NURSE SCHEDULING DECISION SUPPORT SYSTEMS
AS A WORKFORCE MANAGEMENT TECHNOLOGY SOLUTION
IN PUBLIC HEALTHCARE

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ABSTRACT

Although many academic studies report on the development of Decision Support Systems (DSSs) for nurse scheduling and related mathematical models, few of these systems and models are actually used. The purpose of this paper is to contribute to the adoption of these solutions, specifically in the public healthcare system of South Africa. Factors that influence the uptake of nurse scheduling DSSs are identified by means of a study of state of the art, interviews with various role players. A root cause analysis is conducted accordingly in order to identify issues that need to be considered for sustainable facilitation of nurse scheduling DSS, and so contributing toward future development of workforce management solutions for nursing in public healthcare.
1 INTRODUCTION

1.1 Background

1.1.1 Nursing in South Africa

Nursing staff constitute the largest component of hospital’s workforce. Within South Africa’s (SA’s) healthcare system, the nursing profession represents more than 50% of the total professional human resources [1]. The South African Nursing Council has identified a shortage of nurses in SA. In an era where SA’s HIV/AIDS epidemic is booming, nursing staff have periodically represented the biggest required increase across all professional healthcare staff [2]. There is thus a need to manage and support nursing staff in more reasonable and efficient ways.

Strategic support for nurses is envisioned by some Provincial Nursing Strategy (PNS) documents. A particular PNS document addresses operational burdens that nurses are faced with and current provincial and global scaled challenges. These challenges include; a shortage of professional nurses, high attrition rates and migration of skilled nurses. A strategic objective in the PNS document is to enhance nursing management capacity by improving efficiency in decision making in nurse management. [3]

1.1.2 Nurse Scheduling Problem

It is anticipated that scheduling that addresses nursing constraints and preferences whilst aiding hospital objectives will result in high operational merit and better quality work environments.

Recent research and development on mathematical models and integrated scheduling systems that address nurse scheduling is plentiful. The Nurse Rostering Problem (NRP) is universally known for two extreme difficulties: its complex combinatorial optimization modelling and its difficult practical matching and implementation.

In 2007, D L Kellogg and S Walczak reviewed 72 cited articles on nurse scheduling models. Of the 72 articles, 50 developed nurse scheduling models; 34 of those models were conceptualized on a computer; 15 were implemented and only 8 are still in use at present. The ANSOS system is an example of a published academic nurse scheduling model that became a commercial success, because of its ability to evolve and solve more than just scheduling problems. [4]

Three recent studies, which were executed within context of the South African public health sector focused on mathematical modelling rather than sustainable facilitation [5,6,7].

The Integrated Staffing Model (ISM) is an example of an integrated solution aiding nurse scheduling decision making in private healthcare in SA. Mediclinic have worked for two years on their ISM. The ISM embraces scientific standardisation to promote fairness and efficiency within Mediclinic’s healthcare provision strategies. [8]

1.1.3 Health Decision Support- and Workforce Management Systems

The purpose of HDSSs are to improve the efficiency and effectiveness with which health service administrators or clinicians make decisions to optimise personal and organizational performance outcomes. [10]

Nurse scheduling solutions form part of typical workforce management tools, such as time and attendance, workforce payroll, workforce planning and profiling.
1.2 Problem Statement

The problem is that amidst literature confirmed- and commercially advertised nurse scheduling DSSs potential and benefits, there is still little support toward development of such a workforce management tool in South African government-facilitated hospitals.

1.3 Objectives

The first objective of this paper is to identify factors that need to be considered for sustainable facilitation of Nurse Scheduling DSSs. Secondly, the paper aims to contribute towards future development of nurse scheduling DSSs in South African public healthcare by proposing solutions that would increase project facilitation success rates.

1.4 Methodology

Firstly, factors that influence the uptake of nurse scheduling DSSs are identified by means of a study of state of the art, interviews with developers of nurse scheduling DSSs, academic researchers, technology research personal at Medical Research Council SA, hospital managers, nursing managers and supervisors, a private healthcare nursing productivity project manager, commercial workforce management technology group managers. These factors were then brought together in a Root Cause Analysis (RCA) and mapped on a Cause-and-Effect Diagram (CED). The CED translates the factors into barriers that hinder sustainable facilitation of nurse scheduling DSS on condition that they are not considered. Lastly, future development of nurse scheduling DSSs in public healthcare is probed.

2 BARRIERS TO SUSTAINABLE FACILITATION

The RCA is graphically mapped in the form of a CED is split up and displayed in Error! Reference source not found. and Error! Reference source not found. on the following two pages. The resultant RCA Barriers for Sustainable Facilitation are mapped in Figure 2 and Figure 3 and are discussed below in the light of consideration that is needed for sustainable facilitation of nurse scheduling DSSs.

