



The prevalence of e-rostering systems in managing the healthcare workforce asset. A scoping review.

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<p>Abstract:</p> <p>This scoping review aimed to investigate to what extent there is existing and current research about e-rostering software solutions that automatize and optimize nurse staffing in healthcare. The need of healthcare personnel is growing globally and a complex and widespread nurse shortage exist. It is of primary concern to manage the current and future nursing staff well in order to provide a safe and effective healthcare service and to retain staff. Personnel scheduling and rostering is an essential part of managing the workforce asset. The evolvement of new techniques, an increasing workload, laws and regulations concerning workforce scheduling has made managing the workforce asset in healthcare even more challenging than before. Performing an accurate and efficient personnel rostering is fundamental in achieving wellbeing among the nursing staff, ensuring good roster planning practices, generating cost savings, promoting an effective use of resources and enabling nursing managers to focus on their core duties. Relevant research was reviewed comprehensively in order to find research on electronic software solutions for personnel planning in healthcare. A total of 371 studies were found using the keywords defined in Table 1. Based on the title a total of 332 studies were excluded from the study. An evident gap in the research area was discovered as only two (2) separate research findings on the topic were finally included in the study according to the inclusion criteria. An overview of a market analysis on e-rostering systems in Sweden was included. The findings point out and underline a substantial lack of research considering the vast field of healthcare and existing technology. Needs for future research emerged and is suggested to encompass benefits analyses, using methods that enable comparative analysis of the results as well as research on the systems' implementation processes.</p>	
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<p>Sammandrag</p> <p>Syftet med denna scoping review är att klargöra förekomsten av elektroniska och automatiserade personalplaneringssystem som utnyttjar optimering inom hälso- och sjukvården. Det globala vårdpersonalresursbehovet ökar samtidigt som det existerar en omfattande och mångdimensionell brist på vårdpersonal. Det är viktigt att den existerande vårdpersonalresursen leds väl så att samhället kan garantera en trygg och effektivt fungerande hälso- och sjukvård samt bevara vårdpersonalen. Personal och skiftesplanering är en väsentlig del av personalledningen. Utveckling av nya tekniker, en växande arbetsbörda, lagar och förordningar har gjort personalledningen mer utmanande än förr. Att förverkliga en noggrann och effektiv personalplanering utgör en väsentlig del i att sträva efter välbefinnande i arbete och god personalplaneringspraxis. En effektiv användning av personalresurser leder till kostnadsbesparingar. Med hjälp av sökorden som beskrivs i Tabell 1. hittades totalt 371 studier. Av dessa exkluderades 332 på basen av titel och slutligen inkluderades enbart två (2) studier, som fyllde inklusionskriterierna. Till arbetet inkluderades en översikt av en marknadsanalys av elektroniska personalplaneringssystem i Sverige. Resultaten som nåtts med hjälp av en omfattande scoping review tyder på och poängterar ett existerande kunskapsvakuum inom forskningsområdet trots hälso- och sjukvårdens omfattande verksamhetsmiljö och befintlig teknologi. Som fortsatt forskning föreslås effektundersökningar som använder data som möjliggör en komparativ forskning samt forskning som tangerar elektroniska personalplaneringssystemers implementation.</p>	
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<p>Tiivistelmä:</p> <p>Tämän scoping katsauksen tavoite oli selvittää terveydenhuollossa käytössä olevien sähköisten, automatisoitujen ja optimoivien työvuorojärjestelmien esiintyvyys. Hoitohenkilöstöresurssien maailmanlaajuinen tarve kasvaa ja samalla todetaan laaja ja monitahoinen hoitoalan resurssivaje. On ensiarvoisen tärkeää, että olemassa olevaa ja tulevaisuuden henkilöstöresurssia johdetaan hyvin, jotta yhteiskunta voi taata turvallisen ja tehokkaasti toimivan terveydenhuollon sekä säilyttää terveydenhuollon henkilöstön. Henkilöstö- ja työvuorosuunnittelu on olennainen osa työvoiman johtamista. Uusien tekniikoiden kehitys, lisääntyvä työtaakka, työvuorosuunnittelua rajaavat lait ja säädökset ovat tehneet hoitohenkilöstön voimavarojen johtamisesta entistä haasteellisempaa. Tarkan ja tehokkaan työvuorosuunnittelun toteuttaminen on olennainen osa hoitohenkilön työhyvinvoinnin ja hyvien työvuorosuunnittelukäytänteiden tavoittelemista. Resurssien tehokkaan hyödyntämisen on todettu tuottavan kustannussäästöjä. Avaisanhaku tuotti tuloksena 371 tutkimusta, joista 332 suljettiin pois otsikon perusteella. Lopulliseen analyysiin sisällytettiin kaksi (2) tutkimusta, jotka täyttivät tutkimuksen inklusiokriteerit. Tutkimukseen lisättiin katsaus sähköisten työvuorojärjestelmien markkina-analyysistä Ruotsin osalta. Kattavan katsauksen avulla saavutettu vähäinen tutkimukseen sisällytettyjen tutkimusten lukumäärä osoittaa ilmeistä tietovakuumia huomioon ottaen laajan terveydenhuollon toimintakentän ja olemassa olevan teknologian. Jatkotutkimuksen aiheiksi nousi vaikuttavuusanalyysit käyttäen tietoa, joka mahdollistaa vertailevan tutkimuksen sekä myös järjestelmien implementaatioon liittyvät tutkimukset.</p>	
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FOREWORD

I would like to thank Information Specialist Marketta Fredriksson for her kind assistance during the search process.

My sincerest thank you's are also directed to adjunct professor Mika Linna at Aalto University for his precious comments on the thesis, to Pirjo Ketola at Visma Numeron for her kind support and for sharing her wisdom, to my supervisor Heikki Paakkonen for the short response time to my numerous emails and for his support and guidance throughout the process leading me to having finished my thesis.

Most of all I would like to thank my family and friends for being there for me. Always.

Raseborg

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Pia Fredriksson

“If we knew what it was we were doing, it would not be called research, would it?”

(Albert Einstein)

1 AIM

The current study aimed to investigate, by scoping, to what extent there is research on various commercial software solutions used for roster planning and scheduling in healthcare. The aim was also to frame future research questions and to identify possible gaps in the current knowledge base.

The research questions were:

- To what extent is there existing and current research about various electronic commercial rostering systems for staffing in the healthcare sector?
- What kind of narratives can this scoping study produce?

