Effects of Implementing a Barcode Information Management System on Operating Room Staff: Comparative Study

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Abstract

Background: Barcode information management systems (BIMS) have been used in operating rooms to improve the quality of medical care and administrative efficiency. Previous research has demonstrated that the agile development model is widely used in information system development and management. However, the effect of information systems on staff acceptance has not been studied in clinical medical information management systems.

Objective: This study explored the effects and acceptance of applying a BIMS compared with the original information system (OIS) among operating room staff.

Methods: Eighty operating room and supply room staff members of a medical center were recruited. A mobile-based structured questionnaire, including participant characteristics and the information management system scale (IMSS), was used to collect data from January to August 2020.

Results: The results showed that the BIMS had a higher overall quality score than the OIS (103.78±17.15 vs. 102.23±19.83). Significant differences in rapid data reading ($p < 0.05$) and usefulness ($p < 0.05$) were observed between the BIMS and OIS.

Conclusions: Health information technology systems must be available, efficient, effective, and compatible with the user's past experiences, needs, and educational level for high usage motivation. BIMS can be applied to operating and supplying rooms to improve the quality of medical care and administrative efficiency.

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Effects of Implementing a Barcode Information Management System on Operating Room Staff: Comparative Study

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Effects of Implementing a Barcode Information Management System on Operating Room Staff: Comparative Study

Abstract

Background: Barcode information management systems (BIMS) have been implemented in operating rooms to improve the quality of medical care and administrative efficiency. Previous research has demonstrated that the agile development model is extensively utilized in the development and management of information system. However, the effect of information systems on staff acceptance has not been examined within the context of clinical medical information management systems.

Objective: This study explored the effects and acceptance of implementing a BIMS in comparison to the original information system (OIS) among operating and supply room staff.

Method: This study was a comparative cohort design. Eighty staff members from the operating and supply rooms of a medical center were recruited. Data collection, conducted from January to August 2020 using a mobile-based structured questionnaire, included participant characteristics and the Information Management System Scale (IMSS). SPSS version 20.0 for Windows was used for data analysis. Descriptive statistics included mean, standard deviation, frequency and percentage. Differences between groups were analyzed using the Mann–Whitney U test and Kruskal–Wallis test, with a p-value of less than 0.05 considered statistically significant.

Results: The results indicated that the BIMS generally achieved higher scores in key elements of system success, system quality, information quality, perceived system use, perceived ease of use, perceived usefulness, and overall quality score, none of these differences were statistically significant ($p > 0.05$), with the system quality subscale being closest to significance ($p = 0.055$). Nurses showed significantly better perceived system use than technicians (1.58 ± 4.78 vs -1.19 ± 6.24, $p = 0.021$). Significant differences in perceived usefulness were found based on educational level ($p = 0.037$) and experience with OIS ($p = 0.030$), with junior college-educated nurses and those with over six years of OIS experience reporting the highest perceived usefulness.

Conclusions: The study demonstrates that using the agile development model for BIMS is advantageous for clinical environments. The high acceptance among operating room staff underscores its practicality and broader adoption potential. It advocates for continued exploration of technology-driven solutions to enhance healthcare delivery and optimize clinical workflows.

KEYWORDS

Barcode information management system; Barcode; Information system; Operation management information system

Introduction

The implementation of Barcode Information Management Systems (BIMS) in clinical practice is widely recognized for enhancing healthcare quality and safety [1]. BIMS replace manual processes, thereby improving efficiency, quality management, and reducing costs [2]. They are utilized for patient identification, medication administration, and specimen transportation, contributing to reduced nursing turnover and increased patient satisfaction [3-5]. As healthcare quality becomes more important, organizations are upgrading management practices.

Despite the initial costs and potential staff resistance, technologies such as barcodes have demonstrated significant improvements in hospital services [6]. Health information technology (HIT) is significant for effectively managing and improving medical care quality, reducing costs, and addressing various challenges. HIT encompasses a range of technologies used to manage health information, including electronic health records (EHRs), clinical decision support systems (CDSS), and BIMS [7, 8] Effective HIT systems ensure that different technologies can communicate and share data seamlessly, which is critical for coordinated and efficient care [9, 10] However, challenges associated with HIT include cost, interoperability, privacy and security, data quality, and workflow integration [7, 8].

