Embedded Selforganizing Systems

A Role of Training in The Successful Implementation of Hospital Information Systems

Oyuntungalag Buyantur

Department of Business Administration, Graduate School of Business
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
oyuntungalag@must.edu.mn

Sumjidmaa Tumurchudur
Department of Technology Management, School of Business Administration and Humanities
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
sumjidmaa@must.edu.mn

Munkhzul Ochirbat

Information Technology Department
Mongolia Japan Hospital
Ulaanbaatar, Mongolia
bzulaa@gmail.com

Zaya Mashlai
Department of Technology Management, School of Business Administration and Humanities
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
zaya@must.edu.mn

Abstract— **The adoption of HIS has many benefits including reduced waiting time, errors, less paperwork and errors, and easy data retrieval and reporting. The research aims to define whether the training provided by the IT department has an effect on the successful implementation of HIS at the hospital. System and information qualities were significantly associated with the benefit of HIS. Data taken from 296 hospital employees of Mongolian Japan Hospital is used to assess the effect of the implementation of HIS on-employee satisfaction and individual benefit. Training had a mediating role in enhancing the effects of system and information quality effects on net benefits perceived by employees. Assessing individual training results may lead to the effective administration of training at the hospitals.**

Keywords— training, HIS, information quality, system quality, individual benefit.

I. INTRODUCTION

With the evolution of information technology Hospitals have been adopting hospital information systems (HIS). A variety of categories of HIS are utilized, for instance, Clinical decision support systems (DSSs) to enhance the quality of decisions by managers and physicians; Electronic Data Interchange to fasten admission/discharge/transfer of patients; Knowledge Management Systems (KMS) to support financial and marketing activities; and Picture Archiving and Communication System to archive and transfer images.

This study aims to evaluate the performance of IS in public hospitals based on the Delone and Mclean IS success Model and the Technology Acceptance Model. The DeLone and McLean IS Success Model [1] recommends six distinct factors, predicting the success of IS, System Quality,

Information Quality, Service Quality, Intention to Use, User Satisfaction, and Net Benefits [2, 3]. TAM model advocates promote Ease of Use and the Usefulness of the system as determinants of effective use of the system. Several previous studies have utilized both models in the evaluation of HIS and the results were different. For instance, Van Der Meijden et al. [4] and Park et al. [5] examined a variety of HISs of different medical organizations and found that both System Quality and Information Quality significantly influenced User Satisfaction. Pai and Huang [6] examined the influence of three quality determinants of HIS, system, information, and service, on user satisfaction through the mediating factors (perceived ease of use and perceived usefulness) by utilizing path analysis for the structured equation model (SEM). Intention to Use is an important success factor, focusing on Net Benefits as an outcome factor [7].

Delone & McLean (2003) measured success in two levels, as the net benefit of a system for individual work practices and organizational impact [8]. These success factors were found to be also applicable to evaluating health information systems [9]. Moreover, successful implementation is strongly related to end-user perceptions and involvement. As defined in previous studies, key attributes include the support of management, training or education, organizational aspects such as culture and rewards, design of the system, and project management (e.g. IT support) [9, 10]. Hence, these factors may define the success of the implementation of IS.

As Baus (2004) defined usability is one of the critical factors in the successful implementation of the HIS. Time, training, and/or monetary investments are critical factors to provide adequate training to learn how to use the new system. The implementation of IS at hospitals can be successful with

dedicated healthcare professionals who have had the opportunity to receive the education and training necessary to use the HIS and more easily integrate it into their unique setting. Follow-up training and on-site support are good methods to make content with the IS applications and ensure successful usage by users with different levels of computer skills [11].

Satisfaction is an intellectual and emotional response or feelings or attitudes toward an experience with IS [12]. Al-Maskari and Sanderson (2004) assessed "user satisfaction" as the main evaluation concept of information system success [13]. System usage and user satisfaction are surrogate measures of IS and are widely accepted and used as success indicators [14]

Furthermore, the usefulness of a system is often measured by examining user satisfaction. User satisfaction has system-dependent aspects, such as content satisfaction, interface satisfaction, and organization satisfaction, but also system-independent personal aspects such as individual dislike for computers [15]. Wong and Arjpru [16] identified awareness of IS as the critical factor that influences user satisfaction. Furthermore, they stated that IS management needs to have effective IS strategies to maximize user satisfaction to increase the use of an Information System over time. This can be implemented by continually providing regular training on the updates of the system's abilities, supporting employees in learning new knowledge, and extending their skills.