2 BACKGROUND

The need of healthcare personnel is growing globally due to an increasing population growth, ageing, changing epidemiology, new technologies, an increased public demand of healthcare services and mobility. The nursing shortage is affected by factors such as societal trends towards reduced work hours, workforce ageing and, particularly in industrialized countries, early retirement. The challenge of the nursing shortage vary but it is both complex and widespread. Unfavorable working environments such as workload, inadequate supply of staff, violence, stress and burnout affect the supply of staff. An imbalance in skills-mix persist and advanced practitioners, midwives, nurses and auxiliaries are insufficiently used in many settings. Availability and accessibility continue to vary widely within countries because of difficulties in attracting and retaining workers. In trying to solve the challenge health workers need to be kept motivated in an enabling environment. Performance assessments and quality of care should be assigned a higher priority and at the same time, human resource information data and systems require strengthening and investment to meet the needs of decision-makers. (Oulton 2006) (Campbell 2013 p. 11) (Dubois & Singh, 2009, p.1) The picture is similar from a European point of view: Europe faces a moment of transformation. The current situation has been described as a crisis having exposed structural weaknesses in Europe's economy. As the world is moving fast forward, we face long-term challenges such as globalization, pressure on resources and ageing. (European commission 2010 p.6) From a Finnish point of view a

negative demographic development and the populations' dependency ratios geographical unevenness (OSF 2016) creates challenges for managing the nursing workforce.

According to the World Health Organization, health workers who actually deliver health services are the most costly and least readily available resource in a health system. Nevertheless, they are indispensable. Managers at national and local levels struggle on a day-to-day basis with managing this costly but essential resource efficiently so that a more just distribution of workload and a better productivity can be achieved. (WHO 2010)

2.1 Workforce asset management

Optimizing people in a modern organization requires a rapid and effective use of workforce analytics integrating a growing range of people-related data from core software. Workforce Asset Management (WAM) is an integrated and new discipline that sources, structures, compensates and manages the people in organizations. WAM is a combination of functions within the following fields of management; human resources, operations, finance and information technology. In contrast to human resource management, concerned with the strategic management of people, WAM is concerned with strategic, operational, financial and technological management in real time from frontline employee to chief executive also addressing the issue of forecasting. WAMs converged approach focuses on bringing value to both the organization and the people by enabling an efficient and effective alignment of people in order to achieve the organization's mission, strategic vision and key performance indicators. However, an increasing amount of compliances, laws and regulations concerning timekeeping, workforce scheduling etc. has made managing labor activity, data and pay increasingly complex and organizations need to be aware of these challenges around WAM. (Disselkamp, 2013, p.8-13)

2.2 Current workforce challenges in healthcare

Because the health professions are among those with the most demanding working hour arrangements, these careers are becoming less attractive to young people. The healthcare sector has to struggle for keeping health professionals on board and motivated even in times of relatively limited benefits. Due to the high costs of health workforce, it represents

an important asset in any country particularly as the demand for health services keeps growing and as Europe is short of health professionals. Estimates of the shortage vary from a few hundred thousand up to 1 million (by the year 2020). Mistakes or rash decisions in health workforce planning will have serious consequences for many years to come. Regulating working hours regulates workloads, but it does not define the necessary competencies. (Albrecht 2011) Workforce planning means forecasting the necessary talent needed to ensure future success, developing a current workforce profile and determining the requirements of the future workforce. The workforce planning process helps organizations to identify workforce needs, key strategies, goals and processes needed to effect positive change. Workforce planning influences what resources are needed to ensure that workforce considerations are aligned with service and financial planning. The planning process helps healthcare organizations identify the level of competencies required to achieve their vision, goals, and mission, as well as the financial management needed to meet these targets. (Drake et. al. 2013) (Parsons 2010)

Personnel scheduling problems deal with assigning a number of tasks to a number of employees while respecting a number of restrictions that lead to a harder problem compared to a simple assignment problem. Personnel scheduling assumes different connotations in different contexts but is done in order to satisfy service requirements and contractual agreements and to maximize employees' preferences and minimize costs. (Bruni, Detti, 2014) Various existing systems of modelling workforce requirements and staffing needs should be used in conjunction with expertise and software that can support the design of rotas. (Le Jeune et al., 2012) According to the Carter Review only a few UK National Health Service (NHS) trusts use e-rostering's full functionality even though it's seen as a tool to reduce dependency on bank and agency staff and improve predictability and consistency of deployment for staff even where recruitment is still a challenge. The Carter Review recommends that all UK National Health Service (NHS) trusts adopt electronic rostering (e-rostering) by October 2018. (Carter, 2016, p.64)

2.3 Health care management

Flexible work arrangements can be used as a tool in managing the healthcare staffing shortage. Mentoring processes, possibilities for job rotation, further training and leadership are important factors to be considered in recruiting and retaining healthcare personnel. (Heilmann, 2010) Nurse executives need to position themselves as the leaders of the future by moving beyond telling people what they want to hear to taking people where they need to be. The key elements of nursing leadership practice for the future includes serving as a leader to transform care models, have the ability to foster autonomy of practice in care areas, creating systems of care based on evidence-based practice, collaboration, fostering lifelong learning among nurses, and finally, strategically manage resources. For this, a strong evidence base for nurse executive practice is vital. (Drenkard, 2012)

The guiding principle in contemporary clinical decision-making is evidence-based medicine. Unfortunately, the same standards have not been applied to human resource allocation. In an era where focus is on quality and safety, it is vital that the most valuable resources in healthcare are utilized efficiently and that patients' needs are placed at the heart of workforce planning. It is of vital importance that human resource allocation is planned based on robust data. Nurse leaders have taken many initiatives to incorporate evidence and scientific data into the complex context of nurse staffing. Leaders must understand data-driven nurse staffing plans to communicate and budget appropriately for nursing resources. More research and sharing of evidence-based or best practices in nurse staffing needs to be completed and shared with the nursing community. (Dent, 2015) (Le Jeune et al., 2012) At present, the data nurse leaders use is scattered and using evidence as bases for decision-making requires a lot of work. In order to make use of the existing knowledge systematic and permanent interaction between knowledge producers, knowledge providers and knowledge users is required. In addition exploiting the potential of new electronic tools is of great significance. (Ministry of Social Affairs and Health, 2009 p. 33) Roster planning, from a human resources management perspective, includes elements that affect knowledge utilization, motivation, job satisfaction and work-life balance. The first step

towards a dirigible and a more centralized roster planning is the ability to produce balanced output data. In implementing a workforce management system an organization needs to tackle a challenge of change. (Sartjärvi, 2014, p. 16, 180)

Workforce scheduling is a complex process that assigns working hours to the workforce. A nurse schedule is defined as the list of tasks that is assigned to a specific individual for a time period. Moreover, the schedule is a plan that dictates who does what, when and where. Staffing is defined as the acquisition, utilization and retention of a workforce of sufficient quantity and skill to meet stated levels of care. The workforce consist of employees, a major varying component, whose productivity and availability depends on many factors making the outcome of a schedule uncertain until it actually has been worked. Workforce management systems started out as simple mechanical devices dating back to the 1890s and are now web-based computer systems expanding from basic time-keeping to broad management of labor activity, costs schedules and workforce analytics. However, the approach to managing the workforce has not changed as dramatically as the mechanics of capturing, computing, managing and reporting labor activity. (Disselkamp et al., 2013, p 18, 258)(Drake, 2014b) (Kreeft, 2012, p.20)