The advantages of HIT are well-documented, including the ease of reading and interpreting physiological values, reduced time for completing electronic records, and decreased errors in drug administration, blood drawing, and specimen transportation. Consequently, HIT can improve patient safety, enhance nursing efficiency, and increase both nurse and patient satisfaction [3, 4, 11]. A Previous study has shown that barcode systems can reduce surgical instrument packaging time and costs [12], and further research has demonstrated that HIT advances safety and quality of surgical care, reduces staff stress, and enhances service quality [3, 13].

Operating rooms are high-cost, high-skill units where complex and critical issues can significantly impact patient safety. It is essential for operating room nurses to maintain a positive view of patient care, ensure the physical safety of patients, and consider patient vulnerabilities [14]. The quality and efficiency of services in operating rooms are of paramount concern, as surgeries are invasive procedures that require stringent sterilization of medical equipment to prevent nosocomial infections. Such infections can seriously compromise patient safety, prolong hospitalization, and increase medical costs, thereby affecting a hospital's reputation [11]. The National Healthcare Safety Network [15] reported that surgical site infections (SSIs) are the costliest healthcare-associated infections, accounting for 20% of such infections and increasing the risk of death significantly. Improving surgical safety is one of Taiwan's patient safety goals, aimed at enhancing high-quality medical care and avoiding unnecessary patient harm [16].

In the software industry, agile methods are widely adopted for efficient product and service development [17]. Agile Software Development (ASD) has become the primary approach for managing information systems implementation, which is crucial for modern digital health software. ASD facilitates customer feedback and revisions, emphasizing teamwork and collective decision-making in cross-functional teams [18, 19]. The agile transition process (ATP) can be modified to adapt to the original standard process but may face challenges primarily due to human factors [19, 20]. Issues such as a lack of understanding of the development model, direct implementation without comprehension, adherence to familiar practices, and disagreement with development values can lead to resistance and a failure to consider the entire process [19].

The relationship between BIMS, HIT, and ASD is interconnected, with each component playing a crucial role in modernizing and optimizing healthcare delivery. BIMS, as a part of HIT, relies on the robust infrastructure provided by HIT systems to ensure seamless integration and effective data utilization [21, 22]. ASD supports the development and refinement of BIMS by emphasizing flexibility, user feedback, and iterative improvements, ensuring that BIMS solutions are continuously optimized based on real-world usage and feedback from healthcare staff [23]. Effective assessment is crucial when using ASD in operational engineering, as it helps identify team issues and facilitates improvements to enhance user experience. In the context of surgery, information systems manage logistics and materials, involving various professionals such as nurses and technicians. Therefore, this study explores the effects of implementing ASD with BIMS on operating room staff, providing insights into operational management and the comparative impact on staff experiences and efficiencies.

Methods

Study design, setting, and participants

This study employs a comparative cohort design to evaluate the effects of implementing a BIMS on operating room staff, including nurses and technicians. The study was conducted between January 2020 and October 2020.

Participants were recruited from the operating and supply rooms of a medical center in northern Taiwan. A total of 126 staff members, including nurses and technicians responsible for handling sterile device materials or packaging and checking expiration dates, were eligible to participate. Therefore, a census approach was used for this group. Ultimately, 80 staff members, comprising 48 nurses and 32 technicians, agreed to participate and were included in the analysis.

Operation management information system

In surgical procedures, various clinical personnel collaborate to ensure seamless operations. The supply room, a vital medical logistics unit, manages the cleaning, packaging, sterilization, storage, and supply of medical devices, including expiration date management. Staffed by nurses and technicians, this unit ensures adherence to infection control principles for patient safety and efficient surgical procedures. The introduction of original information system (OIS) and BIMS was as follows:

Original information system (OIS)

Under the OIS, the outpatient and emergency information systems are not connected to the surgical information system, requiring doctors to manually enter the surgical schedule repeatedly. The day before surgery, an operating room nurse selects the surgery case cart, specialized equipment, and packaging based on the surgery requirements. When additional packages, specialized tools, equipment, or materials are needed during surgery, nurses must select items and quantities in the original system or generate a handwritten list. They then confirm the material dynamics of temporary selections with the supply room by phone. The lack of immediate access to packaging sterilization information and inventory levels necessitates the estimation of item locations and sterilization processes through paper records, resulting in significant time spent tracking for the supply room.

