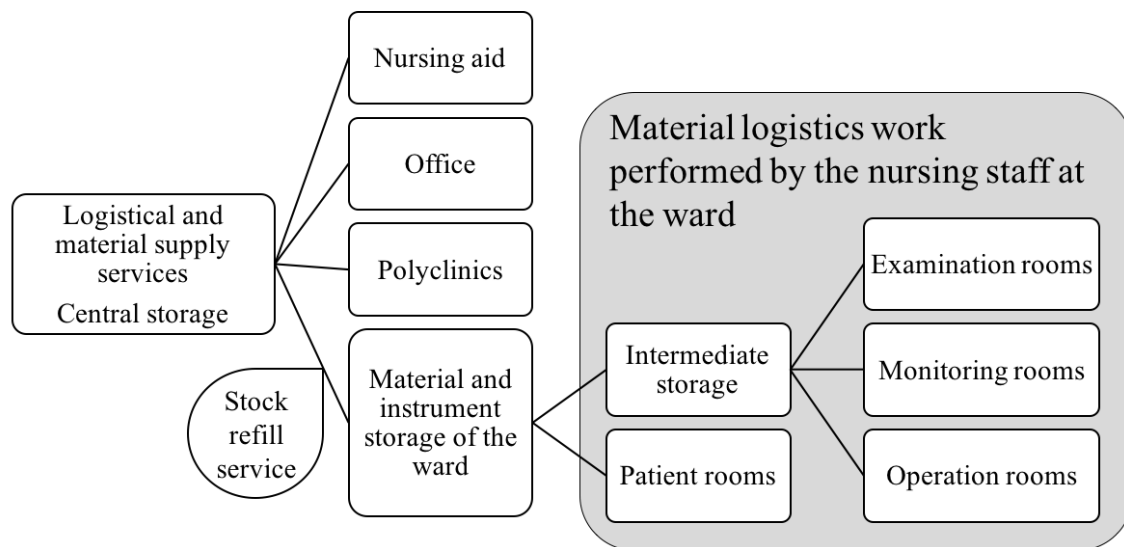


**Figure 2. The research and development processes in Cases 1 (top) and 2 (bottom).**

## 5. Results

### 5.1. Case 1: Internal support services

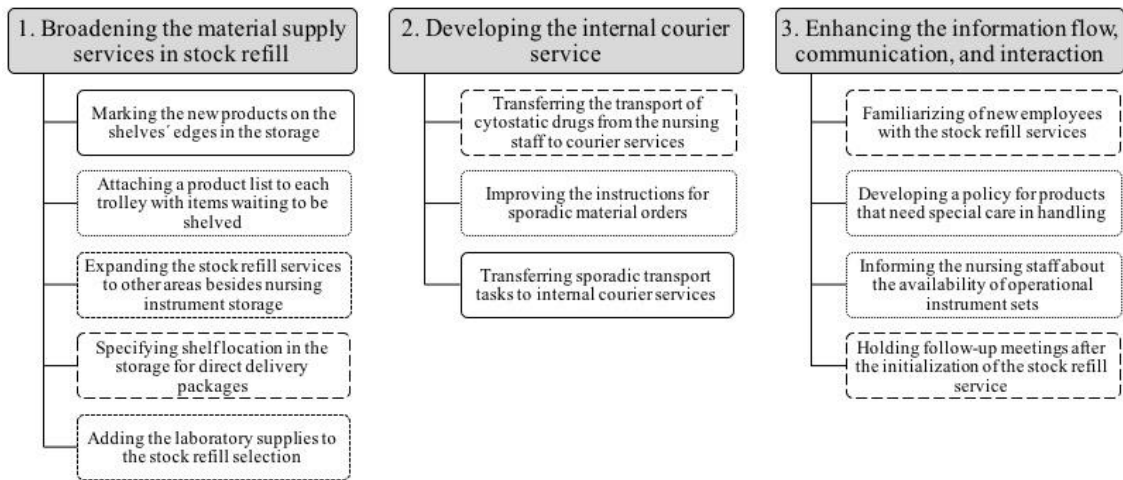
The observations of both the nursing staff in the obstetrics and gynaecology ward and the personnel of the logistics and material supply services brought out an allocation of logistics work, as presented in Figure 3. The stock refill service provided by the logistics and material supply services covered the material and instrument storage of the ward; the procurement and delivery services were also provided for the nursing aid, office and polyclinics. However, the nursing staff performed a lot of material logistics work in the ward. They delivered the needed materials and instruments from the ward storage to patient rooms, as well as various examination, monitoring and operation rooms from a separate intermediate storage.



