Using IROM to Establish Certified Nursing Assistant Dispatching Management Information System: the Hospital's Experience in Taiwan

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Abstract

Background: *The provision of safe, high-quality, and high-satisfaction nursing care is an indicator of whether a hospital's efforts meet its various operation goals other than its mission statement. Because of such phenomena as the growing complexity of diseases, shortages in nursing staff, social changes, and the predominance of dual-income and nuclear families, the demand for nursing assistants (NAs) has increased with time. Currently, most hospital information systems have not yet incorporated a scheme for dispatching and managing NAs; therefore, these tasks are generally still performed manually or semimanually. This lengthens the dispatching process, extends patient waiting times, and decreases satisfaction levels. Although new technologies are considered critical to safer, more efficient, more seamless clinical care, there is a lack of a nursing informatics theory or framework for establishing a nursing care system.*

Method: *This study established a NA dispatching and management system on the basis of the informatics research organizing model (IROM) for a medical center in eastern Taiwan.*

Results: *The end-users of this system could be divided into three sectors: nursing departments, hospital wards, and contracted agencies. The system functions as a medium for contracted agencies to establish and maintain its human resource pool, for ward administrators to submit requests, and for nursing departments to manage the matchup and dispatching of NAs. The hospital's directors could also use the system's various features and back-end management functions to review satisfaction surveys and conduct cost-benefit analyses, which could serve as a basis for negotiating with human resource agencies and upgrade of service quality.*

Discussion: *The system is currently online, but its performance in time-saving, accuracy, and satisfaction will be evaluated in the future. The system is operational in the hospital's Hualian branch, but the Taipei branch has also made inquiries of obtaining a copy of the system and examined the system applicability. Aside from facilitating the sharing of common resources among the hospital's six branches, the system can also be offered to software companies as a technology transfer or for sale to other hospitals. In addition to generating more revenue, this will also solve the problem of message interruptions and miscommunications caused by manpower shortages, thereby improving patient safety and service quality.*

Keywords: *informatics research organizing model, nursing assistant, dispatching and management, information system*

I. Introduction

Because of advancements in medical technology, nursing care, and general awareness of health issues, the morbidity and mortality of many diseases have been markedly reduced. Subsequently, the extended life expectancy has gradually transformed Taiwan into an aging country. Despite the decrease in morbidity and mortality of certain diseases, the additional medical care capacity resulting from such advancements in medicine is soon consumed by numerous idiopathies or diseases of affluence. Internationally, Taiwan's aging rate is second only to Japan, and Taiwan's aged population is expected to reach 14% by 2020 (Huang, Lin, Hsiao, & Chu, 2005). Consequently, the rapidly rising rate of population aging in Taiwan will require established medical models to be modified to cope with the requirements for various diseases.

Dual-income nuclear families are currently the dominant family structure in society in Taiwan, and the conventional nursing care model for extended families is no longer effective. Therefore, hospitalization will cause considerable burden to the families of patients (Huang et al., 2005). Changes in family structure, along with the National Health Insurance (NHI) program's adoption of a global budget system and implementation of the diagnosis-related group (DRG) policy in 2010, have also made hospital operations more difficult. Most hospital operating labor costs are allocated to nursing staff, and any attempt to control such costs will reduce the satisfaction of nursing staff, which will subsequently lead to shortages in nursing manpower (Lee, Wang, Chang,

Huang, & Huang, 2010). To cope with nursing staff shortages and the patient expectations on high-quality treatment, most medical institutions offer hospitalized patients the services of nursing assistants (NAs) through referrals or outsourcing. NAs accompany patients in place of family members and attend to their daily necessities, and provide simple nursing care during hospitalization (Huang et. al., 2005). Worldwide, hospital information systems function as either health information systems or nursing information systems but lack the capability for integrating a NA dispatching function. Therefore, most NA dispatching and management duties continue to be performed manually or semimanually through paper-based documentation, intranet information systems, and telephones. This lengthens the dispatching process, extends patient waiting times, and contributes to managerial negligence. Considering the necessity of nursing care and demand for care services that are more humanitarian, a dispatching and management system is required in order to solve the aforementioned problems. However, most existing systems have been designed without sound planning for related protocols; some have even been designed without a framework or theoretical basis. This can result in system failure. Petter, DeLone, and McLean (2008) indicated that fears about economic conditions and increasing competition create pressure for cutting costs, which requires organizations to measure and examine the benefits and costs of technology. Organizations are interested in knowing the return on such investments. The impacts of IT are often indirect and influenced by human, organizational, and environmental factors; therefore, a system designed upon a framework or theoretical basis can prevent unnecessary resource waste and enhance the success and efficiency of such systems.

