# Evaluation of Hospital Information Management System with Information Systems Success Model

*Araştırma Makalesi/Research Article*

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***Abstract***— The most important and most common of the information systems used in hospitals is the hospital information management system. There is not much research on whether these costly systems actually perform as expected. Researchers evaluate the success of the information system based on users' perceptions and benefits obtained. In this study, the success of the hospital information management system was evaluated using the information systems success model developed by DeLone and McLean in terms of healthcare workers. Information systems success model evaluates the success of information management system with system quality, information quality, user satisfaction, system usage and net benefit components. The population of the study consists of healthcare workers using the hospital information management system in Usak Training and Research Hospital. Convenience sampling method was used in the sample selection. In the analysis of data obtained from 302 healthcare professionals, the structural equation model was used through SPSS 22.0 and AMOS 22.0 programs. Research findings show that; improving the system quality and information quality of the hospital information management system increases user satisfaction and system usage. The increased satisfaction of users contributes to the formation of positive perceptions about the voluntary use of the system by healthcare professionals and the benefits they obtain from the system.

***Keywords***— electronic health records, information systems, information systems success model, hospital information management systems.

# Hastane Bilgi Yönetim Sisteminin Bilişim Sistemleri Başarı Modeli ile Değerlendirilmesi

***Özet***— Hastanelerde kullanılan bilgi sistemlerinden en önemlisi ve en yaygını, hastane bilgi yönetim sistemidir. Maliyeti yüksek olan bu sistemlerin gerçekte beklenen performansı gösterip göstermediği hakkında çok fazla araştırma yoktur. Araştırmacılar bilgi sisteminin başarısını, kullanıcıların algılarına ve elde edilen faydalara bağlı olarak değerlendirmektedir. Bu araştırmada, hastane bilgi yönetim sisteminin başarısı, DeLone ve McLean tarafından geliştirilen bilişim sistemleri başarı modeli kullanılarak sağlık çalışanlarının bakış açısıyla değerlendirilmesi amaçlanmıştır. Bilişim sistemleri başarı modeli, bilgi yönetim sisteminin başarısını; sistem kalitesi, bilgi kalitesi, kullanıcı memnuniyeti, sistem kullanımı ve net fayda bileşenleri ile değerlendirmektedir. Araştırmanın evrenini, Uşak Eğitim ve Araştırma Hastanesi'nde hastane bilgi yönetim sistemini kullanan sağlık çalışanları oluşturmaktadır. Örneklem seçiminde kolayda örnekleme yöntemi kullanılmıştır. 302 sağlık çalışanından elde edilen verilerin analizinde, SPSS 22.0 ve AMOS 22.0 programları aracılığıyla yapısal eşitlik modeli kullanılmıştır. Araştırma bulguları göstermektedir ki; hastane bilgi yönetim sisteminin sistem kalitesi ve bilgi kalitesinin geliştirilmesi kullanıcı memnuniyetini ve sistem kullanımını artırmaktadır. Kullanıcıların artan memnuniyeti, sağlık çalışanlarının gönüllü sistem kullanımına ve sistemden elde ettikleri faydaya yönelik olumlu algıların oluşmasına katkı sağlamaktadır.

***Anahtar Kelimeler***— elektronik sağlık kayıtları, bilişim sistemleri, bilişim sistemleri başarı modeli, hastane bilgi yönetim sistemleri.

## 1. INTRODUCTION

Turkish Health Transformation Program (HTP) started upon 2003 is a reflection of healthcare reform efforts which was introduced in early 1980s in developed countries. The HTP aimed to facilitate access to healthcare services. The aim was achieved successfully and number of hospital visits reached up to 719 million in 2017 from 209 million in 2002. By implementation of HTP, significant investments have been made into medical technologies such as magnetic resonance (MR), ultrasonography (USG), and computarized tomography (CT) in Turkey. When numbers of imaging studies are considered, Turkey stands in first rank among OECD countries [1].