Based on the above rationale, we propose that training plays a mediating role in the success of HIS and the main predicting factors of IS, system, information, and quality. To increase the use of an Information System over time, user satisfaction should be focused on and enhanced by continually providing regular training on the updates and supporting employees in learning new knowledge and skills.

II. RESEARCH METHODOOLOGY

To accurately evaluate the efficiency of such systems, scholars propose different methods. In recent years, the use and satisfaction of HIS have mainly been evaluated in the forms of questionnaire surveys, in-depth interviews, individual case studies, and material collections. For instance, Lising and Kennedy [17] applied a qualitative study by conducting a behavioral observation to know the time allocation during the healthcare process. Lee et al. [18] used one-to-one or one-to-many quality interviews to analyze in-depth the users' opinions on a system. Meanwhile, the questionnaire survey method is the most widely used, aiming at user satisfaction and attitude toward the system. Hortman and Thompson [19] carried out open Q&A in both questionnaires and forms to identify users' satisfaction and opinion, determining that nurses feel positive about the system by reducing paperwork, providing healthcare instruction, and being equipped with learning functions. Chae et al. (2011) utilized a survey of 44 tertiary hospitals and revealed that management support, standardization, and training had a significant effect on HIS adoption by employees [20].

III. RESEARCH INSTRUMENT AND SAMPLING

A questionnaire with 57 items in 7 groups was developed to collect data from 296 hospital workers including doctors,

nurses, and administrative and technical officers of the Mongolia Japan Hospital through forms.google.com. The sample size was calculated as follows:

$$m = \frac{Z^2 \times P \times (1-P)}{\varepsilon^2} \quad n = \frac{m}{1+\frac{m-1}{N}} \quad (1)$$

Where: m is the sample size when the number of populations is unknown; n is the sample size; Z- 95% probability level Z value (1.96); P-probability level (0.5); - sampling error (0.05); N-Population

$$m = \frac{Z^2 \times P \times (1-P)}{\varepsilon^2} = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2} = 384.1 \approx 384$$
$$n = \frac{m}{1+\frac{m-1}{N}} = \frac{384}{1+\frac{384-1}{430}} = 203$$

The survey covered 296 workers of Mongolia Japan Hospital, which is higher than the estimated sample size (203), increasing the reliability of the sample. MS Excel and IBM SPSS Statistics25 were used to process the survey results.

IV. RESEARCH RESULTS

The survey covered 296 respondents which are 87.8% are female, 71.6% are 29-34 aged and 43.2% are doctors. Most of the participants (45.9%) are educated in bachelor's degrees and 50% are worked for more than 3 years (Fig 1). About using and working on hospital information systems 77% work on this system for up to 8 hours, and 45.9% answered that they need some help to work.
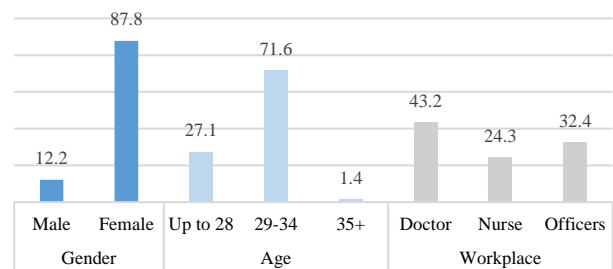

Fig 1. General information about the survey participants

The KMO (Kaiser-Meyer-Olkin) index of sampling adequacy is 0.867, which is above required minimum level, indicates that the sample size is satisfactory.

A principal component analysis resulted in 4 components with 30 items, including training, system and information qualities, and net benefit perceived by the employee (Table I). We used Cronbach's alpha coefficient to test the reliability of the survey questionnaire. Reliability refers to the assessment of the degree of compatibility between the measurement variables of many subsections or the internal stability of measurement. Internal compatibility is acceptable if Cronbach's alpha value is greater than 0.7. In our study, Cronbach's alpha is at an appropriate level, which is between 0.915 and 0.977.