Barcode information management system (BIMS)

The BIMS significantly enhances these operations. A doctor imports the surgery schedule and selects the specialist package and unique device identification (UDI) system final rule. The day before surgery, an operating room nurse confirms the patient's case cart, special package, and required materials. During surgery, if additional packages or specialized tools are needed, nurses use BIMS to select the necessary items and quantities. Technicians then receive urgent messages from BIMS, acquire the supplies, and deliver them to the operating room.

BIMS streamlines communication and tracking, allowing nurses to monitor material processing status conveniently without needing to write application forms or confirm over the phone. It provides detailed information about sterilization equipment and the usage history of sterilized packages, enabling instant tracking of item locations and sterilization processes, along with managing package validity periods. This eliminates the need for phone confirmation with the supply room. If a system warning indicates insufficient supply allocation and the technician cannot resolve it directly, it is reported back to nurses. They use the system to understand device status dynamics and coordinate the process with the clinician.

Nurses oversee sterilization quality control, communicate with clinical units, and guide technical staff. They coordinate staff, manage instruments, handle supply alerts, assist in surgeries, provide patient care, and ensure the sterilization of equipment. Technicians are responsible for cleaning, packaging, sterilizing, and supplying instruments. This collaboration, facilitated by BIMS, is crucial for maintaining efficient and safe surgical procedures. Table 1 describes the comparison between OIS and BIMS in the surgical procedure.

Measurements

Characteristics of participants

The characteristics of the participants included the following variables: identity, sex, age [categorized into three groups: young (19–34 years), early middle-aged (35–49 years), and late middle-aged adults (50–65 years) [24], educational level (below senior high school, specialist, junior college), working years, and experience using the original system.

Information management system scale (IMSS)

The information management system scale (IMSS) developed by Chiang & Lee (2018) was used to evaluate the effectiveness of the nursing staff information system [25]. The IMSS comprises 28 questions divided into three main parts:

The "key elements of system success" section includes two subscales: **system quality**, with seven questions focusing on screen simplicity, data classification, reading speed, response time, screen transition, function availability, and patient care information integration; and **information quality**, with seven questions on team communication efficiency, time savings, information accuracy, and display quality.

The "perceived system use" section also has two subscales**: perceived ease of use**, with five questions on system operation, use, proficiency attainment, and the system's significance in improving clinical work efficiency and team connectivity; and **perceived usefulness**, with five questions on the system's convenience in clinical work, control of patient conditions, work quality improvement, procedure simplification, and usefulness of patient information.

The "attitude toward system use" section includes four questions assessing the information system as a valuable tool for the medical team and its role in improving care quality.

A Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used, with higher scores indicating greater satisfaction, efficiency improvement, and positive attitudes. The scale was tested with 185 nurses, achieving an overall Cronbach's α of 0.973, with subscale α values between 0.897 and 0.920 [25]. This study invited an information supervisor, an information engineer, and a senior nurse to validate the assessments on a scale of 1 to 5 for correctness, suitability, and completeness of the questionnaire contents, resulting in a content validity index (CVI) of 0.94. We recruited 80 participants for this study, achieving an overall Cronbach's α of 0.984, with each subscale having a Cronbach's α ranging from 0.925 to 0.969, indicating high reliability and validity.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 20 software for Windows was used to analyze the data. Continuous variables were presented as mean and standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Mann–Whitney U and Kruskal–Wallis tests were employed for univariate analysis to compare differences in participants' data. A p-value of less than 0.05 was considered statistically significant.

Study procedure and ethical statement

This study was approved by the Institutional Review Board of Tri-Services General Hospital (No. C202005035). The purpose of the study was explained by the same researcher to the operating room and supply room staff of a medical center in northern Taiwan during morning meetings. Out of 126 eligible participants, 80 agreed to participate in the study. Data was collected both before (using OIS) and after the implementation of the BIMS. Baseline data was collected in January 2020, and post-implementation data were collected in September 2020. This approach allowed for a comprehensive comparison of the effects of BIMS on the operating and supply room staff, including nurses and technicians. The details were shown in Fig. 2.