**Figure 3. Logistics work in Case 1.**

The workshops involving both the nursing staff of the target ward and the material supply service staff resulted in 12 practical ideas that are presented in Figure 4. The ideas can be divided into three categories: 1) broadening the material supply services in stock refill, 2) creating an internal courier service to transfer logistics tasks from the nursing staff to the support services and 3)

enhancing the information flow, communication and interaction between the nursing staff and the support service staff. Several of these ideas were put into practice, while some needed further planning and resources before implementation. The line type of each text box indicates the status of the execution of the idea at the end of the field work period.

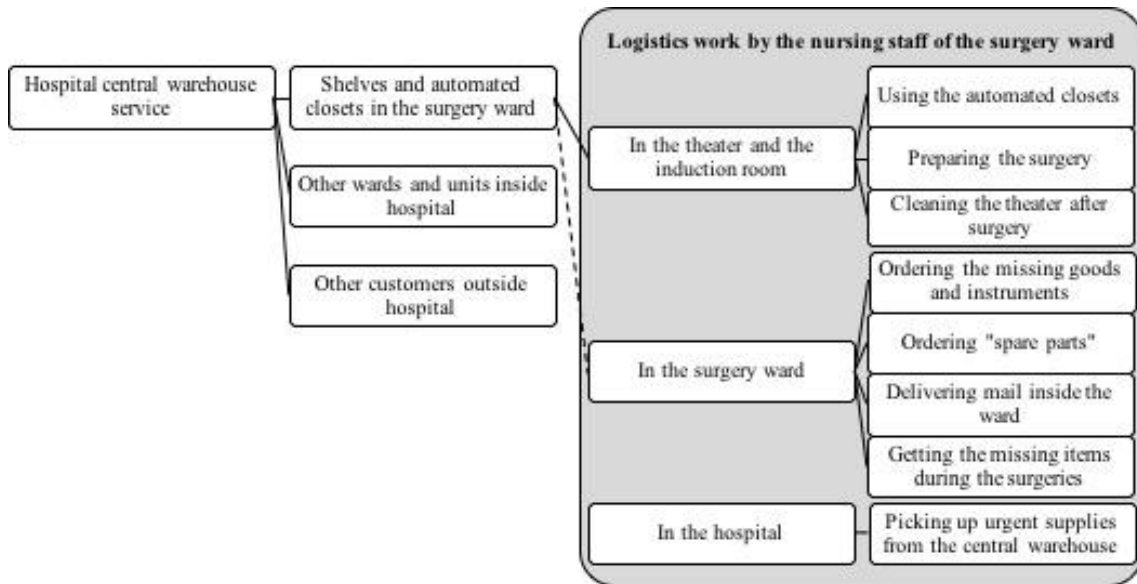


**Figure 4. The 12 practical development ideas from Case 1 workshops.**

### 5.2. Case 2: External support services

The first part of the Case 2 research revealed that the nursing staff members in the surgery ward were performing a lot of manual logistics work. Some of these tasks involved using the shelves and automated closets provided by the hospital central warehouse service. However, other logistics tasks in the surgery ward were not directly related to the provided logistics service. In some urgent scenarios, the nursing staff needed to get the missing supplies by themselves from the warehouse facilities. This task was beyond the scope of the planned procedures and offered service but was still needed if errors occurred in the preparations. Figure 5 lists some examples of the nursing staff's logistics tasks. The work allocation between the nursing personnel and the logistics staff should be clarified in the process of advancing the automated closet system takeover process. However, to date, the current collaboration between the nursing staff and the central