2.1 Healthcare Method Barrier

2.1.1 Complex Healthcare Work Environment

Healthcare work environments are characterized by extensive personal and emotional interaction. For this reason, patient safety and -confidentiality foster strict healthcare policies. These strict policies ripple throughout the healthcare system and affect any intervention with healthcare personnel or resources utilized. Heavy- and critical workloads, anticipated to be more extreme in South African public than in private healthcare, permit limited attention and time for improvement interventions such as nurse scheduling DSSs. Strenuous work environments and strict healthcare policies need to be planned for when facilitating technology workforce management solutions such as nurse scheduling DSSs.

2.1.2 Scheduling Protocol

Integrated nurse scheduling success is dependent on certain workforce management support interactions such as: (1) accurate time and attendance recordings; (2) fair and concise absence management; (3) fair and simplistic leave management; (4) workforce analytics; and (5) human resource nurse profile management.

Above discussed support interactions are administrative support services to nursing staff that support the executive mission of a hospital by managing human resources and official procedures. Efficient administrative support services empower nurses to focus on the primary objective of their profession: providing patients with quality care. [11]

2.2 Healthcare Organizational Barrier
Figure 1 illustrates continuous quality improvement reasoning in healthcare. The private healthcare sector has strong market share components that fuel their improvement effort.

![Figure 1: Relationship between Cost and Quality in Healthcare](image)

Abundant motivational theories are available to use for workforce quality improvement. One important aspect is evident in most prevalent motivation theories: a human being is not only motivated by extrinsic factors, but equally so by intrinsic factors. [13]

### 2.2 Change Management

Organizations such as public and private healthcare constantly face pressure to change in order to adapt to dynamic environments with internal growth- and uncontrollable external factors. Organizations that appreciate and manage change well tend to be most effective. [14]

### 2.3 Support System Method Barrier

#### 2.3.1 Focus on the end-user

Attention needs to be paid to different end-users of a support system solution. In broader scope appreciation of training, experiences and activities of nurses need to be considered. Various commercial nurse scheduling solutions include seniority, skills and certifications along with preferences in their availability formula for nursing staff on call [15]. Other supporting staff and departments also need to be considered when designing the system solution [15,16,17].

#### 2.3.2 Organizational Context

Public healthcare organizational context differs from private healthcare. The South African public health sector was restructured post-1994 to increase access and coverage of healthcare to all. In order to meet healthcare needs of 86% of South SA’s population the DoH has established a hierarchy of health services which has rules and endeavours of its own [20].

#### 2.3.3 System Support

The perception of reliable customer support is important in the purchase and implementation of any information system [21]. Kellogg and Walczak [4] confirm this statement and weigh it as one of the major reason for failure of academic nurse scheduling solutions. Academics are not prepared to provide system-maintenance relationships for their solutions.
Unsustainable Nurse Scheduling DSS Facilitation in Government Facilitated Hospitals

Figure 2: Expansion Segment 1 of CED for Unsustainable Nurse Scheduling DSS Facilitation
2.3.3
Unsustainable Nurse Scheduling DSS Facilitation in Government Facilitated Hospitals

2.3.1
Lack of Evidence-based Financing

2.3.2
Unspecific to Context

2.3.3
Lack of Prioritising Solution Technology

2.3.4
Isolated Research-Application Outcome

2.4.1
Solution Controls:
Constrains and Objectives

2.4.2
Tedious Workflow

2.4.3
Distrust of Technology Solutions

2.5.1
Lack of Business Case

2.5.2
Disproportions in Finance Spending

2.5.3
Strained Expenditure

2.5
Financial Barrier

Figure 3: Expansion Segment 2 of CED for Unsustainable Nurse Scheduling DSS Facilitation
2.3.2 Stakeholders

Successful project facilitation usually imbeds ownership administration and participation opportunity by identify change stakeholders and communicating their responsibilities as such:

- **A Champion** is an individual whom is the driving force behind the change initiative.
- **The Initiating Sponsor** is a high-level management individual who lends support and prestige to the work of the champion.
- **The Steering Committee** is a group of stakeholders for whom the change process is being undertaken, they should lend direct management guidance and support to the change effort.
- **The Engineering Team** is a team that does the actual analysis and preparation of the master change plan, and help to guide and manage the deployment of the master plan.
- **The Design Team** is a team that does the detail design and development of refreezing concepts.
- **The Change Management Team** is a team that is responsible for the human relation issues that prepare and support employees for change, i.e. change communication, training etc. [22]