Results

Characteristics of participants

Eighty staff members from the operating and supply rooms participated in the study, comprising 42 nurses (60%) and 38 technicians (40%). The mean age of the participants was 47.1±10.4 years. Most participants were female (80.0%), and had a bachelor's degree or above (42.6%). Additionally, 46.2% had over 21 years of service experience, and 71.2% had more than 6 years of experience using the OIS. Table 2 presents these details.

Difference between OIS and BIMS in Information Management System Scale Scores

The results, as presented in Table 3, show that the BIMS generally achieved higher scores compared to the OIS across various metrics. While BIMS showed improvements in key elements of system success, system quality, information quality, perceived system use, perceived ease of use, perceived usefulness, and overall quality score, none of these differences were statistically significant ($p > 0.05$). The closest to significance was the system quality subscale ($p = 0.055$). Attitudes towards system use were similarly positive for both systems. Overall, BIMS demonstrated a trend towards better performance, but without significant statistical differences from OIS.

Difference between OIS and BIMS according to participant characteristics, key elements of system success, perceived system use, and attitude toward system use

The difference between the OIS and BIMS was calculated by deducting the OIS score from the BIMS score across various participant characteristics and key elements of system success, perceived system use, and attitudes toward system use among 80 participants. A positive difference indicates a better information management system using BIMS. Significant differences were observed in participant identity and perceived system use, with nurses showing better perceived system use than technicians (1.58 ± 4.78 vs -1.19 ± 6.24, $p = 0.021$). No statistically significant differences were observed in gender, age, educational level, length of service, or experience in using an OIS ($p > 0.05$). Table 4 lists these details.

Table 5 showed the differences between the BIMS and OIS scores according to participant characteristics and the two subscales, perceived ease of use and perceived usefulness, of the perceived system use were also investigated. The results revealed significant differences between the participant identity and perceived usefulness. Nurses had better perceived the system usefulness than technicians (0.85±2.46 vs -0.63±3.39, $p = 0.033$). No statistically significant differences were observed in the demographics, perceived ease of use, and perceived usefulness ($p > 0.05$).

Table 6 lists the differences in participant characteristics and perceived usefulness between nurses and technicians using BIMS and OIS. The results showed significant differences in perceived usefulness based on educational level ($p = 0.037$) and experience in using the OIS ($p = 0.030$). Junior college-educated nurses reported the highest perceived usefulness. Additionally, nurses with more than 6 years of experience using the OIS reported higher perceived usefulness compared to technicians.

Discussion

This study utilized an ASD information framework to manage the implementation of a BIMS for operating and supply room staff, focusing on the management of surgical packages. While there was no statistically significant difference in the IMSS scores between the OIS and BIMS, the overall IMSS quality score of the BIMS was higher than that of OIS. The results demonstrated that 71.2% of the participants had a substantial length of service and over 6 years of experience using the OIS. Previous research has shown that information systems with user-friendly interfaces and ease of operation are advantageous. These benefits should facilitate acceptance by staff in the working environment [26].

This study provided valuable insights into whether nurses perceived system use better than technicians. The findings revealed that nurses indeed had a better perception of system use compared to technicians. Previous research has indicated that agile transformation is user-based, with attitudes, norms, and self-efficacy being key determinants of intention and healthy behavior [19, 27]. These factors are primary concerns in people's perceptions of agile transformation. Interventions based on self-determination theory in health settings have been shown to effectively promote the adoption and maintenance of health-related behaviors [28]. Nurses' better perception of system use compared to technicians can be attributed to their extensive experience, with most nurses in this study having over 20 years of service. Additionally, the BIMS is user-friendly, with simplified operations and improved work efficiency. The system's traceability management of equipment packages also contributed to a stronger sense of identity in clinical care. This enhanced the willingness to use BIMS and encouraged proactive suggestions for system improvements to better meet actual demands.

Regarding perceived usefulness, the subgroup analysis between nurses and technicians showed that educational level and experience using an OIS were statistically significant factors. Effective software development must consider perceived system usefulness to motivate usage [29]. Therefore, the system should align with users' past experiences, needs, and educational levels to improve outcomes. Operating and supply room nurses are responsible for directing and supervising technicians in performing various sterilization techniques. Nurses involved in developing a surgical BIMS considered standard operating procedures and clinical practice experience. Given that most staff in this study had over 20 years of service and were accustomed to the daily workflow, it was challenging for information engineers to modify the information program immediately during work changes, causing staff pressure. Health Information Technology (HIT) should improve efficiency and operator satisfaction by aligning workflow and equipment at a reasonable cost [30].