2.4 The nurse rostering problem (NRP)

In health care research, the terminology relating to staff scheduling has been used imprecisely. Staff scheduling has been largely unrecognized, unrewarded and undervalued. In operations management research the phenomena is examined using the term “nurse rostering problem”. A nurse roster is defined as a calendar for a period of t days containing n persons and a nurse schedule the list of tasks that is assigned to a specific individual for a time period (Kreeft, 2012, p.20). As manual rostering systems are unsatisfactory in delivering appropriate staffing levels, e-rostering is used to tackle scheduling tasks. It is probable that the increased use of e-rostering benefits nurses and patients. However, there are certain aspects to consider related to e-rostering. At present rostering and requirement are considered separate processes. Variations in patient flows and varying care needs changes requirement rapidly. Forecasting e.g. ward requirements could enhance rostering systems. The most important contribution of e-rostering is that it requires explicit rostering rules within a formal roster policy, which in turn creates improved transparency. E-

rostering is beneficial in roster maintenance as it allows analysis of a worked roster, e.g. the roster “robustness”, defined as an ability to tolerate post-approval changes without breaking roster rules. E-rostering systems are in general designed to optimize the filling of shifts rather than emphasizing the quality of individual rosters. Thus, the prioritization of fairness is not reflected in e-roster planning apart from bureaucratic rules to mandate equality. E-rostering might enhance the nurses’ sense of empowerment by self-scheduling rosters. (Drake, 2014b)

The generalized nurse rostering problem refers to the dilemma of generating feasible high-quality staff schedules (‘rosters’) assigning nurses to specific shifts in accordance with work agreements. The roster specifies for each staff member the sequence of shifts and days off (e.g. ‘roster-line’) to be worked during the roster period. The roster must contain and take into account pre-specified demand constraints such as minimum staffing requirements and skill-mix. Feasible rosters include adequate rest periods and minimum violations of work contracts and preferably considers nurses’ preferences. The rosterline is typically strictly governed by laws, union regulations and internal agreements. The complex requirements challenge managers to create feasible and high quality rosters. Rosters have traditionally been created manually by the head of the section or by an experienced member of the staff. (Dohn, Mason, 2013) (Valoux et al. 2012) Nurse scheduling has attracted the attention of personnel managers, operations researchers and computer scientists for over 50 years but there are only a few functioning systems and a lack of consistency prevails, many healthcare institutions still use manual practices. (Petrovic, Vanden Berge, 2012) (Ásgeirsson, Sigurðardóttir, 2016) (Sartjärvi, 2015, p. 18). The phenomena at hand is of critical importance for a variety of reasons; the automatic generation of high quality nurse schedules can lead to improvements in hospital resource efficiency, staff and patient safety, staff and patient satisfaction and administrative workload. (Burke et al 2004) Solving a real-world NRP manually often requires a large amount of time and cost. Due to its complex nature and motivation to produce automated nurse rostering systems for the hospital administration, considerable research have been performed. Still, exact solutions have not yet been presented due to the combinatorial nature of this problem (Awadallah et al., 2017). Roster design has a direct impact on ward performance in terms of staff retention, resource use, cost-effectiveness and service delivery. (Drake, 2014a) Striving to solve complex NRPs in order to provide dynamic and efficient quality

of health services is a challenge for healthcare management but also for both practitioners and researchers in operations research (OR) and artificial intelligence (AI) communities. A successful solution requires mathematical programming models for scheduling problem of nurses' working shifts. (Fang, Qu 2012) (Yilmaz 2012) (Cappanera, Scutellà 2013) Several different mathematical approaches, each method incorporating strengths and weaknesses, have been utilized in trying to solve the nurse rostering programs. (Burke, Curtois 2014) (Valouxis et al. 2012) (Lü, Hao 2012) (Tassopoulos et al. 2015).

2.5 E-rostering

E-rostering enables managing when and which staff are required, linking knowledge to patient need and incorporates a potential to reduce dependence on temporary staff. E-rostering technology is a tool, not a solution in itself. Implementing e-rostering involves substantial change in current practices. (Read, 2016)

Electronic rostering provide accurate and timely access to staffing fairness, equity of shift patterns and easy management of leave. E-rostering systems are useful when they include necessary parameters that enable a production of a good schedule. Options as self-scheduling and rolling shift lines can be uploaded into e-rosters. Self-rostering supports work-life balance and rolling shifts offer an added advantage to allocate staff to teams. (Price, 2016) There is a call for a uniform and integrated use of e-rostering systems. (Carter 2016, p. 62)

Interactive computing refers to software that is told by humans what to do. Human-computer interaction has an impact on the ease-of-use and the theoretical aspects of a scheduling algorithm. Throughout the 20th century, human-computer interaction gave rise to artificial intelligence (AI). AI algorithms imitate human intelligence processes e.g. learning, reasoning and self-correction. The field of human-computer interaction is a discipline that deals with the design, evaluation and implementation of interactive systems. (Kreeft, 2012, p.32)

According to a Finnish study, there are five basic reasons for the increased interest in nurse rostering optimization. First, hospitals are more aware of the possibilities in decision support technologies and the interest of handling the schedules manually is decreasing. Second, human resources are one of the most critical and most expensive resources for hospitals, thus an attentive workforce planning can lead to notable improvements in productivity. Third, good schedules are important resulting in increased wellbeing and decrease in sick-leaves among staff. Fourth, new algorithms are developed to tackle previously intractable nurse rostering problems, at the same time computer power has increased to a level that researchers are able to solve large-scale instances. The fifth benefit of automating the scheduling process is the significant amount of time saved by the administrative nurses involved. (Kyngäs et al., 2012)

As the relation between adequate nurse staffing levels and overtime work with nurses' perceived patient safety, quality of care, and care left undone has been established (Cho et al. 2016) (Ball et al. 2014) the relevant follow-up question emerges: what variety of electronic systems and software solutions are in use to ensure an adequate staffing in the healthcare sector?

2.6 Legislative aspects

The European Union member countries are bound by the Working Time Directive 2003/88 that serves as the basis for national legislation on working times. The Directive lays down minimum safety and health requirements for the organization of working time. (EUR-Lex, 2003) In Finland, the Working Hours Act (Finlex, 1996) regulates working times. The majority of the Finnish care sector personnel is employed by municipalities and thus apply a collective labor agreement, the General Collective Agreement for Municipal Personnel (KVTES). (Hakola & Kalliomäki-Levanto 2010, p.13) The Working Hours Act and the Annual Holidays Act form together a working hour regulation. The ways of working have changed during the past decades and therefore an update of the current legislation to meet the modern needs is in progress. (Ministry of Economic Affairs and Employment, 2016) Rapid technological developments have brought new challenges for the protection of personal data. Directive 95/46/EC of the European Parliament and of the Council seeks to harmonize the protection of fundamental rights and freedoms of

natural persons in respect of processing activities and to ensure the free flow of personal data between Member States (EUR-Lex, 2016).