Alliance of nurse researchers, health departments, third-party vendors and the project initiator is highly recommended to help close the research-application gap [4]. Nurse scheduling DSS project initiators for public hospitals have mostly only been academic researchers in the field of Operations Research or Industrial Engineering. [5,6,7]

2.4 Technology Barrier

By addressing presented technology barriers discussed below, nurse scheduling DSSs can be proved feasible and indispensable as a technology solution improving nursing

2.4.1 Lack of Prioritising Solution Technology

Nurse scheduling DSS development is currently constrained by a shortage of nurses and poor nursing workforce management support interactions in public healthcare that involve: (1) records of scheduling drivers; (2) time and attendance input; and (3) absence and leave management. Prioritising solution technology according to constraints must be done. [8, 23]

2.4.2 Solution Controls: Constraints and Objectives

2.4.2.1 Constraints

- **Nurse Shortage**: A shortage of nurses makes it difficult to award present nurses with preferred and flexible schedules whilst satisfying patient care needs and hospital objectives. [2]
- **Records of Scheduling Drivers**: Scheduling driver input such as attendance and patient case-mixes records are not readily available to improve aligned decisions of predicted patient demand with nurses available. [8]
- **Time & Attendance Input**: Current time & attendance recording leaves room for unintentional- and intentional error, is a very tedious and an inaccurate source of information to nursing management. [19, 24, 25]
- **Absence & Leave Management**: Current absence & leave systems leave room for serial offenders to cheat the system while obedient nurses filling in don’t receive the credit they deserve while helping out with crises. [19, 24, 25]

2.4.2.2 Objectives

Objectives were identified as: financial feasibility, easy implementation, easy maintenance, integrated interaction, value added to nurses and value added to hospital analytics. [19, 24, 25] These objectives were used and ranked accordingly in study
performing a technology prioritising exercise. In this technology prioritising exercise Time & Attendance-{}, and Absence & Leave Management systems were ranked to be government-facilitated hospitals in SA’s most imperative next-step in workforce management technology support. Many barriers and strategies identified for nurse scheduling DSSs as a technology workforce management solution in this paper can be extrapolated for facilitation of automated Time & Attendance-{}, and Absence & Leave Management systems. [26]

2.4.2 Tedious Workflow

Automating manual systems is not only based on cost-savings but also on the elimination of tedious processes that produce inaccurate, untimely and un-integrated outputs [27].

Converting a manual system to an automated system will require a work team to conduct a Situational Analysis. A Situational Analysis will pinpoint problem areas automation can correct and identify risk opportunities and improvement of automation [28]. The work team must look for: (1) redundant data entry; (2) inefficiencies; (3) employee and employer dissatisfaction; (4) unacceptable error rates; and (5) administrative costs etc.

2.4.3 Technology Solutions

It is noted that nurses have little trust and acceptance of computerized DSSs [4]. Hsiao’s [29] analysis of technology adopter’s fears according to reliability-related and value-oriented distrust is embedded in the discussions below.

2.4.3.1 Technical Support

Reliability-related distrust occurs when nursing staff expectations of an ICT solution is reduced due to lack of technical support. This is true when a solution is presented without appropriate implementation strategies and system-maintenance relationships.

2.4.3.2 Change Incentives and Unsuitd Process Flow

Value-oriented distrust arises when nurses’ beliefs of a workforce management ICT solution differs gravely from champion and initiating sponsor beliefs. The change incentives are possibly poorly communicated and the change process flow unsuited. To correct the latter, Participation Opportunity and Ownership Administration is necessary.

2.5 Financial Barrier

A key barrier to facilitation of an ICT solution, nurse scheduling DSS parts, appears to be the anticipation of high costs and uncertainty of benefits.

2.5.1 Business Case

Anticipating and quantifying some of the cost-savings and costs of a workforce management ICT solution can be the key to gaining approval from higher-level role-players to assign resources to further development of workforce management parts [30]. The latter is the formation of a business case which is itemised and discussed below.

2.5.2 Anticipated Cost Savings

Benefits of workforce management are advertised by commercial vendors promising:

2.5.2.1 Control workforce cost
- Move nursing staff from time-consuming tasks to higher-value tasks.
- Increase ownership and flexibility of scheduling intrinsically motivating nurses.
- Increase visibility and control over workforce-related metrics.
2.5.2.2 Control workforce productivity

- Automate time-consuming manual processes.
- Ensure timely response to workforce demand and changes.