The use of information technology in medical material management significantly reduces staff workload. Acceptance of this technology is influenced by software and hardware availability, user age, and education level. Younger users, with better information skills due to recent education and widespread technology exposure, tend to be more accepting [31, 32]. However, insufficient training, concerns about system security, and interdepartmental communication pressures can hinder usage. Additionally, changes in workflow, competition for computer access, and extra time required to handle information can reduce interpersonal interactions, further obstructing implementation [32, 33]. In the supply room, nurses and technicians collaboratively manage logistics and medical materials. Nurses are responsible for education, guidance, and quality control to ensure the safety of medical materials for patients. BIMS operational functions vary by authority level, with nurses using their system privileges to monitor instrument flow and supply levels, coordinating with clinical processes to enhance recognition and support of clinical care. Literature highlights the importance of defining human-machine collaboration, interactive empowerment, and a digital ecosystem [34]. A strategic management approach to digital quality management, guided by principles of humanistic care, is essential. Continuous development of digital technologies aims to achieve optimal care quality [34, 35]. Nursing managers, who also serve as educators, communicators, and supervisors, facilitated the smooth implementation of agile transition processes through continuous team discussions, workflow adjustments, and ongoing staff education and training.

Limitations and recommendations

This study had several limitations. First, a self-reported structured questionnaire was used to measure the effectiveness of the information system. Second, participants were recruited from the operating and supply rooms of a single medical center. Finally, the completion rate was 63%. Based on these limitations, the following recommendations are presented: First, objective instruments should be used to measure the effectiveness of the information system, and qualitative interviews can be conducted to better understand user experience. Second, participants from multiple institutions should be recruited to enhance the external validity of the findings. Third, various strategies should be implemented to increase the completion rates of surveys and questionnaires. Finally, while this study collected quantitative data from nurses and technicians, it is recommended to gather qualitative data in a subsequent phase to validate and complement these findings.

Conclusions

This study developed a BIMS to replace handwritten information with barcode data. A traceability information management system was established for surgical instruments and packages, facilitating cooperation among the operating room, supply room, software information, and infection control teams to formulate information-based operating specifications. The study reexamined and refined the agile transformation process through inter-team communication. Additionally, staff education was emphasized to enhance the acceptability and efficiency of BIMS.

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Ethics approval and Funding

This study was approved by the Institutional Review Board of Tri-Services General Hospital (No. C202005035).

Author statement

Chia Yen Li: Conceptualization; Methodology; data curation; formal analysis; investigation; writing original draft. Mei Hui Huang: Conceptualization; methodology; data curation. Yu Shiue Lin: methodology; data curation. Chi Ming Chu: Conceptualization; data curation; writing–original draft preparation. Hsueh Hsing Pan: Conceptualization; methodology; data curation; writing original draft preparation.

Summary Table

Problem: For improved patient safety and effectiveness, the availability of a is essential. However, there is currently no standardized method for evaluating its implementation and impact.

What is Already Known: Barcode information management systems (BIMS) enhance healthcare quality and safety, improve efficiency, reduce costs, and increase patient satisfaction.

What This Paper Adds: This study compared the OIS and the BIMS in terms of key elements of system success, perceived of system use and attitudes of system use. The results provide evaluators with evidence that BIMS is more efficient in reading data quickly and is more useful compared to OIS.

Conflicts of Interest

None declared.