The increased Turkish population, life expectancy and proportion of aged population have also raised demand for health sector. As a result of increased hospital presentations, it has become impossible to store data produced as paper or compact disk (CD) media and to classify, analyze and transform these data into data and useful information. In addition, it is impossible to manage and to develop policies and achieve success in an important, major sector such as health without a basis of data [2-5]. Thus, the use of information technologies has been obligatory in the healthcare sector. In this context, Health Ministry has collaboration with Healthcare Information and Management System Society (HIMSS) providing international accreditation for use of information technologies in hospitals. Upon 2018, overall 162 hospitals have been qualified to HIMMS Electronic Medical Records Adoption Model (EMRAM) Level 6 certification while 2 hospitals have been qualified to HIMMS EMRAM Level 7 certification. Turkey is the leading country in Europe [6].

In Turkey, efforts on information system in healthcare have been introduced with support World Bank in 1990s. In 1999, there were efforts to develop information systems for hospitals affiliated to Health Ministry. However, upon 2003, information systems have begun to be outsourced in the context of http [7]. The Health Ministry stands as a regulatory organization in determining principles and standards on information systems and accredits informatics companies serving the healthcare sector. By 2019, there are 56 companies accredited by the Health Ministry, which are providing Hospital Information Management System (HIMS) service. In Turkey, all public and private hospitals are using a HIMS [8].

It is important to improve benefit produced by users via information systems, rather than having an information system [9, 10]. In healthcare sector, transformation of technological investments to benefit requires effective use of information systems and user satisfaction which is an important determinant for success of these systems. Thus, information systems are considered as social systems rather than being technical systems with behavioral outcomes [11, 12]. Currently, healthcare providers have become both user and part of HIMS. Thus, HIMS "is defined as “a socio-technical subsystem of Hospital” [13]. Technical and social aspects as well as administrative aspects should have to be integrated effectively [14]. The evaluations and requests of technical experts and end users are crucial to the success and development of information systems [15-17]. It is important to assess information system from perspective of health care providers in order to fulfill expectations, anticipated outcomes and to prevent novel problems with use of informatics in healthcare services [13, 18, 19].

Information systems success models (ISSMs) are used to assess information managements systems used in organization via ratings by users [20]. The ISSM is a model that assumes system and information quality perceived by users affects system satisfaction and use which, in turn, affect net benefit [21]. The model is being widely used to assess distinct information systems used in organizations. In this study, we assessed the success of HIMS used in Training and Research Hospitals using ISSM proposed by DeLone and McLean.

## 2. MATERİALS AND METHODS

### *2.1. Population and Sample*

The research is designed as quantitative research and is an explanatory and cross-sectional field study. The study population included healthcare providers using the hospital information management system in Uşak Training and Research Hospital. The study sample was selected using a convenience sampling method. Overall, 326 healthcare providers contributed to the study voluntarily. When questionnaires completed were assessed, it was seen that 24 questionnaires were incomplete with identical participation levels in all expressions; thus, data from 302 questionnaires were analyzed.

### *2.2. Research Model and Hypotheses*

The research model was developed based on ISSM proposed by DeLone and McLean and accepted in the literature. The success of HIMS was measured by “system quality, information quality, system use, patient satisfaction and net benefit perceived”. Information quality defines “the characteristics of the outputs produced by the information system” such as being definite, useful, accurate, sufficient, complete, and up-to-date.18 System quality expresses characteristics required from an information system. The system quality is assessed according to features such as being ease to use, reliable, flexible and adaptive to user demands [22]. The quality of the information system and the quality of the information produced by the system increase the voluntary use of the system and the satisfaction of the system users [20, 23].

User satisfaction denotes level of satisfaction regarding whether expectations of users that use information system and policy makers at administrative level are fulfilled.18 It is well-known that system use by user becomes more intensive when they are satisfied [24]. The benefits to users

of information system (individual influence) and effects on organizational performance (organizational effect) is generally conceptualized as net benefit [23]. Healthcare providers expressed benefits from HIMS as readily and rapid access to information, accuracy in scheduling and registration processes, improved service quality and productivity of providers [25, 26]. Voluntary system use and user satisfaction increase perceived benefits from the information system [20, 23]. Figure 1 presents study model.