II.   Literature Review

NA systems and NA system management

The inception of NAs in Taiwan is described as follows: (1) Both the NHI adoption of the global budget system and the implementation of the DRG policy since 2010 have posed considerable difficulties to the operation of hospitals. Consequently, controlling nursing staff labor costs has become critical because they account for most hospital labor costs. Therefore, hospital directors have sought to modify existing nursing service patterns to improve the cost-effectiveness of hospitals (Lee et al., 2010; Mei, Lee, Liang, Liu, & Huang, 2009). The out comes of organizational reforms on the basis of cost-effectiveness principles were that the nursing noninvasive services or those that were considered basic and routine (e.g., body cleaning, perineal care, turning and repositioning, and chest percussion) were delegated to more cost-effective NAs. (2) The conventional ideal of one or more family members constantly attending to patients is incompatible with the prevailing dual-income nuclear family structure in modern society. Instead, NAs often replace or assist patients' relatives in accompanying and attending to patient, collaborating with nursing staff, and passing messages between patients and their families (Feng et al., 2008). (3) The demand for medical care stems from the increasingly aged population, decrease in mortality rates, and numerous idiopathies or diseases of affluence. Personnel responsible for assisting nursing staff at hospitals or medical institutions in attending to the daily necessities of disabled patients are classified as "nursing assistants", whereas those providing in-home care services to disabled patients are classified as "in-home service providers" (Yang, Chao, 2000). According to the 1993 Regulations Governing the Training and Related Matters of Nursing Assistants in Nursing Institutions proclaimed in Taiwan, nursing personnel performing nontechnical tasks are officially classified as "nursing assistants". Furthermore, according to Article 11, Nursing Institution Establishment Standards, aspiring NAs must undergo 60 hours of academic training and 40 hours of practical training before receiving certification. The purpose of this requirement is to ensure the capabilities of NAs and the quality of services provided (Huang et al., 2005). Evidently, the purpose of NAs is to reduce medical resource wastage, to cope with ongoing demand for medical care, and to enable optimal utilization of the expertise of professional nursing staff.

According to a previous study, "total care" can effectively alleviate the financial burden placed on patients' families and enable them to allocate more time for household affairs. Six months after Taiwan's Tri-Service General Hospital introduced the total care concept, the labor costs of its 22 nurses and 7 NAs was 2.7% lower than before, when 25 nurses were required for the job. Although the ratio of accidents (such as falling, pressure ulcers, and medication errors) did not decline significantly, patient satisfaction levels changed perceptibly (Lee, et al., 2005). However, 52.5% of the nursing staff responsible for acute care considered it an increase in their workload when they were required to communicate with NAs, or when they had to supervise and direct their works. Among these nurses, only 25% were satisfied with the NAs' expertise, and only 35% were satisfied with their performance (Liou, Chang, 2007). According to Lin and Tseng (2005), 70.8% of NAs earned less than NT$25,000 (approximately US$780) per month and their level of overall job satisfaction was merely 68%, whereas their attribute satisfaction measurements were in the descending order of relationship with patients (75%), relationship with colleagues, working conditions (72%), management style of supervisor (70%), and salary (57%). Other studies have also indicated that job satisfaction influences the care service quality, patient satisfaction, and the NAs' willingness to stay in the job (Molyneux, 2011; Sung & Yang, 2006). Therefore, to retain more NAs, institution directors have been advised to conduct system-related enhancements,

such as improving NAs' benefits, organizational climate, and management styles. Recently, Taiwanese medical institutions have adopted two approaches to manage NAs. One is that the institution recruits, trains, and administers its own NAs. The other is that the institution outsources administrative works, and simply relays information on patient needs to a human resource agency, and a suitable candidate is found through the agency's recommendations (Huang et al., 2005). A review of the literature revealed that the information systems used in most hospitals worldwide operate as either a health information system or a nursing information system but lack a management scheme for NAs. The dearth of studies on such systems and their efficiency further signifies the value of the present study.