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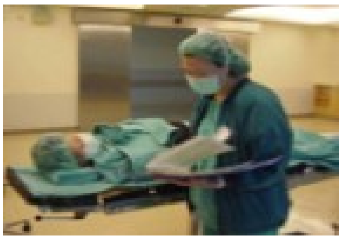
Table 1. Comparation between original information system and barcode information management system

Original information system (OIS)	Operating Room and Supply Room Procedures	Barcode information management system (BIMS)
Outpatient Information System and Emergency Information System must **repeat import** of surgical schedules		Integrating Outpatient Information System and Emergency Information System
1.Patient identification through medical records, patient wristbands, and patient confirmation.  **2.Material, package, case car information** unable to manage inventory, needs constant confirmation.  **3.Medical records** and records of sterilized items are both handled in **paper format.** 		**1.Patient identification** using medical records, patient wristbands, and patient confirmation, **assisted by barcode information.**  **2.** Material, package, and case car are **all** managed through information **technology.**  3.Both **medical records** and records of sterilized items are managed **digitally**. 
1.Difficult to manage. 2.Consumes manpower and time.		1.Real-time. 2.Digital Reporting.

Surgery
1.Patient identification
2.Material & package & case car (application / shipped / acceptance)
3. Medical records

Physician enters surgery schedule

Eligibility assessment (n=126)

After surgery
1.Shift change
2.Statistical analysis

Fig. 2. Flow chart of study population.

Table 2. Characteristics of participants (N=80).

Variable	mean ± SD	n（%）
Identity		
Nurse		48(60.0)
Technician		32(40.0)
Gender		
Male		16(20.0)
Female		64(80.0)
Age	47.1±10.4	
Young adults (19-34 years)		8(10.0)
Early middle-aged adults (35-49 years)		39(48.8)
Late middle-aged adults (50-65 years)		33(41.2)
Educational level		
Below senior high school		24(30.0)
Junior college		22(27.5)
Bachelor and above		34(42.6)
Length of service year	18.3±11.9	
<10 years		25(31.2)
10-20 years		18(22.5)
>20 years		37(46.2)
Experience of using original information system		
<3 years		19(23.8)
3-6 years		4(5.0)
>6 years		57(71.2)

Table 3. Comparison of OIS and BIMS Information Management System Scale Scores (N = 80).

Variable (item)	OIS Total Mean ±SD	OIS Average Mean ±SD	BIMS Total Mean ±SD	BIMS Average Mean ±SD	z	*p*
Informational Management System Scale						
Key elements of system success	48.51±9.96	3.46±0.71	49.88±8.55	3.56±0.61	-1.38	0.166
System quality (7)	24.13±4.78	3.45±0.68	25.01±4.11	3.57±0.58	-1.92	0.055
Information quality (7)	24.37±5.38	3.48±0.77	24.87±4.57	3.55±0.65	-0.81	0.420
Perceived system use	35.46±7.11	3.54±0.71	35.94±5.76	3.59±0.57	-0.79	0.425
Perceived ease of use (5)	17.71±3.69	3.54±0.73	17.93±3.04	3.58±0.60	-0.58	0.561
Perceived usefulness (5)	17.75±3.63	3.46±0.71	18.02±2.91	3.60±0.58	-0.81	0.420
Attitudes of system use (4)	18.25±3.74	4.56±0.94	17.96±3.42	4.49±0.86	-0.58	0.559
Overall quality score	102.23±19.83	3.65±0.71	103.78±17.15	3.71±0.61	-0.85	0.394

Data are shown as means ± standard deviations. SD: standardized deviation

OIS: Original information system

BIMS: Barcode information management system

Table 4. Comparison of OIS and BIMS scores for participant characteristics and key elements of system success, perceived system use, and attitude toward system use (N=80).

Variable	Key elements of system success		Perceived of system use		Attitudes of system use	
	Difference between OIS and BIMS					
	Mean ± SD	*p*	Mean ± SD	*p*	Mean ± SD	*p*
Identity		0.140 [a]		**0.021** [a]		0.188 [a]
Nurse	2.27±7.04		1.58±4.78		0.12±2.92	
Technician	0.03±9.98		-1.19±6.24		-0.91±4.11	
Gender		0.473 [a]		0.530 [a]		0.256 [a]
Male	-0.19±8.26		-1.00±6.25		-1.31±4.09	
Female	1.77±8.39		0.84±5.34		-0.03±3.27	
Age		0.710 [b]		0.299 [b]		0.901 [b]
Young adults	2.75±68.6		1.75±4.13		0.13±2.17	
Early middle-aged adults	1.69±7.30		0.89±5.56		-0.62±3.64	
Late middle-aged adults	0.67±9.87		-0.33±5.85		0.00±3.54	
Educational level		0.827 [b]		0.237 [b]		0.273 [b]
Below senior high school	1.29±10.88		-0.75±6.64		-0.71±4.53	
Junior college	2.23±6.99		1.82±4.56		0.50±2.81	
Bachelor and above	0.88±7.26		0.47±5.24		-0.50±2.97	
Length of service year		0.547 [b]		0.241 [b]		0.180 [b]
<10 years	-0.16±6.99		-1.12±5.53		-1.36±3.43	
10-20 years	1.44±8.35		1.59±5.62		-0.26±3.32	
>20 years	2.68±9.46		0.82±5.36		0.64±3.46	
Experience of using original information system		0.425 [b]		0.109 [b]		0.158 [b]
<3 years	-0.58±7.51		-1.63±5.91		-1.68±3.59	
3-6 years	-1.00±2.94		-1.50±2.38		-1.25±2.62	
>6 years	2.19±8.80		1.32±5.42		0.24±3.37	