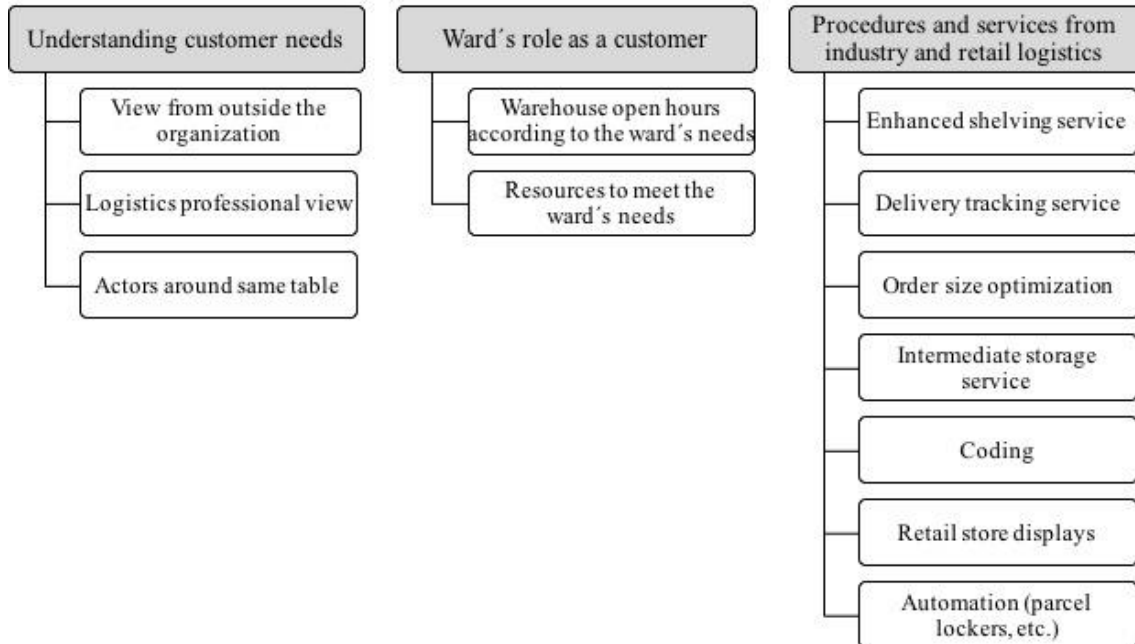
warehouse personnel is still characterised by challenges in reducing the logistics work performed by the nurses.



**Figure 5. Logistics work by the nursing staff in Case 2.**

In the focus group discussion, the surgery ward personnel and the LSP representative discussed possible solutions to overcome the reported challenges. Both sides contributed to finding three main solutions (Figure 6). These jointly created solutions highlighted understanding customer needs as the most important starting point in developing the logistics services. By using an external service provider, the ward would play a stronger role as a customer since its needs would be mapped in the beginning of the new business relationship. The parties would then have the natural need for arranging joint meetings with members from outside the hospital to adapt to each other's needs and resources. Furthermore, as a large company, the LSP had resources that would ensure the necessary open hours and reliable processes without having the risk of errors during employee sick leaves. Practically, the LSP could offer manual work that would support the functions in the surgery ward, as well as new services to help the nursing staff concentrate solely

on direct patient work. These services, including retail store displays and parcel lockers, were provided by the LSP and used by various industry and retail customers.



**Figure 6. Development ideas from Case 2 workshops aided by LSP participation.**

### 5.3. Observed need for joint interface

The task of healthcare support services is to enable the core process, that is, the nursing work. An essential element of the nursing work is the care chain, along which the patient proceeds, that consists of subsequent care processes, including treatments and operations carried out by the nursing staff. The care chain can be viewed as a horizontal path that is intersected by the vertical support service process, such as laundry service or instrument and material service. The interfaces between these two operations are located in the nodes where the support services and the care chain cross. Both the observations of the everyday work of the nursing staff and the support service staff, as well as the interviews, revealed that while the processes (the care chain operated by the nursing staff and the support services) intersected, the employees involved in these processes did not encounter each other at work. The work paths of the nursing staff and the support

service personnel mainly crossed indirectly, and communication and co-operation between the parties in their everyday work was sparse, mainly occurring when a problem arose that needed to be solved. In the development processes undertaken in both Cases 1 and 2, the workshops arranged by an outside facilitator created a tangible interface for collaboration between the personnel groups.

## **6. Discussion**

### ***6.1. Characteristics of a rational healthcare support service work system***

This study aims to answer how rational task allocation between the nursing staff and the support service provider in the healthcare context can increase the positive or the desired outcome of the work system. The new construction for the task allocation in the case organisations was created in the development processes presented in the previous sections, consisting of several development ideas on a practical level. In Case 2, the process also included insights and enhanced views of having an external service provider as a practical solution for the task allocation. Before their implementation, the proposed ideas were evaluated by the supervisors of the target organisations. Based on both this evaluation and the execution of the ideas, as well as on the views conveyed by the employees throughout the development process, a few general characteristics of a rational support system were identified. These included resilience, reliability, ease of access and comprehensiveness, which are presented in detail in this section.

In the rational work system, which is discussed in detail in Section 6.2, the elements need to work well together. This process is promoted through communication and dialogue that also prevent viewing the factors related to work and its development in separate silos. The participatory approach is useful for creating and maintaining communication between the parties. Also earlier

research showed the importance of co-operation among ergonomics professionals, healthcare personnel and decision makers in building a better functioning healthcare work system (Hignett et al. 2013).

The rationalisation of work by minimising waste leads to work intensification that can result from the increase in either mechanical or psychosocial exposure and the decrease in the porosity of work (Westgaard & Winkel 2011). Work intensification can be linked to negative effects on the physical and psychosocial well-being of employees. However, in their systematic review of studies on production system rationalisation processes, Westgaard and Winkel (2011) stated that studies presenting negative outcomes of work rationalisation often lacked employee participation and employee–management dialogue in the rationalisation process. Thus, employee participation can be considered an important modifier for positive outcomes in terms of improved health or diminished risk factor.