Brief introduction to the informatics research organizing model

The informatics research organizing model (IROM) was proposed by Effken (2003) to compensate for the lack of theoretical and conceptual frameworks in the study of nursing informatics and to guide researchers in this field. IROM is an abstract concept, which Effken (2003) viewed as a conceptual framework that is insufficient to form a theory. It consists of two components: The outer ring involves the systems research organizing model (SROM), and the inner ring pertains to the system life development cycle (SDLC); accordingly, the two models interact with each other and form a dynamic cycle known as the IROM. The function of the SROM is to identify the problem and alleviate it through evaluating the environment and applying nursing informatics interventions. The course of solving problems through technological means should also be considered. The SROM is composed of four constructs: the client, context, nursing informatics intervention, and outcomes. The four constructs can be briefly defined as follows: (1) The client is not necessarily a real person; it can refer to relevant data, information, structures, behaviors, or characteristics. (2) The context refers to the cultural, economic, social, and physical environment. (3.) Nursing informatics intervention refers to the nursing informatics solution for the client regarding the content, structure, and flow of information as well as the technology used. (4.) Outcomes are information, knowledge, decisions, and actions that improve cost, quality, safety, and satisfaction outcomes related to the client. SDLC is a process model that is represented by the central ring as five phases. Evaluation, sometimes considered the sixth phase, is considered to occur throughout the process (Effken, 2003). The six phases of the SDLC can be defined as follows: (1) The planning phase is aimed at defining the problem and searching for an alternative or solution. (2) In the analysis phase, the source of the problem, available resources, budgets, schedules, decision making (for outsourcing or in-house development), specifications, and contracts are analyzed. (3) The design phase is aimed at establishing work schedules and flow charts, estimating the budget, confirming system specifications, designing the user interface, and determining which programming language should be used. (4) The implementation phase involves finalizing the system design, arranging user training courses, testing the system, and formally launching the system. (5) The maintenance phase focuses on sustaining system operations and increasing the number of users. The sixth phase, evaluation, is aimed at assessing whether the intervention of the system fulfils its purpose, determining the feasibility of upgrading system functions, and determining the specifications for the upgrade. Please refer to Effken (2003) for a framework diagram of the IROM. Although the IROM was originally developed for studying nursing informatics, it could also be used for establishing nursing information systems. For example, Lin, Effken, Li, and Hao (2008) designed a tailored Web-based educational mammography program on the basis of the IROM for groups at high risk of breast cancer. After corrections on the basis of system feedback, Lin and Effken (2010) applied it to conduct research and found that the tailored intervention group had perceptions that were significantly more positive toward mammography and they demonstrated significantly higher intentions to undergo a mammogram than the standard intervention group did after the intervention.

III.   Methods

In line with the concept of the SROM, the following constructs were identified: the semimanual NA dispatching system (client); the hospital and the contract agencies (context); the online NA dispatching system (nursing informatics intervention); and the entire pool of human resources, enhanced dispatching efficiency, more objective NA service indices obtained, and improved caring quality (outcomes). This SROM was applied to the SDLC, and Table 1 presents the deployment of the online NA dispatching and management system.

Table1: rincip. Design Process of the NA Dispatching and Management System Based on the SDLC

SDLC Phase	Goal	Actions Taken
System Planning	Identify the problem and then search for alternatives or solutions	PI and Co-PI analyses revealed that among the most pressing problems faced by the nursing department of a certain hospital in eastern Taiwan, its NA dispatching system was listed as a priority (please refer to Table 2 for the dispatching procedures and problems before the new system was developed). A dispatching system linking the nursing department, intensive care ward, and human resource agency was determined to be necessary.
System Analysis	Analyze the main	1. Submission of existing paper-based documentation by the nursing department