3 METHODS

In scoping the field of technology solutions for staffing, a scoping review method was used according to the process described by Arksey and O'Malley. (Arksey & O'Malley, 2005) This technique is appropriate as broad questions are posed and gaps in the evidence base can be identified by summarizing research findings. (Squires et al., 2017) The method provides viable alternatives to more traditional methods of reviewing and synthesizing existing literature. This is an exploratory scoping review with the objective to guide future studies. The type of the study is literature mapping and the main objective is to identify the location of the literature on the topic of various software solutions for automated roster planning in healthcare and to determine the magnitude of the research topic. (Rumrill et al, 2010)

A scoping study addresses a broad topic where different study designs can be relevant. This study method is guided by a requirement to identify all relevant literature regardless of study design. The study process includes the identification of the research question and relevant studies, study selection data charting and collating, summarizing and reporting the results. (Arksey & O'Malley, 2005) (Rumrill et al, 2010)

3.1 Identification of relevant studies

The period for this review was 2010 to 2017. The identification of relevant studies was performed by searching the following electronic databases: Academic Search Elite (EBSCO), ScienceDirect, Cochrane Library, Sage, PubMed, Emerald, Cinahl, Cinahl Fulltext, and ProQuest. The literature search was conducted using keywords of various combinations as listed in Table 1. Studies that were included in the review met the inclusion criteria: original, peer-reviewed research reporting on software solutions for roster planning. The selection was further limited to studies published in English from European Union member countries due to the fact that all are bound by the same Working Time Directive.

Table 1. Keywords

"Personnel staffing and scheduling"	e-rostering systems	Workforce	Healthcare
<ul style="list-style-type: none"> • roster planning • rostering management • design of roster • nurse rostering 	<ul style="list-style-type: none"> • e-rostering • scheduling information systems • scheduling and rostering healthcare information system • electronic scheduling systems • computerized systems • automatic schedule creation • application 	<ul style="list-style-type: none"> • manpower • labor • labour 	<ul style="list-style-type: none"> • health care • nursing

3.2 Study selection

From the 371 unique citations retrieved from the search, three (3) studies met the inclusion criteria and were included.

3.3 Charting the data

The charting approach was narrative in order to enable a contextual presentation synthesizing and interpreting the collected data. The study method was descriptive-analytical in order to apply a common analytical framework to all the primary research reports and enabling to collect standard information on each included study. (Arksey & O'Malley 2005)

3.4 Collating, summarizing and reporting the results

An overview of the search process is presented in a flow chart (Figure 1.) as to all reviewed material.

STUDY PROCESS FLOW CHART

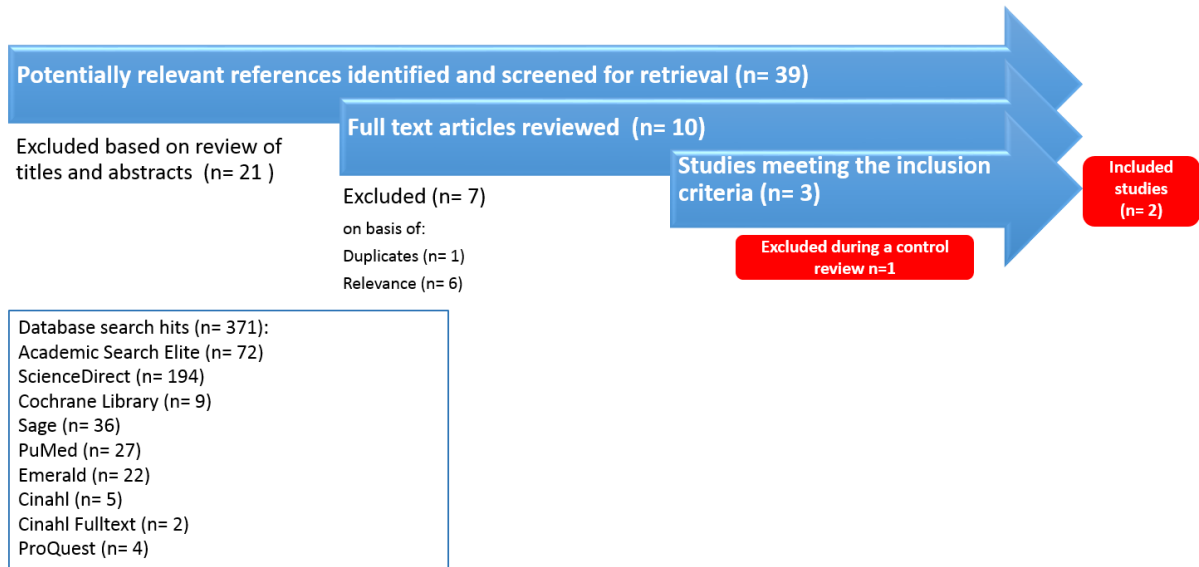


Figure 1. Study process flow chart

The keywords in Table 1. was used in searching research on various workforce-scheduling systems used commercially within the context of healthcare. The search was performed 19th to 23rd September 2017 and produced 371 findings. The title of each result was reviewed and assessed whether the study was essential for the study or not. From the 371 findings, 332 studies were discarded and 39 studies were selected for further review as to the title and abstract. Most of the discarded 361 studies were from operational research, concerning mathematical algorithms and technical approaches or they were not healthcare related. Consequently, 10 studies were screened reading the full text article, 7 of these were discarded due to them not fulfilling the inclusion criteria of geographical reasons or them not presenting an e-rostering system. Finally, 3 studies were included as they met all the inclusion criteria. During a control review of the selections, one more studie was excluded due to it being performed outside the European context. During a control review of the selected articles it was found that one of the selected studies did not meet the inclusion criteria, thus only 2 studies could be included in the study.

A thematic organization of the findings is presented in Table 2. (Rumrill et al, 2010)

Table 2. Thematic organization of findings

Author(s)	Year	Location	Objective	Software solution	Study design
Wray	2013	United Kingdom	To present the concept of e-rostering in managing staffing and work schedules.	Healthroster™ by Solent NHS Trust	None
Paschou Papadimitriou, Nodarakis, Korezelidis Sakkopoulos and Tsakalidis	2015	Greece	Presenting a new personnel rostering system using mobile technologies	{PROTOTYPE} Personnel rostering system	Questionnaire-based survey

The research poses a question on which narratives this study can produce. In trying to answer this the author has tried to reshape previously existing information in a way that it would contribute to new perspectives in order to enhance professional practice and inform future empirical research. This has been done by creating a greater insight in the topic than could be possible only from an individual study. (Rumrill et. al., 2010) The narrative is formed under the headline Key Issues and describes how the results relate to the aim of this scoping review.