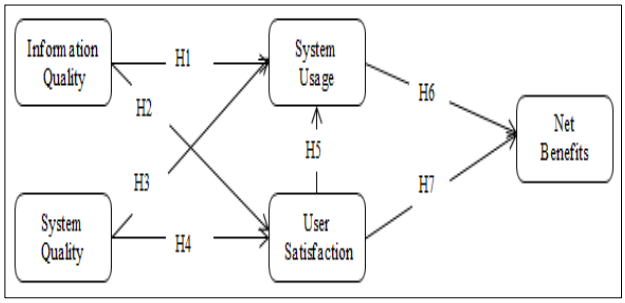


Figure 1. Research model

Based on the study model and relevant literature, the following hypotheses were proposed:

*H1: Information quality has significant positive effect on system use.*

*H2: Information quality has significant positive effect on user satisfaction.*

*H3: System quality has significant positive effect on system use.*

*H4: System quality has significant positive effect on user satisfaction.*

*H5: User satisfaction has significant positive effect on system use.*

*H6: System use has significant positive effect on net benefit.*

*H7: User satisfaction has significant positive effect on net benefit.*

### *2.3. Data Collection Tools*

The data collection form consists of two parts. In the first part, there are 5 questions related to the demographic characteristics of healthcare professionals. In the second part, "Information System Success Model Scale" is included. The scale consists of five dimensions: “system quality, information quality, user satisfaction, system usage and net benefit”. The information quality dimension includes items about the system's ability to produce correct, complete, clear, adequate, and well-formed information. The system quality dimension includes items about the features of the system that are easy to use and learn, flexible, adapting to the demands, and directing the user with warnings [22, 27]. In the dimension of system usage, there are items about the tendency of users to use the system voluntarily and to carry out their work depending on the system [28]. In the user satisfaction dimension, there are items regarding the general satisfaction of the users from the system [29]. In the net benefit dimension, there are items regarding the benefits of the system for patients, hospital, management and users [30].

### *2.4. Data Collection Method*

The data of the study were collected between November and December 2019. Before data was collected, the purpose of the study was explained and the consent of the participants was obtained. Health professionals who accepted to participate in the study voluntarily had to spare 8-10 minutes to fill out the research form.

### *2.5. Statistical Analysis*

SPSS 22 and AMOS 22 programs were used to analyze the data. The demographic characteristics of the participants were made in the frequency analysis and given as numbers and percentages. The validity of the scale used in the study was tested with exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The reliability of the scale was tested with the Cronbach alpha (Cα) coefficient. In addition, the "composite reliability" (CR) and "average variance extracted" (AVE) values were calculated for each sub-dimension in the scale. Hypotheses are tested with the structural equation model (SEM).

### *2.6. Ethics Aspects of the Research*

This study was approved by the Uşak University Social and Human Sciences Scientific Research and Publication Ethics Committee (Date: 06.11.2019 and numbered 2019/59). Written permission was obtained from Uşak Training and Research Hospital for the study (Numbered 45786011-611.99).

### *2.7. Research Limitations*

This study was conducted based on opinions of healthcare providers regarding HIMS success used in Uşak Training and Research Hospital. Given that there are 56 accredited organizations providing HIMS services in Turkey, it is impossible to generalize our results to all HIMSs. It can be recommended to conduct studies on other HIMS in different hospitals. Secondly, there are ongoing efforts to add different variables to model in order to improve information system success model. In the study, HIMS success was assessed by initial model. In future researches, HIMS success can be assessed by additional factors in the model.

## 3. RESULTS

The frequency analysis results of the participants regarding gender, age, education, profession, and seniority are given in Table 1.