As defined previously, resilience can be perceived as an organisation’s ability to anticipate, respond and adapt to change, regardless of whether the nature of the change is gradual, such as healthcare system modifications on a large scale (due to technological advances and development, for example), or disruptive, such as a sudden accident or a crisis. In healthcare support services, resilience is required for the system to fulfil the needs of the nursing staff in their varied and fast-tempo work under swiftly changing situations. The challenge lies in the scaling of resources to be able to respond to changing circumstances while remaining efficient. Resilience can be regarded as adaptivity between the needs of the nursing staff and the defined tasks of the support services that enables the support services to respond and fulfil the varying needs of the nursing staff. According to Amalberti (2013), it is important to find the proper balance in healthcare, where resilience exists in cases where the complexity and the variety of the medical system dominate, while there should be less resilience in standard cases to ensure safety of the operations. In our

thinking we see it useful to embed resilience to work systems as a key contributor towards contemporary rational work system. This research presents an approach to be further developed.

The nursing staff's well-being on the job can be promoted through acts that enable them to concentrate on the actual nursing work, which also provides further benefits to the quality of patient work and safety as well (Gurses et al. 2009). The opportunity for the nursing staff to concentrate on nursing work and use their expertise instead of performing tasks dealing with instruments and materials handling and patient transport, for example, was found desirable in the case organisations. Letting the support service provider take care of the tasks that do not require nursing expertise but enable the nursing processes sets the requirement for support service reliability in the eyes of the nursing staff. During the workshops, the nursing staff specifically emphasised their need to be able to rely on the work of the material and logistics services. Reliability increases their well-being by reducing their stress levels caused by the uncertainty in the material supplies. Reliability can also be connected to resilience in terms of support services that work well and can be trusted to function also in case of unexpected or disruptive situations.

The support services must also be easy to use to enable the nursing staff to concentrate on their actual nursing work. Moreover, the communication channel between the nursing staff and the support service provider should be easily accessible and fast. To enable efficient operations of the support services, it is vital to have the information on what is needed, where and when. In practice, this means that well-selected communication channels with suitable interfaces and functioning information systems are required.

To ensure the support service system's effective performance in terms of comprehensiveness, all the connections and the interfaces with other operations in the organisation must be considered. This aspect is most easily achieved when the entire system can be established at once but becomes more challenging when it demands changing practices that are often strongly embedded in the



organisation. In the case of material logistics, the support services should be developed to cover the entire material logistics chain from the purchase of the materials to the end-use situation with the patient. All practices and spaces where materials are used or stored should be included in the examination. This step would help avoid the nursing staff's logistics work, which often exists in real-life situations (e.g., the target organisation in Case 1; see Figure 3) that hinders the nursing staff's concentration on actual nursing work. Waste due to outdated materials could also be minimised. Achieving comprehensiveness in practice requires going through all the logistics processes. Identifying the needs of the nursing staff is also a crucial factor in terms of comprehensive logistics services.

The positive outcomes of the implemented practical ideas were perceived in the Case 1 organisations as smoother flow of work and better communication between the nursing staff and the support service personnel. Decreased stress due to clarified task allocation and the opportunity for the nursing staff to concentrate on nursing work when the support service takes more responsibility of the tasks that do not need expertise in nursing were also experienced as positive outcomes of the development process in both cases. Employee well-being as one positive outcome (see Carayon 2009) was mediated both by the nursing staff and the logistics service providers in interviews and workshops during the development process. Thus, the data of this qualitative study highlights the experiences of both parties of the employees as well as their superiors on the benefits of the development process in terms of employee's well-being and productivity at work.

## ***6.2. Work system model applied to the combination of nursing and support services in healthcare***

This section integrates the results of this research into the work system model. The work system that includes both parties – core process (nursing) and support services – is presented in Figure 7 and described in the following paragraphs. To ensure the effective performance of the whole system, all the parts of this twofold scheme and their interplay must work seamlessly.

The observations of the everyday work of nursing and support service **employees** revealed little or no direct communication between the personnel groups. Interactions occurred only in situations where problems arose that needed to be solved. One of the practical development ideas in Case 1 was the need for regular meetings that would provide much strengthening efforts for a collaborative mindset and resilience. The meetings were subsequently held and brought about the needed communication between the staff parties. Furthermore, in Case 2, the positive experiences of having an external professional attend the meetings provided new viewpoints. These practices have the potential of diminishing gaps between professional groups and enhancing resilience (Braithwaite et al. 2013).