In order to further clarify the reporting of the research findings a template was created applied for each identified roster planning solution as seen in Table 3. (Arksey & O'Malley 2005)

Table 3. Roster planning template

Roster planning solution	Basic characteristics	Evidence relating to effectiveness (economical and qualitative)	Gaps in research
Healthroster™	An e-rostering software that includes flexible work patterns, skill requirements and minimum staffing levels. Optimizes the use of personnel resources.	<ul style="list-style-type: none"> Predictive savings up to £1 million per year due to more accurate monitoring of the workforce and reduction in use of bank and agency staff. Ward managers are freed to work on the ward and supporting the staff. 	<ul style="list-style-type: none"> Which factors define the staffing need? Security issues concerning personal data are not addressed.
{PROTOTYPE} Personnel rostering system	A smartphone application with a back-end information system. The mobile application is the key module and tool in the proposed system, enabling potential users to easily interact with the component managing rosters and shift schedules	<ul style="list-style-type: none"> Enables real-time communication btw hospitals' personnel and rapid response to shift change needs. Can be easily integrated with existing Information Systems already used in hospitals. Improves personnel and shift management and consequently reduces personnel dissatisfaction. Contributes to better operational and financial management. Allows the staff to introduce personal shift preferences Uses local caching for minimizing data transmission costs. 	<ul style="list-style-type: none"> Security issues concerning personal data are not addressed.

4 KEY ISSUES

Two (2) separate studies were found that describe two various electronic commercial rostering systems currently used in the healthcare context. In the study conducted by Paschou et al., a comprehensive description of a prototype for personnel rostering system is displayed in order to describe the mobile usability of such a system. In the study by Wray a more facile approach is presented to a system named Healthroster™, its features are not as thoroughly presented as in the study of Paschou et al. and presents a narrative of experiences among users. Due to the thorough description in the Paschou study, a deeper understanding of the technological application features is enabled when in the Wray study it is not.

The two studies that were found both address a different method and system for personnel scheduling and rostering, creating the personnel duties and tasks schedules and timetables. (Paschou et al. 2015) (Wray, 2013) Both systems are hosted on web-based software hosting sites. The prototype system described by Paschou et al. included possibilities for making updates and modifications in real-time according to user's needs. The findings indicate that e-rostering is considered an easily accessible and useful tool in personnel planning and that it contributes to better operational and financial management. E-rostering enables ward managers to an optimal use of nursing resources. E-rostering systems' predictive cost-savings are substantial. Costs are reduced by reducing the use of bank and agency staff (i.e. substitute personnel), not re-keying and submitting timesheets and by minimizing data-transmission costs by using local caching. In one study, the e-rostering system was reported to have the ability to be used in integration with other information systems within hospitals on a regional and a national level. The use of e-rostering frees managerial workforce for other tasks, which in turn involves further change in working methods but has an assumed impact on the quality of asset management. Flexible work patterns, personal preferences, skill requirements and minimum staffing levels were factors that were taken into account in the planning process in practice. The studies report that e-rostering improves working conditions and reduces personnel dissatisfaction. The Wray study addressed the issue of safety, concluding that e-rostering enhances safety by the reduced need of bank and agency staff.

The determinants for nurse staffing levels or the defined need for workload input were not presented and reported in the reviewed studies. The issue of personal data safety was not precisely addressed even though two of the systems were web-based.

In trying to find research on commercial e-rostering systems, it seems as if this study has addressed a research area that not yet explicitly exist. Because of the scarce research findings the author wished to bring forward a market analysis on the use of electronic commercial rostering systems that investigated the market situation in Sweden. The report displays various systems in an unpublished marketing analysis performed for Visma Numeron Ltd and conducted by the Finnish-Swedish chamber of commerce (FINSVE) in 2014. Four different workforce management systems were reported to be in current commercial use in Sweden within the healthcare context at the point of the market analysis. The systems are; Time Care, Quinyx, Medvind, Visma Gat and Heroma. Additionally one Finnish workforce management system, Numeron WFM. is presented in Table 4. It is also worth mentioning that Visma Numeron administrates a comprehensive resource management tool called Numeron WFM, which is currently in use in Finland in health and social care, security, facility services, retail, transportation and logistics.

These systems, together with the research findings of this study, Healthroster and the prototype system described by Paschou et al., all create automatized, and in the FINSVE and Numeron WFM systems also optimized, schedules for the healthcare sector.

Software system (Corporation)	Features	Customer segments
Time Care / Allocate Optima (Allocate Software) http://www.allocatesoftware.se/	Focuses on human resource management and optimization	Swedish municipalities and county councils (i.a. healthcare and care for the elderly)
Quinyx (Quinyx AB) https://www.quinyx.com/se/	A personnel management system for staff-intensive industries. A web-based workforce management system	Restaurants, hotels, retail, call centers, public sector, care and care and nursing care, construction industry
Medvind (Medvind informationsteknik) http://www.medvind.it/	A work time planning system that deals with allocation of resources. A standard system, that can be tailored as to the needs and preferences of a company, taking into account i.a. different working time models	Healthcare, media municipalities, retail, restaurants, hotels, mining, rescue and security service, transport
Visma Gat (Visma AB) www.gatsoft.se	An administrative tool for managing human resources	Hospitals, municipalities, fire departments, transport and media
Heroma (CGI Sverige AB) https://www.cgi.se/cgi-ip-solutions/hr-system-and-integration/heroma	An administrative tool for managing human resources	Public sector

Table 4. Market analysis on electronic rostering systems in the Swedish healthcare sector

The market analysis offered a facile overview of the various systems and introduced the website for more information. By screening the websites, certain features were more explicitly described concerning the FINSVE-analysis systems than had been possible to screen from the articles found in this scoping review. One apparent difference between the research findings from the scoping study and the results from the market analysis of FINSVE is the fact that the systems are described in more depth on the corporate websites of the FINSVE-analysis systems. Consequently, a broader selection of features was observed concerning the market analysis' systems. For instance, at least Visma Gat, Medvind and Quinyx take the underlying collective labour agreement into account in the rostering process, which is an important statutory factor. This is not described in the either Paschou's or Wray's research. Other features such as error messaging, heads-up warnings concerning lack of resources och knowledge, wage interpretation, forecasting and monitoring costs and time resources etc. is available as features in the FINSVE-analysis systems and Numeron WFM. However, in order to perform an in-depth comparative review would need a separate research formulation.

All reviewed systems are web-based software. The Paschou personnel rostering system's application has the possibility to identify inconsistencies in the schedule, either at launch, during automatic renewal and update by the system itself. This feature was possible also in the Time Care, Visma Gat and Numeron WFM systems. A real time communication of vacations, requests for alteration, cancellation och transfer of schedule was reported possible in the Paschou personnel rostering system, this feature is also possible within the systems reported by FINSVE and Numeron WFM. The Paschou personnel rostering system had the possibility to automatically detect and display employees who are at the hospital at any given time. The use of such a feature in major disaster situations within a healthcare facility would be of crucial importance. The same feature was not clearly presented concerning the other systems.

Most reported systems incorporate mobile applications, however the study by Wray did not reveal this aspect. In the Paschou personnel rostering system the mobile application forms the key module and tool for the rostering system allowing the user to easily interact with the roster and shift issues manager. This same feature is reported to be possible in Medvind, Quinyx, Time Care, Visma Gat, Numeron WFM and Heroma, systems that

facilitate an increased responsiveness to employee requests and seeks to prevent over and under resourcing.