TABLE I.   FACTOR ANALYSIS RESULT

Factors	Rotated Component Matrixª				
	Indicators	Component			
		1	2	3	4
Benefit	HIS eliminates the disadvantages of paper records	0.893			
	The introduction of HIS has advantages for employees	0.879			
	HIS will provide easy access to customer information	0.868			
	The introduction of HIS is beneficial to the hospital	0.848			
	HIS will make medical care better	0.820			
	The use of HIS can improves decision-making skills	0.814			
	Using HIS will make care faster	0.808			
	HIS will improve communication between staff	0.798			
	HIS is often used in work	0.737			
	I think I need HIS for my work	0.680			
	HIS made the process easier	0.659			
	HIS has a positive effect on the quality of my work	0.622			
	Using HIS in daily work improves productivity	0.604			
Information	HIS information is constantly updated		0.856		
	HIS produces a full report		0.811		
	Reports from other units meet my job requirements		0.783		
	HIS information is organized and easy to read		0.779		
	HIS releases information in a timely manner		0.737		
	It's easy to find information on the HIS		0.736		
	The information generated in the HIS is accurate		0.727		
	HIS provides the information I need for my work		0.702		
	Errors reported to HIS are corrected in a short period of time		0.604		
System	HIS is easy to integrate with other systems			0.782	
	HIS suits my work style			0.770	
	HIS is user friendly (doctors, nurses, ...).			0.739	
	The HIS user interface is well organized			0.735	
	HIS is flexible			0.721	
Training	Training on the use and operation of HIS organized by the IT department is effective				0.823
	Sufficient knowledge and information about HIS have been acquired through new employee orientation training				0.768
	It is interesting to use HIS in everyday work				0.668

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Hierarchical regression analyses have been performed to assess the effect of information quality, system quality, and training on the benefit of hospital information system adoption.

TABLE II.   REGRESSION OF HIERARCHICAL LINEAR MODELING ANALYSIS

Variables	Dependent variable: Hospital Information System Benefit		
	Model 1	Model 2	Model 3
Intercept	0.917 (0.000) ***	1.624 (0.000) ***	1.691 (0.000) ***
Information quality	0.393 (0.000) ***	0.220 (0.000) ***	0.098 (0.568)
System quality	0.464 (0.000) ***	0.131 (0.084)	0.401 (0.011) *
System quality × Training		0.078 (0.000) ***	
Information quality × Training			0.084 (0.049) *
R^2	0.578	0.625	0.630
F	200.820	162.130	123.732

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, N=296

Results demonstrate that information quality and system quality have a significant positive effect on benefits perceived by employees (Model 1,Table II). According to Model 2 and Model 3, training has a mediating role between information quality and benefits, as well as, between system quality and benefits. R^2 of Model 2, which includes the interaction of system quality and training, had significant change predicting approximately 62.5% of the variance in the perceived benefit. In Model 3 we removed the interaction of system quality and training and added information quality and training interaction. Results demonstrate an R^2 has a significant change in the value of 0.630.

To make a comprehensive conclusion we made a detailed analysis of all items. A frequency analysis was used to define the contribution of each item.
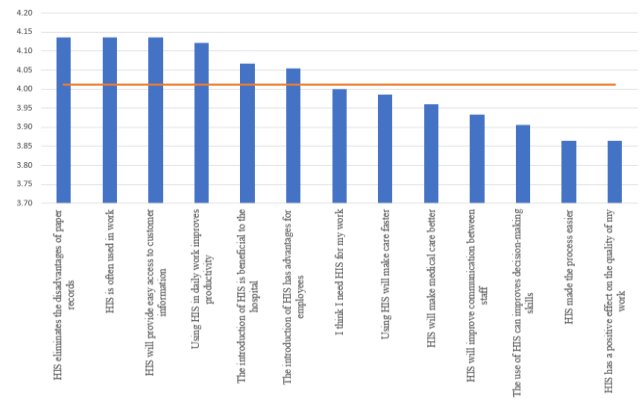