**The tools and the technology** used by the nursing staff and the support service personnel in executing their respective tasks differed in the sense that the materials and the instruments needed in nursing work were delivered by the logistics and material service staff. For the latter, the materials and the instruments were goods delivered according to the product numbers and codes, while for the nursing staff, the same objects were distinctively different tools, each used for a special purpose in the patient care process. In Case 1, this difference was the reason behind many of the practical development ideas that were based on the nursing staff's need for quick and easy delivery of instruments in sudden situations, which was found problematic (e.g., due to the material order information technology system that used only certain product names or codes that were not always clear for the nursing staff). On the other hand, an effective solution was found for informing the nursing staff about product changes in the nursing instrument and material warehouse by marking the new products on the shelves.

The major tool and technology aspects that caused challenges in Case 2 were the automated closets. The recently implemented closets caused trouble due to both misuse and unsuitability in relation to all the needed goods. Thus, more planning, training and collaboration between the

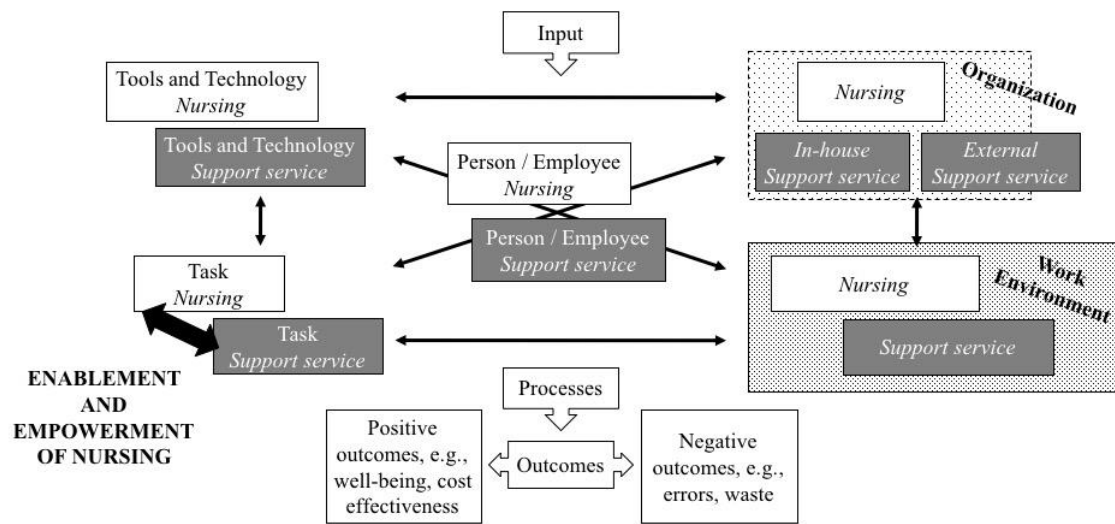
support service personnel and the nursing staff are necessary for the effective functioning of the new tool.

At the **organisational** level, the structure of the elements in the work system depends on how the support services have been arranged. Outsourcing support services is common to devote more time to core functions (Schulz & Brenner 2010). In case of in-house support services (e.g., Case 1), the core process and the support services operate under the same organisation, although both have their own internal organisational environments as well. On the other hand, in case of external support services (e.g., Case 2), the parties can belong to separate organisations with clearly different corporate cultures.

The relationship between the core process and the support services is most importantly defined by the **main task** of the support service provider, which is to enable and empower the core process (Paananen et al. 2011). This relationship can be perceived as a two-way interaction in the sense that the needs of the core process set the preconditions for the operations of the support services, while the variety of work tasks carried out by the support service provider aims at enabling the core process. Communication and information flow between the two parties are also essential.

The core process undertaken by the nursing staff and the support functions performed by the service provider also share the physical **work environment** to at least a certain extent in terms of the coinciding nodes in their work. In Case 1, the stock refill service executed by the support service staff involves transporting materials and instruments to the ward where the nursing staff works, as well as taking care of the organisation and the tidiness of the nursing instrument storage. Additionally, both parties also work in different environments – the support service staff in the central warehouse of the logistics and material services and the nursing staff in patient rooms and various procedure rooms (e.g., examination, monitoring and operation rooms). In Case 2, the joint work environment is the induction room adjoining the theatre where surgeries are performed.

The work of both the nursing staff and the support service provider consists of various processes that lead to either positive (desired) or negative (undesired) **outcomes** or both. If the work system (presented in Figure 7) functions well in terms of the separate work systems of both parties, as well as their interplay through rational task allocation (Gurses et al. 2009) and waste elimination (Braun & Tietz 2015; Yu-Lee 2011), positive outcomes such as employee well-being and decreased stress can be achieved (Carayon 2009). These results offer the potential of bringing monetary value through decreased costs (Maskell & Kennedy 2007).