The Visma Gat, Time Care, Heroma, Numeron WFM and Medvind systems enable a knowledge allocation as well as an integration to other programs, such as MS Outlook, economic and remuneration systems and agency personnel systems. The Paschou personnel rostering system's architecture enables integrations with any hospital information system, a feature also available in other systems reported by the FINSVE analysis and Numeron WFM.

5 CONCLUSIONS

Healthcare professionals need research findings in order to be able to choose the suitable systems to support day-to-day decisions concerning workforce asset management and schedule and roster planning in practice. Nurse managers consider their role as managers to have been strengthened due to the use of electronic information systems that are an essential element in the daily work as the systems' enable fulfillment of managerial tasks easier than before (Lammintakanen et al., 2010). As modern technologies are available, they could be implemented and benchmarked more efficiently if references in research were to be found. This scoping study did not produce more than two research findings. However, performing this study and finding even a few results constitutes an overview of the current research field concerning e-rostering systems. This study and its results now form a basis of which to proceed to further research the topic. Considering the vast field of healthcare a substantial lack of studies if the field was observed in a European setting. Needs for future research emerged and includes benefits analyses, using methods that enable comparative analysis of various workforce systems and their features as to evaluate their comprehensiveness and agility. It is also of interest to study the factors determining the workforce as well as research on the systems' implementation processes. There seems to be a need to clarify and further define the terminology around the phenomena of e-rostering.

It is also worth pondering upon the scarcity of the findings. One reason for this might be that enterprises offering various e-rostering solutions do not wish to reveal the mathematical approaches and algorithms used in software development. The lack of research in the

field might also be attributable to meagerness of collaboration between end-users, researchers and commercial software development corporations, a view that is supported by recent research (Martikainen, 2015, p. 55). However, in a Finnish study, researchers allege that nurse rostering cooperation between commercial software vendors and academics does work. According to Kyngäs et al., hospitals are open about their operational details and enable cooperation with academics who want to publish the results of their work. Kyngäs and colleagues bring forth the aspect of an existing gap between academic and commercial solutions and question whether commercial products include the best academic solutions. Based on the researchers experience they conclude that the best strategy for real-world nurse rostering research is to cooperate with problem owners and software vendors. (Kyngäs et. al, 2012) Reporting research findings on a well-functioning system and modes of operation would be an excellent reference for extending the use of such systems.

6 IMPLICATIONS FOR NURSING MANAGEMENT

E-rostering can help reduce nurse managers' workload and increase flexibility by automating the process of staff scheduling, provided that the users commit to using them. A recent study concluded that happy employees achieve a higher productivity than their unhappy peers do. (Oswald et al., 2015) Therefore, nurse managers need to strive for an effective and flexible personnel rostering, which in turn promotes the wellbeing of the employees. (Price, 2016). It seems as though the change from manual personnel scheduling and rostering is only at its beginning. The change in how schedules and rosters are planned requires several planning periods in order to perceive the effects of new instruments, control methods and aims. Parallel to the practical planning nurse managers need to recognize the challenges emerging from the implementation of new rostering systems. (Sartjärvi, 2015, p. 16, 182-184)

One of the possible reasons for the existing gap between the nurse rostering theory and practice is that the academic community focuses on the development of new techniques rather than developing systems for healthcare institutions (Petrovic, Vanden Berge, 2012)

An optimal set of solutions and creative ways of solving the nurse rostering problem might be found when healthcare organizations get information on various possible technical solutions and software on nurse rostering problems, providing a clear picture about their advantages and disadvantages and therefore their suitability to respective nursing environments. A deeper understanding of the automatic creation of schedules require interdisciplinary knowledge and close collaboration within organizations and between different parties taking into account the vast amount of information needed in the process. In this process, the nurse managers have an important role as experts on and connoisseurs of their own staff. A comprehensive, flexible and interactive e-rostering system is of cardinal importance in the demanding and versatile world of healthcare.

ETHICAL APPROVAL

Ethical approval was not required for this paper.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship and/or publication of this study.

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SVENSKSPRÅKIGT SAMMANDRAG

Syftet med denna studie var att med hjälp av en scoping studie kartlägga förekomsten av elektroniska skiftesplaneringssystem vars ändamål är att automatisera och optimera arbetsplaneringen inom hälso- och sjukvården.

Mastersarbetet är skrivet i artikelform med det preliminära syftet att i framtiden lämna in artikeln till Journal of Nursing Management. Därför följer arbetets struktur de riktlinjer

som den vetenskapliga tidskriften i fråga har för skribenter som önskar få sin forskning publicerad. En översiktsartikel (review article) skall för inlämning till Journal of Nursing Management sammanfatta, analysera och evaluera publicerat material på ett viktigt ämne genom att erbjuda nya teorier, synteser eller idéer. Artikelns maximilängd är 5000 ord, inklusive abstrakt och referenser. Figurers och tabellers maximiantal är sex (6) och sökorden skall vara max. fem (5) stycken. Ett strukturerat abstrakt skall innehålla följande:

Syfte: Vad är syftet med artikeln?

Bakgrund: Varför är artikeln viktig just nu?

Evaluering: Hurdan typs information användes och hur analyserades och evaluerades detta?

Resultat: Vilka var de viktigaste frågorna som framkom från analysen?

Slutsats(er): Vilka är de centrala slutsatserna och konsekvenserna för praktiken?

Konsekvenser för vårdledningen: Vilka konsekvenser har artikeln för vårdledarskapet och vad tillför den nuvarande kunskapen?

Tidskriften Journal of Nursing Management kräver att samtliga skribenter avslöjar eventuella existerande och potentiella intressekonflikter samt eventuell finansiering av forskningen. En existerande intressekonflikt utesluter inte automatisk publicering. Även om inte intressekonflikt existerar, skall detta anges vid inlämning av artikeln. All finansieringsdata beskrivs i Acknowledgements-delen av arbetet. (Wiley Online Library)