Table 1. Demographic characteristics of participants

| | Frequency | Percentage |
|---|---|---|
| **Gender** | | |
| Female | 219 | 72,5 |
| Male | 83 | 27,5 |
| **Age** | | |
| 18-24 | 17 | 5,6 |
| 25-29 | 59 | 19,6 |
| 30-34 | 71 | 23,5 |
| 35-39 | 74 | 24,5 |
| 40-44 | 51 | 16,9 |
| ≥45 | 30 | 9,9 |
| **Educational Status** | | |
| High School | 74 | 24,5 |
| Associate's Degree | 85 | 28,2 |
| Bachelor's Degree | 113 | 37,4 |
| Postgraduate | 30 | 9,9 |
| **Profession** | | |
| Doctor | 21 | 7,0 |
| Nurse | 96 | 31,8 |
| Midwife | 16 | 5,3 |
| Medical Secretaryship | 113 | 37,4 |
| Health Technician | 27 | 8,9 |
| Administrative Personel | 29 | 9,6 |
| **Seniority** | | |
| 1-4 | 50 | 16,6 |
| 5-9 | 91 | 30,1 |
| 10-14 | 70 | 23,2 |
| 15-19 | 33 | 10,9 |
| ≥20 | 58 | 19,2 |
| **Total** | **302** | **100** |

Of the participants, 27.5% were male while 72.5% were female. When age range was assessed, 73.2% of participants were under 40 years of age. Approximately one-half of participants (46.7%) had less than 10 years of professional experience. When education level was considered, 75.5% had college degree. Of participants, 69.2% were nurses and medical secretaries who are using HIMS most intensive and active manner.

As a result of the EFA, the scale consists of 17 items under 5 dimensions. The total explanatory rate of the scale is 71.150. Table 2 presents the factor loads of the items, the CR, AVE, and Cα values of the variables.

Table 2. The results of EFA and reliability analysis

| Variables | Factor Loads |
|---|---|
| **Information Quality** *(CR=.868; AVE=.623; Cronbach's alpha =.877)* | |
| HIS provides me with all the information I need [20]. | .843 |
| The information provided by HIS is well formatted [20]. | .792 |
| The information provided by HIS is clear enough [25]. | .765 |
| HIS produces correct information [20]. | .754 |
| **System Quality** *(CR=.865; AVE=.617 Cronbach's alpha =.875)* | |
| HIS is easy to learn [25]. | .850 |
| HIS is easy to use [25]. | .809 |
| HIS directs the user with warnings [25]. | .742 |
| HIS can flexibly adjust to new demands or conditions [20]. | .734 |
| **System Usage** *(CR=.761; AVE=.618 Cronbach's alpha =.766)* | |
| If HIS were not mandatory, I would still use it [25]. | .876 |
| I run my business depending on HIS [26]. | .684 |
| **User Satisfaction** *(CR=.740; AVE=.588 Cronbach's alpha =.859)* | |
| Overall, I am satisfied with the HIS [27]. | .801 |
| I think the HIS is very helpful [27]. | .731 |
| **Net Benefits** *(CR=.843; AVE=.520 Cronbach's alpha =.915)* | |
| HIS helps the hospital control the work process [28]. | .778 |
| HIS improves the overall care of the patient [28]. | .753 |
| HIS improves management control [28]. | .743 |
| HIS helps reduce the costs of the Hospital [28]. | .732 |
| HIS increases my productivity [28]. | .585 |

It was found that factor load ranged from 0.585 to 0.876 for expression about scales used in the study model. For reliability analysis, Cα coefficients and CR values were estimated for each dimension in separate manner. Both Cα coefficients and CR value should have to be above 0.7 [31]. The AVE should have to be >0.5 while CR should have to be >AVE for convergent validity [32]. As shown in Table 2, AVE ranged from 0.520 to 0.623 while Cα coefficients and CR value were 0.766-0.915 and 0.740-0.868, respectively. In all scales, Cα coefficients and CR value were >0.7. The outcomes indicated high reliability for all factors. For all factors included to model, AVE values >0.5 and CR values >AVE values indicated convergent validity. Based on these values, validity and internal consistency were proven for scales used in the model.

The data set was subjected to CFA to test the construct validity. CFA results are given in Figure 2 and Table 3.