Fig 2. Perceived benefit of employees

According to respondents, the implementation of HIS has many benefits such as improving productivity by eliminating paper records, easing everyday work, fastening clinical services, and overall productivity of the employee. However, improvements in the quality of medical care, communication between staff, decision-making, and speed of workflow have not been recognized by employees (Fig 2).
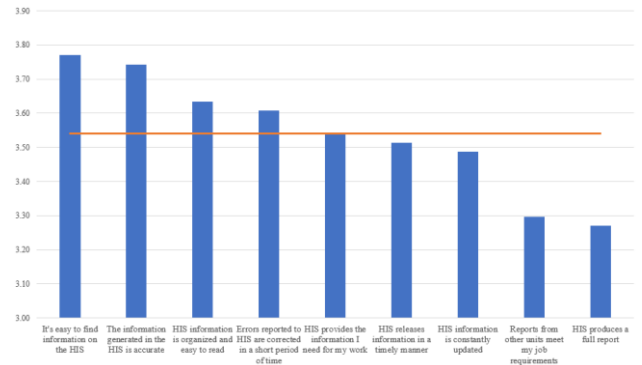

Fig 3. Information quality of HIS

With the implementation of HIS, information has been well organized, providing easy access to required data, correctness of the data is facilitated by promptly fixing errors. Unfortunately, issues with reports' incompleteness and incoherence to job requirements are observed (Fig 3).
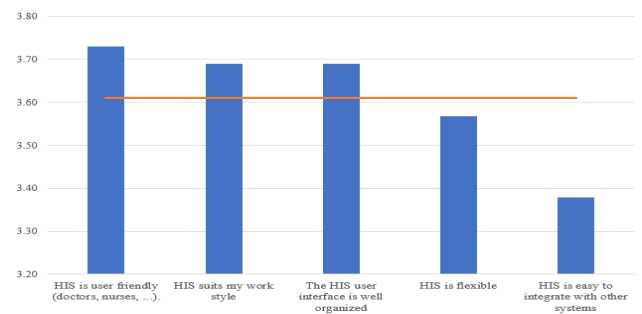

Fig 4. System quality of HIS

According to the results, implemented HIS's system quality is user-friendly, suited to work style, and has a well-organized interface. However, complications with integrating with other systems, and inflexibility are observed (Fig 4).
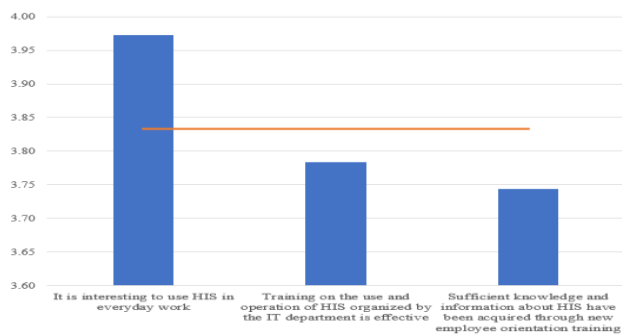
Fig 5. Perceived training of employees

Training provided by Mongolia Japan Hospital's Information Technology unit such as guidance, manuals, and HIS menu instructions is insufficient from the users' perspective (Fig 5).

Overall, more than half of the respondents expressed a positive attitude toward the implementation of the hospital information system. They defined the benefits of HIS as good support in their work by lessening paperwork and fastening everyday operations. However, the use of hospital information systems presents some difficulties. For instance, 85.1% believed that even though the hospital information system digitized the records, it created the need to process new documents. Moreover, 83.7% think that new tasks have been added by using the hospital information system.

V. Conclusion and recommendations

The objective of this study was to determine factors influencing the success of the system during implementation from the user's perspective. The conceptual model and hypotheses were defined based on IS Success Model and the Technology acceptance model. The model was validated by Reliability analysis and the Principal Component analysis. Multiple regression analysis was adopted to test hypotheses.

From the results, we may conclude that system and information quality have a major effect on the acceptance of information systems and Training enhances the effects of predicting factors. From this, we can elaborate that training on every step of implementation will ease and fasten the process of acceptance of the system.