	problem, resources available, budget allocations, and schedule	within 1 month. 2. The hospital's in-house information center was unable to offer timely assistance in the establishment of the system owing to its high workload. A plan was drawn to collaborate with a software company determine system specifications within 2 months. 3. System was to be established within 8 months. 4. System was to be established and finish modification within 1 year. 5. Budget: As an industry-university cooperative project, it was co-funded by the hospital and the university.
System Design	Confirm system specifications, interface design, programming language, and so on.	Functions required by the nursing wards, nursing department, and contract agencies included inputting and outputting information on administration tasks, searches, editing, notifications, and dates. Accordingly, the system requirements were determined as follows: 1. Operation System: Windows 7 2. Development Environment: Microsoft .NET Framework 4.0 3. Programming Language: ASP.NET 4. Database: SQL Server 5. Platform: Internet Explorer, Mozilla Firefox 6. Server: MSSQL server with a database from Accton Technology Corp. 7. System Structure: consists of three major parts (i.e., system server, NA database and dispatching records, NA tracing platform) 8. System server: SQL server and a web interface for data input and tracking the progress of NAs 9. NA tracking platform: a Web-based platform through which the dispatcher, client, and dispatching agency can obtain basic information and track the work progress of NAs. 10. The interface should utilize different fonts for different headings. The background color should be white, and the text should be presented in either black, blue, or red for easier reading.
System Implementation	Complete the system design, arrange user training, test the system, and formally launch the system	1. Five meetings were held to discuss the system functions, test details, and modifications. 2. The system is currently in use.
System Maintenance	Maintain system operation and increase the number of users	1. Compile a user manual for the system 2. Submit the source code to the hospital's in-house information center for future maintenance or expansion
System Evaluation	Evaluate the intervention's success, feasibility of its upgrade, and specifications for the upgrade	1. The system is currently operational, although it is not yet at the evaluation phase. Three end-users agreed in informal inquiries that it facilitates time-efficient communication, satisfactory matching of suitable NAs, and timely feedback on NAs' services by head nurses on duty or head nurses monitoring staff performance. 2. End-users suggested that requests for dispatching could be filed directly by patients or their relatives. The addition of an online patient feedback function was also suggested to enhance the value of feedback. 3. The system is operational in the hospital's Hualian branch, but the Taipei branch has also made inquiries to obtain a copy of the system.

Table2: NA Dispatching Process Before Intervention, Issues Identified Before Intervention, and Corresponding NI Solutions

Step	Process	Issues	NI Solution
1	A patient or patient's relative requiring NA services completes an NA dispatching request form at the nursing station	1. The semimanual operations were conducted through heavy reliance on telephone calls, except for entering the request form into the system and issuing NA performance assessment forms, which are completed online. Communication by telephone can often be delayed because of heavy workloads, engaged telephone lines, inaccessible NAs, inaccessible head nurses on duty during night shifts, or some other reasons. 2. The hospital's intranet was not connected with the contract agency's database, impeding the timely matching of suitable NAs. 3. The performance assessment form dichotomous outcome evaluation as either "satisfactory" or "unsatisfactory" is not an objective assessment of an NA's overall performance. 4. Inability to specifically and	Nurses can log on to the NA dispatching system and file an application through a NA dispatching request form from a patient or a patient's relative.
2	A nurse on duty enters the request from the information system and submits it to the head nurse in charge of the ward.		
3	A clerk in the nursing department receives the application from the information system and then contacts a human resource agency through telephone (there were three agencies contracted with the hospital.)		A clerk in the nursing department locates a suitable NA and notifies the head nurse of the ward through the NA dispatching system. Nurses in the ward are also granted access to the system to check the application progress.
4	A clerk from the nursing department enters information obtained over the telephone into the information system and sends an email notifying the applicant.		
5	The NA reports to the ward leader or head nurse of the ward. For night shifts, the NA reports to the head nurse on duty.		After the NA sets out for the hospital from the contract agency, the system registers this activity and enables the hospital nursing

6	The nursing department clerk logs on to the information system and sends an NA performance assessment form.	objectively evaluate the shortcomings of each step of the process for developing an improvement strategy.	department and relevant ward to verify the NA's information and progress.
7	The ward's head nurse evaluates the NA's performance as either "satisfactory" or "unsatisfactory" at the end of the NA's shift.		A new assessment form with a 5-point Likert scale and text-based evaluation was created. The head nurse of the ward can log on to the system and complete the form. This combines both qualitative and quantitative methods.
8	Performance assessment forms are collected at the end of each month as a reference to determine whether employment of the NA should continue, and to calculate performance bonuses.		The time interval of performance assessments can be customized.