2.5.2.3 Control Compliance

- Centralize and align policy administration for consistency.
- Easily enforce company, local, industry, or government policy.
- Reduce compliance risk with detailed audit tracking. [8, 27, 31]

A work team can elapse or expand on these benefits in manifold matters by considering potential benefits to: efficiency, service delivery, decision making, staff development and financial management. [8] Mercer (2010) conducted a study on the total financial impact of employee absenteeism and concluded that employee absence is equivalent to about 35% of base payroll. This 35% is made-up of: (1) direct cost such as benefit provided during off-time; and (2) indirect cost such as operational inefficiency impact.

2.5.2.4 Anticipated Cost

Anticipated cost for typical ICT nursing workforce management solutions are:

- Hardware costs
- Software costs
- Installation costs
- Training costs
- Recurring costs

[8, 27, 31]

The approval of a total cost ownership budget, that includes anticipated costs as set out above, would in public healthcare rely on financing in the form of a conditional grant. Depending on the scale of the workforce management solution the grant would be awarded on national-, regional- or at hospital level. This financing is elaborated on next.

2.5.3 Bureaucratic Financing

2.5.3.1 Cause-and-effect of South African Financing and Expenditure

The South African public health sector was restructured post-1994 to increase access and coverage of healthcare to all. Unfortunately together with restructuring overall quality faltering brought troubling health trends. Economists warn that SA’s current public-private healthcare mix is widening healthcare inequality. The public healthcare sector serves about 86% of SA’s population with approximately a third less of health expenditure available to them than available to private healthcare [20].

2.5.3.2 Lack of Evidence-based Financing

Public healthcare financing is based on two mechanisms: (1) a geographic distribution formula that accounts for population weighed outside of medical schemes; and (2) a system of conditional grants for earmarked services in tertiary care and professional training. The planning of services rely thus on a bureaucratic system of control that lacks evidence-based knowledge of predicted workload or case-mix. New healthcare financing mechanisms being researched are duly in favour of IT integration that accurately and efficiently uses data in hospitals to determine funding in evidence-based manners. [32]

2.5.3.3 Disproportions in Finance Spending

Lowest per capita spending is reported in rural areas with high rates of poverty - these areas are considered high-risk areas. [33] The disproportions in spending are imperative when discussing funding for a workforce management initiative for nurses in SA. It seems rational to avoid high-risk areas for workforce management initiatives, but it must be viewed as a
challenge to provide equitable healthcare support to all South African nursing staff so that they could better deliver equitable healthcare to all members of SA’s society.

2.5.4 Strained Expenditure

Public hospital expenditure is further constrained by cost- and demand pressures and inefficiencies as per the discussions that follow in this subsection. [32]

2.5.4.1 Cost Pressure

Cost of medicines, equipment and staff have been rising faster than general inflation, reducing the volume of services that can be purchased for the same expenditure.

2.5.4.2 Demand Pressure

Healthcare services demand increase along with population growth, technological improvements and change in overall chronic disease burdens.

2.5.4.3 Inefficiency

Excessively tedious and unsupported administration of services and tasks lead to delays and poor value for money. Where more efficiently managing the nursing workforce, which represent more than 50% of healthcare professionals, would definitely lead to more efficient and effective treatment of diseases.

Tertiary- and Regional hospitals inefficiencies should be addressed first with workforce management initiatives, as they are the most visible and costly operational unit of the SA’s public health system absorbing about 38% of the healthcare budget, and represent an estimated 75% of all healthcare facilities [32].

3 CONCLUSION

Even though nurse scheduling DDSs have the confirmed potential to contribute to the utilization and effectiveness of the nursing workforce, there is still little support toward development of such a workforce management tool in South African government-facilitated hospitals. Methodological, organizational, system support, technological and financial dimensions need to be considered to successfully facilitate nurse scheduling DDSs.

This paper firstly identifies factors that need to be considered for sustainable facilitation of Nurse Scheduling DDSs, and categorised it in methodological, organizational, system support, technological and financial dimensions. Pragmatic research results were ensured by basing the RCA in Chapter 2 on comprehensive resources in the academic community, healthcare and nursing community as well as the workforce management industry that have experience with technical solutions for healthcare staff in both private and public hospitals.

Finally this paper aimed to contribute toward future development of nurse scheduling DDSs in South African public healthcare, and it did so by suggesting resolutions that would increase project facilitation success rates.

Skilled healthcare professionals such as RNs are already so scarce that public healthcare cannot afford not to pay attention to workforce management initiatives, as proposed by this project. If this study raises cognizance amongst important role-players, allied with nursing workforce management in public healthcare, of core concepts and strategies which public healthcare needs to recognize to facilitate sustainable nursing workforce management technology solutions, then it has already succeed in its core purpose.

4 REFERENCES