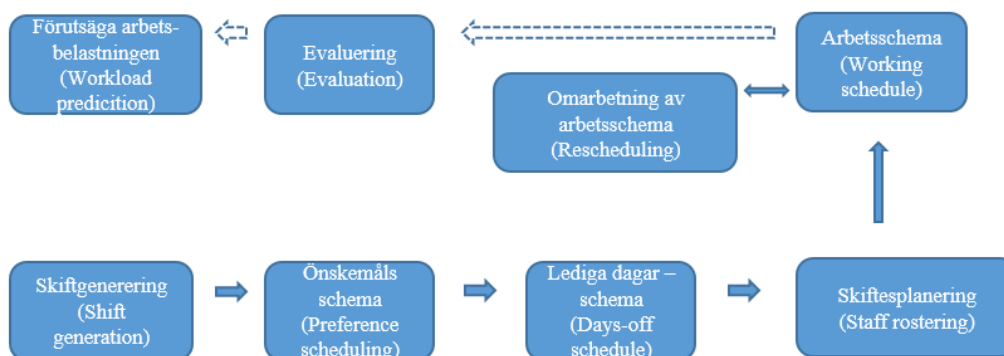
En ökad befolkningstillväxt, demografisk skiftning, en förändrad epidemiologi, nya teknologier, en högre grad av mobilitet och en tilltagande efterfrågan på hälso- och sjukvårdsservice bidrar till ett ökat behov av hälso- och sjukvårdspersonal. Hälso- och sjukvårdspersonalen är en dyr men samtidigt oundgänglig resurs som berörs av utmanande arbetstidsarrangemang. (Oulton 2006) (Campbell 2013 p. 11) (Dubois & Singh, 2009, p.1) Det är en daglig utmaning att leda hälsovårdspersonalresursen så att en rättvis fördelning av arbetsbördan och en bättre produktivitet uppnås (WHO 2010). Enligt en finsk studie finns det fem olika orsaker till det tilltagande intresset gentemot optimering av vårdarnas arbetsscheman. Först, sjukhusen har blivit mer medvetna om möjligheterna i teknologier som stöder beslutsfattandet och intresset för att göra arbetsscheman manuellt minskar.

Andra orsaken är att mänskliga resurser är en av de mest kritiska och kostsamma resurserna för ett sjukhus och en observant arbetsskiftplanering kan leda till märkbara förbättringar i produktivitet. Som en tredje orsak ses att en bra arbetsskiftsplanering leder till ökat välbefinnande och minskar sjukfrånvaron bland personalen. En fjärde orsak är nya algoritmer som utvecklats för att hantera tidigare svårhanterad arbetsskiftsplanering inom sjukvården samtidigt som datorernas kapacitet har förbättrats och storskaliga problem kan hanteras. Den femte orsaken är en strävan att bättre hantera arbetstiden, en automatisering av arbetsskiftplaneringsprocessen sparar märkbart den planeringsansvariges tidsresurser. (Kygäs et al., 2012)

Personalbemanning och skiftesplaneringen antar olika former beroende på ifrågavarande kontext och utförs genom att tilldela uppgifter till arbetstagare med hänsyn till existerande begränsningar för att tillfredsställa servicekrav och kontraktbundna avtal. (Bruni, Detti, 2014) Centrala element i framtidens vårdledarskap kommer att bestå av förmåga till strategiskt resursledarskap och insikt i datadrivna skiftesplaner. I hälsoforskning har terminologin som hänför sig till arbetsskiftsplanering använts otydligt (Kreeft, 2012, p.20). Vårdarnas skiftesplanering har attraherat forskare i decennier, trots detta finns enbart några fungerande system i bruk och organisationer använder sig fortsättningsvis av manuell skiftesplanering (Petrovic, Vanden Berge, 2012) (Ásgeirsson, Sigurðardóttir, 2016) (Sartjärvi, 2015, p. 18). Elektronisk skiftesplanering erbjuder en exakt och läglig tillgång till rättvis bemanning och skiftmönster förutsatt att de innefattar nödvändiga parametrar, möjlighet till personlig schemaläggning och rullande shift (Price, 2016). Elektroniska skiftesplaneringssystem uppfattas som lättillgängliga och användbara verktyg som bidrar till bättre operationell och ekonomisk ledarskap genom optimal användning av personal, minskad användning av interna eller inhyrda vikarier och mindre behov av planeringstid. (Carter, 2016, p.64) I elektroniska planeringsprocesser kan flexibla arbetstidsarrangemang, personliga önskemål, kunskapskrav och minimi bemanningsnivåer beaktas (Price, 2016). Elektronisk skiftesplanering förbättrar arbetsförhållanden och minskar personalens missnöje på arbetsplatsen (Cho et al., 2016). Interaktiv datateknik avser programvara som människor styr genom att berätta för datan vad den skall göra. Människo-data interaktionen gav på 90-talet upphov till artificiell intelligens (AI) som klarar av att härma människans intellektuella processer som inlärning, argumentering och självkorrigering.

(Kreeft, 2012, p.32) Artificiell intelligens utnyttjas i planeringen och förverkligandet av olika elektroniska personalplaneringssystem.

Personalplaneringsprocessen har av Kyngäs et al. definierats med hjälp av figuren nedan.



Figur. Personalplaneringsprocess (Kyngäs et al. 2012)

Personalplaneringsprocessen startar med att förutsäga arbetsbelastningen. På så sätt bedöms hur många arbetstagare behövs för att utföra visst arbete under en viss tidsperiod. Skiftgenerering är en process som definierar skiftets struktur, vilka arbetsuppgifter skall genomföras under särskilda skift och vilket kunnande som behövs i olika skift. Inom sjukvården arbetar personalens traditionellt i tre skift; morgon, kväll och natt. En viktig aspekt i personalplaneringen är beaktandet av personalens önskemål och en målsättning att försöka uppfylla önskemålen så långt som möjligt. Att schemalägga lediga dagar innebär beaktandet av vilodagar bland arbetsdagarna samt semestrar, skolningar etc. Skiftesplanering allokerar personalen i olika skift. Omarbetandet av schemat sker ofta ad hoc och görs manuellt för att åtgärda t.ex. sjukfrånvaro. Evaluering innebär en utvärdering av förverkligad bemanning och arbetstagarnas nöjsamhet med schemat. (Kyngäs et al. 2012)

Workforce asset management (WAM) är en ny disciplin som kombinerar strategisk, operationell, ekonomisk och teknologisk ledarskap i realtid, WAM har fungerat som arbetets teoretiska referensram. WAMs syfte är att allokera personalen för att uppnå organisationens mission, strategiska visioner och centrala prestationsindikatorer.

Mastersarbetet forskningsmetod är en explorativ scoping studie som kartlägger förekomsten av elektroniska skiftesplaneringssystem och erbjuder förslag till fortsatt forskning. I brist på en existerande svensk översättning av begreppet scoping review, använder jag mig av det engelskspråkiga begreppet.