A detailed review of construct items revealed that not only technical support but also user-centric management, including training, involvement of employees at every stage of implementation, and development of a user-friendly interface may enhance the successful adoption of HIS. Moreover, the limitations described by respondents may help managers and decision-makers do more rational decisions.

Overall, despite the strengths such as decreased number of work and fastened workflow, the quality issues of the system are under consideration. Further development of HIS at Mongolia Japan Hospital has to consider users' opinions to define which items should be improved. As can be seen from

the respondents' opinion user menu, guidance is required for quality work. In this instance, the Information Technology unit may have to develop a thorough operational plan, focusing on the main problem area. Moreover, training and running specialized courses for the staff, especially for new employees may encourage them to perform tasks better and take the initiative in solving everyday problems with the system.

References

[1]. DeLone WH, McLean ER. The DeLone and McLean model of information systems success: a ten-year update. Journal of Manag Inf Syst 2003;19(4):9-30.

[2]. Tumurchudur, S. and Buyantur, O., 2022. Analysis of Success Factors of E-Learning. *Embedded Selforganising Systems*, 9(4), pp.34-38.

[3]. Sumjidmaa, T., Oyuntungalag, B. and Mungunzul, M., analysis of e-learning success factors: the mediating role of intention to use. In *The 5th International Conference Mandakh-2022* (p. 4).

[4]. Van Der Meijden MJ, Tange HJ, Troost J, Hasman A. Determinants of success of inpatient clinical information systems: a literature review. J Am Med Inform Assoc 2003;10(3):235-43.

[5]. Park J, Chae YM, Lee YT, Cho K, Kim J, Lee BH. Evaluation of CDSS for drug prescriptions based on success measures. J Korean Soc Med Inform 2009;15(3):293-301.

[6]. Pai FY, Huang KI. Applying the Technology Acceptance Model to the Introduction of healthcare information systems. Technol Forecast Soc Change 2011;78(4):650-60.

[7]. Cho, K. W., Bae, S. K., Ryu, J. H., Kim, K. N., An, C. H., & Chae, Y. M. (2015). Performance evaluation of public hospital information systems by the information system success model. *Healthcare informatics research*, 21(1), 43-48.

[8]. Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*, 19(4), 9–30.

[9]. Van der Meijden, M. J., Tange, H., Troost, J., & Hasman, A. (2001). Development and implementation of an EPR: how to encourage the user. International Journal of Medical Informatics, 64(2-3), 173–85.

[10]. Gagnon et al., 2012; Häyrinen & Saranto, 2004;

[11]. Baus A (2004) Literature Review: Barriers to the Successful Implementation of Healthcare Information Systems.

[12]. Wixom BH, Todd PA (2005) A theoretical integration of user satisfaction and technology acceptance. Information systems research 16: 85-102.

[13]. Al-Maskari A, Sanderson M (2010) A review of factors influencing user satisfaction in information retrieval. Journal of the American Society for Information Science and Technology 61: 859-868.

[14]. Bokhari RH (2005) The relationship between system usage and user satisfaction: a meta-analysis. Journal of Enterprise Information Management 18: 211-234.

[15]. Aggelidis VP, Chatzoglou PD (2012) Hospital information systems: Measuring end-user computing satisfaction (EUCS). J biomed inform 45: 566-579.)

[16]. Wong B, Arjpru C (2007) A Study of How User Satisfaction and User Dissatisfaction Affect the Success of an Information System

[17]. Lising, M. and Kennedy, C., 2005. A multimethod approach to evaluating critical care information systems. *CIN: Computers, Informatics, Nursing*, 23(1), pp.27-37.

[18]. Pourmand, A., Lee, H., Fair, M., Maloney, K. and Caggiula, A., 2018. Feasibility and usability of tele-interview for medical residency interview. *Western Journal of Emergency Medicine*, 19(1), p.80.

[19]. Hortman, P.A. and Thompson, C.B., 2005. Evaluation of user interface satisfaction of a clinical outcomes database. *CIN: Computers, Informatics, Nursing*, 23(6), pp.301-307.

[20]. Chae, Y. M., Yoo, K. B., Kim, E. S., & Chae, H. (2011). The adoption of electronic medical records and decision support systems in Korea. *Healthcare informatics research*, 17(3), 172-177).