**Figure 7. Work system model applied to the combination of core process (nursing) and support services in Case 1 (in-house support service provider) and Case 2 (external support service provider).**

### 6.3. Study limitations

Conducting a study in an interdisciplinary research project has been fruitful yet challenging due to e.g. variety of views and concepts in the different research fields. Furthermore, the data collection methods differ for workshops, interviews and group discussions. Eventually, this paper's authors are conscious of the naturally subjective role of qualitative researchers.

## **7. Conclusions**

This study aims to answer how rational task allocation between the nursing staff and the support service provider in the healthcare context can increase the positive or the desired outcome of the work system. This is done in practice by seeking new solutions and courses of action for the task allocation to increase employee's well-being and productivity at work. The solutions regarding practical work are found in a relatively straightforward manner through participatory development and involvement of the employees and the external facilitators, as well as their proficiency. One of the underlying reasons for the challenges in task allocation is the lack of a joint interface between the personnel groups because their respective members do not naturally encounter each other in everyday work. Based on the work system model and the complementary concepts of cost and resilience, as well as the two studied cases, we suggest a support service system characterised by four properties: resilience, reliability, ease of access and comprehensiveness. These factors play significant roles in both employee well-being and productivity, as well as cost effectiveness. In the work system model, cost effectiveness can be considered a positive outcome, whereas resilience is needed in adapting the tasks of the support service provider and the nursing staff to achieve the positive outcomes.

In this study, the positive outcomes of rational task allocation were examined through qualitative methods. Hence, the assessment of impact of the research and development process carried out in the target organisations is based solely on the experiences mediated by the employees and supervisors involved in the study. This analysis offers a base for more detailed research about the factors and their impact to positive outcomes, such as employee's well-being and productivity at work, using also monetary measures and quantitative assessment. In the future, more research in the healthcare context is necessary to gain broader insights into the rapidly changing environment

(i.e., the healthcare reform in Finland). As one direction to widen the perspective of this study, the role and tasks of a patient participating in his or her own care have potential as rewarding areas for research and development.

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## **References**

- Amalberti, R. (2013). Resilience and safety in health care: Marriage or divorce? In E. Hollnagel, J. Braithwaite, & R.L. Wears (Eds.). *Resilient health care*, 27–38. Farnham, UK: Ashgate.
- Braithwaite, J., Clay-Williams, R., Nugus, P., & Plumb, J. (2013). Health care as a complex adaptive system. In E. Hollnagel, J. Braithwaite, & R.L. Wears (Eds.). *Resilient health care*, 57–74. Farnham, UK: Ashgate.
- Braun, K.W., & Tietz, W.M. (2015). *Managerial accounting* (3rd ed.). Boston, USA: Pearson.
- British Standard BS65000 (2014). *Guidance for organizational resilience*. British Standards Institution.
- Carayon, P. (2009). The balance theory and the work system model ... twenty years later. *International Journal of Human–Computer Interaction*, 25(5), 313–327. doi:10.1080/10447310902864928

- Carayon, P., Schoofs Hundt, A., Karsh, B.-T., Gurses, A.P., Alvarado, C.J., Smith, M., & Flatley Brennan, P. (2006). Work system design for patient safety: the SEIPS model. *Quality and Safety in Health Care*, 15(Suppl I), i50–i58. doi:10.1136/qshc.2005.015842
- Carayon, P., & Smith, M.J. (2000). Work organization and ergonomics. *Applied Ergonomics*, 31, 649–662.
- Carayon, P., Wetterneck, T.B., Rivera-Rodriguez, A.J., Schoofs Hundt, A., Hoonakker, P., Holden, R., & Gurses, A.P. (2014). Human factors systems approach to healthcare quality and patient safety. *Applied Ergonomics*, 45, 14–25.
- Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, 15(2), 1–14.
- Coch, L., & French, J.R.P. (1948). Overcoming resistance to change. *Human Relations*, 1(4), 512–532.
- Driessen, M.T., Proper, K.I., Anema, J.R., Bongers, P.M., & van der Beek, A.J. (2010). Process evaluation of a participatory ergonomics programme to prevent low back pain and neck pain among workers. *Implementation Science*, 5(65).
- Eltantawy, R.A. (2016). The role of supply management resilience in attaining ambidexterity: A dynamic capabilities approach. *Journal of Business & Industrial Marketing*, 31(1), 123–134.
- Flick, U. (2007). *Designing qualitative research. The SAGE Qualitative Research Kit*. London: SAGE Publications Ltd.
- Gurses, A.P., Carayon, P., & Wall, M. (2009). Impact of performance obstacles on intensive care nurses' workload, perceived quality and safety of care, and quality of working life. *Health Services Research*, 44(2p1), 422–443. doi:10.1111/j.1475-6773.2008.00934.x
- Häkkinen, K. (2015). Safety management – from basic understanding towards excellence. In S. Väyrynen, K. Häkkinen, & T. Niskanen (Eds.). *Integrated occupational safety and health management – solutions and industrial cases*, 7–15. Cham, Switzerland: Springer.
- Herrera, A., & Janczewski, L. (2016). Cloud supply chain resilience model: Development and validation. In *Proceedings of the 2016 49th Hawaii International Conference on System Sciences (HICSS)*, 3938–3947. Koloa, USA: IEEE.
- Hignett, S., Carayon, P., Buckle, P., & Catchpole, K. (2013). State of science: Human factors and ergonomics in healthcare. *Ergonomics*, 56(10), 1491–1503.