IV.   Conclusion and Discussion

Constructed on the basis of the IROM framework, the proposed system enables human resource agencies to establish and maintain a manpower database, enables hospital wards to file applications and performance assessments, and enables nursing departments to recruit suitable candidates. In addition to the dispatching of personnel, the system also offers a performance assessment form that provides a 5-point Likert scale and text-based columns for feedback, thus facilitating a more accurate evaluation of NA performance. Specifically, nursing departments can use the propose system to assess the performance of individual NAs or NAs in a ward during a certain period, solving problems related to dispatching, supervising, and assessing NAs for the nursing department, ward, and human resource agency. Multiple tests were conducted for system aspects such as the font size and color (e.g., adjusting the font size and color for the request form and the assessment form), the user interface (e.g., adjusting the format of the interface according to the requirements of different users), and the modification of various features (e.g., changing the status of abnormal events from "deleted" to "solved," inquiring about of an NAs dispatch status, and monitoring an NA's performance during different ward shifts). Suggestions were also accepted and implemented to render the system more user-friendly. Through its systematic features and backend management, the dispatching and management of NAs are expected to become more effective. Moreover, available manpower and patient feedback may facilitate improving care services. Currently, the system is operational in the hospital's Hualian branch, but the Taipei branch has also inquired about implementing the system. In addition to facilitating the sharing of common resources among the hospital's six branches, the system can also be offered to software companies as a technology transfer or sold to other hospitals. Aside from generating additional revenue, the system can also solve the problem of message interruption and miscommunication resulting from a lack of manpower, thereby enhancing patient safety and service quality.

Acknowledgment

References

[1]. Effken, J. A. (2003). An Organizing Framework for Nursing Informatics Research. *CIN: Computers, Informatics, Nursing, 21*(6), 316-325.

[2]. Feng, R. C., Sang, Y. Y., Chang, W. C., Chen, M. M., Chou, S. O., & Yin, J. C. (2008). Establishment and evaluation of the skill-mix model in a medical center. *VGH Nursing, 25*(3), 249-258.

[3]. Huang H. L., Lin, I. C., Hsiao,S. J. , & Chu, T. P (2005). The Establishment and Evaluation of Certified Nursing Assistants Dispatching Management Information System: Case Study of One Hospital. *The Journal of Taiwan Association for Medical Informatics, 14*(3), 33-44.

[4]. Lee, S. F., Wang, W. F., Chang, Y. Y., Huang, W. J., & Huang, M. C. (2010). The Working Experiences of Nurse Aides in a Medical Center That Employs a Nursing Skill Mix Model. *Journal of Nursing and Healthcare Research. 6*(4), 1-8.

[5]. Liou, Y. F., & Chang, B. Y. (2007). Exploring the impact of the skill mix model on clinical care from nurses' perspectives. *Chang Gung Nursing, 18*(4), 487-498.498.

[6]. Lin, C. C., & Tseng, M. Y. (2005). A survey of job satisfaction and its related factors among nurse aides. *The Journal of Long-Term Care, 9*(4), 349－360.

[7]. Lin, Z.C., Effken, J. A., Li, Y. J., & Ho, C. H. (2008). Designing a Tailored Web-Based Educational Mammography Program. *CIN: Computers, Informatics, Nursing, 29*(1), 16-23.

[8]. Lin,Z. C. & Effken, J. A. (2010). Effects of a tailored web-based educational intervention on women's perceptions of and intentions to obtain mammography. *Journal of Clinical Nursing. 19*(9-10), 1261-1269. Doi: 10.1111/j.1365-2702.2009.03180.x. Epub 2010 Mar 16.

[9]. Mei, T. T., Lee, J. L., Liang, Y. W., Liu, L. F., & Huang, L. C. (2009). Exploring the current state and progress of the skill-mixed model in Taiwan. *The Journal of Nursing, 56*(3), 66－71.

[10].   Molyneux, J. (2011). Nurses' Job Satisfaction Linked to Patient Satisfaction. *American Journal of Nursing. 11* (5), 16. Doi: 10.1097/01.NAJ.0000398037.25162.fb
[11].   Petter, S. DeLone,W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European Journal of Information Systems. 17*(3), 236-263. Doi: 10.1057/ejis.2008.15
[12].   Sun, P. L., & Yang, S. M. (2006). A comparative study on the satisfaction of nurse aides for 2 years in a medical center hospital. *VGH Nursing, 23*(4), 340-347.
[13].   Yang, L. C., & Chao, S. Y. (2000). An investigation into the characteristics and working environment of nurse aides in various medical institutions in Taiwan. *The Journal of Nursing, 47* (4), 22-30.