SD: standardized deviation. OIS: Original information system. BIMS: Barcode information management system.

[a]Mann–Whitney U test; [b]Kruskal–Wallis test

Table 5. Comparison of OIS and BIMS scores for participant characteristics and perceived system use, including perceived ease of use and perceived usefulness (N=80).

Variable	Perceived of system use			
	Perceived ease of use		Perceived usefulness	
	Mean ± SD	*p*	Mean ± SD	*p*
Identity		0.093 [a]		**0.033 [a]**
Nurse	0.73±2.84		0.85±2.46	
Technician	-0.56±3.32		-0.63±3.39	
Gender		0.995 [a]		0.452 [a]
Male	-0.18±3.51		-0.81±3.27	
Female	0.31±2.99		0.53±2.82	
Age (year)		0.340 [b]		0.405 [b]
Young adults	0.87±2.99		0.87±1.45	
Early middle-aged adults	0.54±3.01		0.36±3.05	
Late middle-aged adults	-0.33±3.21		0.00±3.11	
Educational level		0.667 [b]		0.075 [b]
Below senior high school	-0.33±3.53		-0.42±3.59	
Junior college	0.50±2.81		1.31±2.15	
Bachelor and above	0.41±2.97		0.06±2.76	
Length of service year		0.392 [b]		0.355 [b]
<10 years	-0.48±3.20		-0.64±2.87	
10-20 years	1.07±2.97		0.52±3.03	
>20 years	0.00±3.01		0.82±2.83	
Experience of using original information system		0.286 [b]		0.120 [b]
<3 years	-0.57±3.33		-1.05±3.08	
3-6 years	-1.50±2.38		0.00±0.00	
>6 years	0.59±2.99		0.72±2.89	

SD: standardized deviation. OIS: Original information system. BIMS: Barcode information management system.

[a]Mann–Whitney U test; [b]Kruskal–Wallis test

Table 6. Comparison of participant characteristics and perceived usefulness between nurses and technicians (N=80).

Variable	Perceived usefulness		
	Nurse (n=48)	Technician (n=32)	
	Mean ± SD	Mean ± SD	*p*
Gender			0.076 [a]
Male	0.00±0.00	-0.87±3.37	
Female	0.87±2.48	-0.41±3.50	
Age (year)			0.083 [b]
Young adults	1.00±1.67	0.50±0.71	
Early middle-aged adults	1.04±2.69	-1.17±3.35	
Late middle-aged adults	0.47±2.36	-0.39±3.64	
Educational level			**0.037** [b]
Below senior high school	-0.50±2.12	-0.41±3.73	
Junior college	1.71±2.23	0.00±1.22	
Bachelor and above	0.45±2.53	-2.20±3.27	
Length of service year			0.054 [b]
<10 years	0.85±1.57	-1.22±3.08	
10-20 years	0.58±2.76	0.37±3.81	
>20 years	1.09±2.48	-0.16±3.97	
Experience of using original information system			**0.030** [b]
<3 years	0.40±0.89	-1.57±3.43	
3-6 years	0.00±0.00	0.00±0.00	
>6 years	0.90±2.58	0.14±3.73	

OIS: Original information system. BIMS: Barcode information management system.
SD: standardized deviation.
[a]Mann–Whitney U test; [b]Kruskal–Wallis test

Supplementary Files