- Hohenstein, N.O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: A systematic review and paths for further investigation. *International Journal of Physical Distribution & Logistics Management*, 45(1/2), 90–117.
- Holden, R.J. (2012). Social and personal normative influences on healthcare professionals to use information technology: Towards a more robust social ergonomics. *Theoretical Issues in Ergonomics Science*, 13(5), 546–569.
- Holden, R.J., Carayon, P., Gurses, A.P., Hoonakker, P., Schoofs Hundt, A., Ant Ozok, A., & Rivera-Rodriguez, A.J. (2013). SEIPS 2.0: A human factors framework for studying and improving the work of healthcare professionals and patients. *Ergonomics*, 56(11), 1669–1686.
- Hollnagel, E. (2011). Prologue: The scope of resilience engineering. In E. Hollnagel, J. PARIÈS, D.D. Woods, & J. Wreathall (Eds.). *Resilience engineering in practice: A guidebook*, xxix-xxxix. Farnham, UK: Ashgate.
- Hollnagel, E. (2014). Resilience engineering and the built environment. *Building Research & Information*, 42(2), 221–228.
- Hollnagel, E., Braithwaite, J., & Wears, R.L. (2013). *Resilient health care*. Farnham, UK: Ashgate.
- International Organization for Standardization (ISO) Standard, ISO 6385 (1981). *Ergonomic principles in the design of work systems*. Geneva: ISO.
- Jones, R., Latham, J., & Betta, M. (2013). Creating the illusion of employee empowerment: Lean production in the international automobile industry. *International Journal of Productivity and Performance Management*, 24(8), 1629–1645.
- Kaplan, R.S., & Porter, M.E. (2011). How to solve the cost crisis in health care. *Harvard Business Review*, 89(9), 46–52.
- Koivupalo, M., Junno, H., & Väyrynen, S. (2015). Integrated management within a Finnish industrial network: Steel mill case of HSEQ assessment procedure. In S. Väyrynen, K. Häkkinen, & T. Niskanen (Eds.). *Integrated occupational safety and health management – solutions and industrial cases*, 41–67. Cham, Switzerland: Springer.
- Kotavaara, O., Pohjosenperä, T., Juga, J., & Rusanen J. (2017). Accessibility in designing centralised warehousing: Case of health care logistics in Northern Finland. *Applied Geography*, 84, 83–92.



- Kriegel, J., Jehle, F., Dieck, M., & Mallory, P. (2013). Advanced services in hospital logistics in the German health service sector. *Logistics Research*, 6(2–3), 47–56.
- Langford, J., & McDonagh, D. (Eds.). (2003). *Focus groups: Supporting effective product development*. London: Taylor & Francis.
- Maskell, B.H., & Kennedy, F.A. (2007). Why do we need lean accounting and how does it work? *Journal of Corporate Accounting & Finance*, 18(3), 59–73.
- Masters, J. (1995). The history of action research. In I. Hughes (Ed.). *Action research electronic reader*. Sydney, Australia: The University of Sydney.
- McNair, C., Polutnik, L., & Riccardo, A. (2006). Customer-driven lean cost management. *Cost Management*, 20(6), 9–21.
- Olesen, P., Powell, D., Hvolby, H., & Frasen, K. (2015). Using lean principles to drive operational improvements in intermodal container facilities: A conceptual framework. *Journal of Facilities Management*, 13(3), 266–281.
- Orton, J.D. (1997). From inductive to iterative grounded theory: Zipping the gap between process theory and process data. *Scandinavian Journal of Management*, 13(4), 419–438.
- Paananen, H., Häikiö, M., Väyrynen, S., & Syväjärvi, A. (2011). New methods for increasing the hospital personnel participation into the development processes – Case Lapland Hospital District. In S. Albolino, S. Bagnara, T. Bellandi, J. Llana, G. Rosal-Lopez, & R. Tartaglia (Eds.). *Healthcare systems ergonomics and patient safety 2011: Proceedings of the International Conference on Healthcare Systems Ergonomics and Patient Safety*, 245–247. Oviedo, Spain, June 22–24, 2011. CRC Press/Balkema, Taylor & Francis Group.
- Peltokorpi, A., Turtiainen, A.-M., & Kämäräinen, V. (2009). Tukipalveluiden uudelleenjärjestämisellä tehokkuutta vuodeosastohoitoon (Improving the efficiency of hospital ward care through reorganisation of healthcare support services). *Premissi*, 6, 39–45.
- Pettit, T.J., Fiksel, J., & Croxton, K.L. (2010). Ensuring supply chain resilience: Development of a conceptual framework. *Journal of Business Logistics*, 31(1), 1–21.
- Pohjosenperä, T., Kekkonen, P., Pekkarinen, S., & Juga, J. (2017). Modularity in healthcare logistics – a case study of four hospitals in Finland. Manuscript submitted in June 2017.