Målsättningen med scoping review studier är att fastställa hurdan evidens, antingen kvantitativ eller kvalitativ, finns tillgänglig i ett visst ämne genom att kartlägga erhållen data oberoende av studiens kvalitet. I scoping review studier görs inte formella bedömningar av inkluderade forskningars metodologiska kvalitet. (Arksey & O'Malley, 2005) En scoping review kan vara en s.k. föregångare till systematiska litteraturstudier, men det är viktigt att precisera skillnaden mellan dessa olika metoder. En av de största skillnaderna är att scoping review studier inte bedömer studiernas kvalitet utan har oftast som syfte fungera som preliminär utforskande process som identifierar omfattningen och typen av existerande evidens. Scoping studier används ofta för att styra till mer fokuserad forskning och utveckling genom att bidra med en tydligare problemformulering. Scoping studiernas metodiska tillvägagångssätt kan användas för att undersöka bredden av forskning inom ett visst ämnesområde. (Rumrill et al, 2010)

Det är möjligt att identifiera åtminstone fyra vanliga orsaker till varför scoping studier utförs. Den första är att undersöka forskningsaktivitetens omfattning och karaktär för att kartlägga forskningsområden där det är besvärligt att upptäcka omfattningen av tillgängligt material. Den andra orsaken kan vara en vilja att bedöma värdet av att utföra en systematisk översiktsforskning. Då fungerar scoping studien som en preliminär kartläggning för att säkra existensen av litteratur inom ämnet eller ifall en systematisk översiktsforskning i ämnet redan gjorts samt för att uppskatta kostnaderna för en eventuell systematisk översiktsstudie. Den tredje orsaken är att sammanfatta och sprida forskningsresultat till en bred publik som inte själv har resurser att utföra en kartläggning inom ett visst ämne. Den fjärde och viktiga orsaken är att finna forskningsluckor i existerande litteratur genom att dra slutsatser från befintlig litteratur om det övergripande läget beträffande forskningsaktivitet inom ett visst område. (Arksey & O'Malley, 2005)

Mitt mastersarbete följer Arksey och O'Malleys modell för scoping review studier och är uppbyggd enligt följande stadier:

- Stadie 1. Identifiera forskningsfrågorna (syfte)
- Stadie 2. Identifiera relevanta studier (sökprocessen)
- Stadie 3. Val av inkluderade forskningar (enligt inklusionskriterierna)
- Stadie 4. Kartläggning av data samt skapandet av figurer och tabeller
- Stadie 5. Samla, sammanfatta och rapportera resultaten

Sökorden i tabell 1. (Table 1.) användes för att finna olika elektroniska personalplaneringssystem som är i kommersiellt bruk inom vården. Sökningen förverkligades 19.-23.9.2017, sökningen utfördes i nio (9) olika databaser och sökresultaten var sammanlagt 371 stycken. Samtliga sökningsresultatens rubriker lästes och en bedömning om relevansen till forskningen gjordes. Av de 371 sökningsresultaten utsorterades 332 forskningar. De återstående 39 forskningarnas titlar och abstrakt lästes, varav 10 forskningar lästes i sin helhet. Av de 10 lästa artiklarna inkluderades 3 forskningar som fyllde samtliga inklusionskriterierna. Inklusionskriterierna var: forskningen skall vara sakkunniggranskad originalforskning från tiden 2010-2017 och beskriver elektroniska personalplaneringssystem. Enbart engelskspråkiga forskningar från EU-länder inkluderades. Den geografiska begränsningen baserade sig på faktum att EU-länder är bundna av gemensamt arbetstidsdirektiv. Under en ytterligare granskning av de inkluderade forskningarna uppdagades ett fel i tolkningen av systemets ursprung i forskningen av Pereira et al. (Pereira et al., 2011) och studien exkluderades ur forskningen.

Med tanke på hur omfattande och avgörande service hälso- och sjukvården är, kändes det förvånansvärt att inte flera forskningar beträffande skiftesplaneringssystem inom vården hittades och det verkar som om ett forskningsområde som inte ännu uttalat existerar tanterats. Orsakerna till varför inte fler forskningar fanns förblir dolda men kan eventuellt bero på att en stor del av systemen administreras och utvecklas på den fria marknaden, algoritmer och systemutveckling är delar av företagens produktutbud som inte i detalj vill belysas för allmänheten på grund av konkurrens- och marknadsföringsskäl. Avsaknaden av forskningar kan också bero på att det inte existerar ett naturligt samarbete mellan forskare, slutanvändare och företag som skulle möjliggöra en fortsatt produktutveckling. Det finns en uttalad klyfta mellan teori och praktik eftersom det akademiska samfundet fokuserar på att utveckla nya tekniker men inte utvecklar direkta system för hälso- och sjukvårdsorganisationer (Petrovic, Vanden Berge, 2012).

Eftersom så få forskningsresultat hittades gjorde skribenten en sammanställning av olika personalplaneringssystem som grundar sig på en marknadsundersökning gjord i Sverige 2014. Arbetet har beställts av Visma Numeron Ab och utfördes av Finsk-svenska handelskammaren (FINSVE).

Software system (Corporation)	Features	Customer segments
Time Care /Allocate Optima (Allocate Software) http://www.allocatesoftware.se/	Focuses on human resource management and optimization	Swedish municipalities and county councils (i.a. healthcare and care for the elderly)
Quinyx (Quinyx AB) https://www.quinyx.com/se/	A personnel management system for staff-intensive industries. A web-based workforce management system	Restaurants, hotels, retail, call centers, public sector, care and care and nursing care, construction industry
Medvind (Medvind informationsteknik) http://www.medvind.it/	A work time planning system that deals with allocation of resources. A standard system, that can be tailored as to the needs and preferences of a company , taking into account i.a. different working time models	Healthcare, media municipalities, retail, restaurants, hotels, mining, rescue and security service, transport
Visma Gat (Visma AB) www.gatsoft.se	An administrative tool for managing human resources	Hospitals, municipalities, fire departments, transport and media
Heroma (CGI Sverige AB) https://www.cgi.se/cgi-ip-solutions/hr-system-and-integration/heroma	An administrative tool for managing human resources	Public sector

Tabell 4. Marknadsanalys om elektroniska personalplaneringssystem i kommersiellt bruk i Sverige.

Sökorden i marknadsanalysen sammanfaller till stor del med de sökord som används i scoping studien. De centrala använda begreppen i marknadsanalysen beträffande personalplaneringssystem var följande:

FINSVE

- Arbetstidsplanering
- Schema- och personalstyrning
- Schemaläggning av personal
- Bemanningsoptimering
- Bemanningsplanering system för (optimal) resursallokering
- Workforce scheduling
- Personalplanering
- Personalhanteringssystem för personalintensiva branscher

Denna scoping studie resulterade i enbart två forsknings fynd. Resultatet utgör en aktuell översikt av utförda forskningar inom ämnet och bildar en grund från vilken nya forskningsfrågor kan formuleras. Resultatet understryker behovet av fortsatt forskning, särskilt

med metoder som möjliggör en jämförelse mellan olika existerande elektroniska personalplaneringssystem och deras olika tekniska funktionsmöjligheter, omfattning och vighet. Fortsatta studier inom området behövs även i form av såväl effektanalyser av implementationen av dylika system som av själva implementationsprocessen. Konsekvenserna av denna studie för vårdledarskapet är en översikt om att elektroniska skiftesplaneringssystem finns och är användbara förutsatt att systemen används i sin fulla utsträckning. Det är skäl att ta i bruk alla möjliga metoder för att hålla kvar personalen och möjliggöra en så flexibel och rättvis skiftesplanering som möjligt, något som elektroniska skiftesplaneringssystem bidrar till. En mer omfattande presentation av på marknaden existerande elektroniska skiftesplaneringssystem behövs för att chefer skall kunna välja de bästa lämpande för sina respektive kontext. Omfattande, flexibla och interaktiva elektroniska skiftesplaneringssystem behövs i en krävande och föränderlig vårdverklighet.

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