- Ponomarov, S.Y., & Holcomb, M.C. (2009). Understanding the concept of supply chain resilience. *International Journal of Logistics Management*, 20(1), 124–143.
- Poulin, E. (2003). Benchmarking the hospital logistics process: A potential cure for the ailing healthcare sector. *CMA Management*, 77(1), 20–23.
- Qureshi, Z.H., Ashraf, M.A., & Amer, Y. (2007). Modeling industrial safety: A sociotechnical systems perspective. In *Proceedings of the 2007 IEEE International Conference on Industrial Engineering and Engineering Management*, 1883–1887. Singapore: IEEE.
- Rajala, H.-K., & Väyrynen, S. (2013). Participative approach to strategy communication: A case of small- and medium-sized metal enterprises with a review after seven years. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 23(4), 346–356.
- Schulz, V., & Brenner, W. (2010). Characteristics of shared service centers. *Transforming Government: People, Process and Policy*, 4(3), 210–219.
- Smith, M.J., & Sainfort, P.C. (1989). A balance theory of job design for stress reduction. *International Journal of Industrial Ergonomics*, 4, 67–79.
- Spinuzzi, C. (2005). The methodology of participatory design. *Technical Communication*, 52(2), 163–174.
- Stewart, D.W., & Shamdasani, P.N. (2014). *Focus groups: Theory and practice*. (Vol. 20). Thousand Oaks, USA: Sage Publications Inc.
- United Nations International Strategy for Disaster Reduction. (2004). *Living with risk: A global review of disaster reduction initiatives*. Geneva: United Nations.
- van Eerd, D., Cole, D., Irvin, E., Mahood, Q., Keown, K., Theberge, N., Village, J., St. Vincent, M., & Cullen, K. (2010). Process and implementation of participatory ergonomic interventions: A systematic review. *Ergonomics*, 53(10), 1153–1166.
- Väyrynen, S., Jounila, H., Latva-Ranta, J., Pikkarainen, S., & von Weissenberg, K. (2016). HSEQ assessment procedure for supplying network: A tool for promoting sustainability and safety culture in SMEs. In P. Arezes & P.V. Rodrigues de Carvalho (Eds.). *Ergonomics and human factors in safety management*, 83–108. Industrial and Systems Engineering Series, CRC Press. Boca Raton, FL: Taylor & Francis Group.

- Väyrynen, S., Kisko, K., Filppa, H., & Väänänen, M. (2014). Review, framework and Likert-scale survey for improving intra-organisational communication of Finnish case companies. In P. Lorenz & P. Dini (Eds.). *Proceedings of COLLA 2014: The Fourth International Conference on Advanced Collaborative Networks, Systems and Applications*, 12–20. Seville, Spain: IARIA.
- Vink, P., Koningsveld, E.A.P., & Molenbroek, J.F. (2006). Positive outcomes of participatory ergonomics in terms of higher comfort and productivity. *Applied Ergonomics*, 37, 537–546.
- Westgaard, R.H., & Winkel, J. (2011). Occupational musculoskeletal and mental health: Significance of rationalization and opportunities to create sustainable production systems – a systematic review. *Applied Ergonomics*, 42, 261–296. doi:10.1016/j.apergo.2010.07.002
- Yin, R. (2003). *Case study research: Design and methods*. Thousand Oaks, USA: Sage Publications Inc.
- Yu-Lee, R.T. (2011). Proper lean accounting. *Industrial Engineer*, 43(10), 39–43.