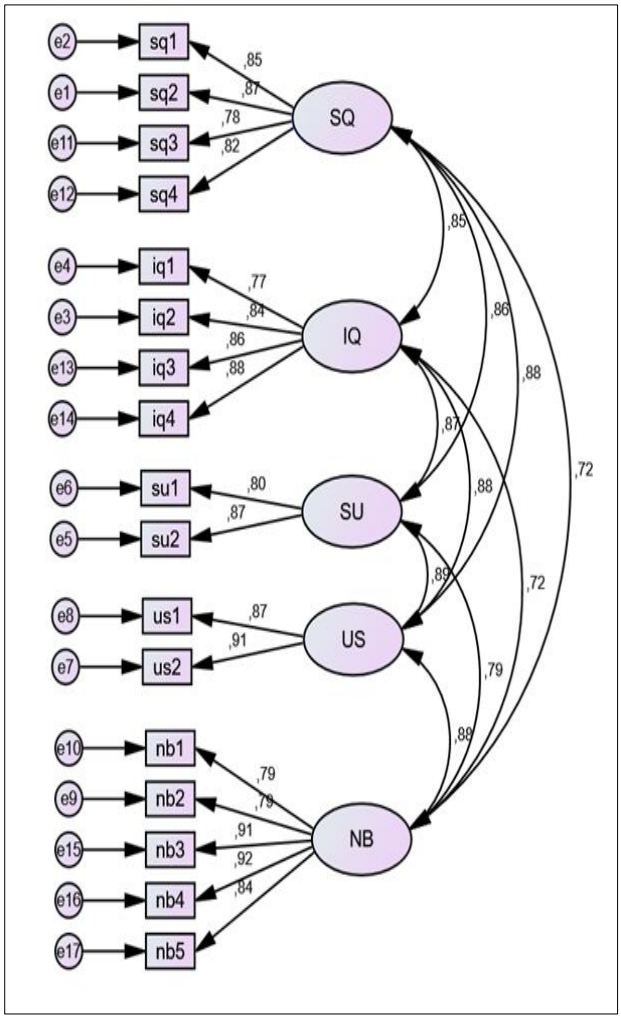


Figure 2. CFA results

Table 3. CFA actual, acceptable, and goodness-of-fit values

| Fit Measure | Actual Fit | Acceptable Fit | Good Fit |
|---|---|---|---|
| $X^2$/df | 2.405 | ≤ 3 | ≤ 2 |
| GFI | 0.902 | ≥ 0.90 | ≥ 0.95 |
| AGFI | 0.863 | ≥ 0.85 | ≥ 0.90 |
| CFI | 0.967 | ≥ 0.95 | ≥ 0.97 |
| NFI | 0.945 | ≥ 0.90 | ≥ 0.95 |
| RMSEA | 0.068 | ≤ 8 | ≤ 5 |
| SRMR | 0.0302 | ≤ 10 | ≤ 5 |

According to the confirmatory factor analysis result, chi-square statistics (x2=262.170) and goodness of fitting index (df= 109, x2/df= 2.405, GFI= 0.902, AGFI= 0.863, CFI= 0.967, NFI= 0.945, RMSEA= 0.068, SRMR= 0.0302) are within acceptable limits [33]. According to these results, the construct validity of the scales used in the study was provided.

The hypotheses created in line with the research model were tested with the SEM. Path analysis goodness of fit values are given in Table 4.

Table 4. Actual, acceptable, and goodness-of-fit values for path analysis

| Fit Measure | Actual Fit | Acceptable Fit | Good Fit |
|---|---|---|---|
| $X^2$/df | 2.431 | ≤ 3 | ≤ 2 |
| GFI | 0.901 | ≥ 0.90 | ≥ 0.95 |
| AGFI | 0.864 | ≥ 0.85 | ≥ 0.90 |
| CFI | 0.966 | ≥ 0.95 | ≥ 0.97 |
| NFI | 0.943 | ≥ 0.90 | ≥ 0.95 |
| RMSEA | 0.069 | ≤ 8 | ≤ 5 |
| SRMR | 0.0302 | ≤ 10 | ≤ 5 |

According to the results obtained in the structural model, chi-square statistics (X2 = 269.794) and goodness of fitting index (df = 111, x2 / df = 2.431, GFI = 0.901, AGFI = 0.864, NFI = 0.943. CFI = 0.966, RMSEA = 0.069, SRMR = 0.0302) appears to be within acceptable limits [33].

Seven hypotheses were tested in the SEM. Analysis results are presented in Figure 3 and Table 4.

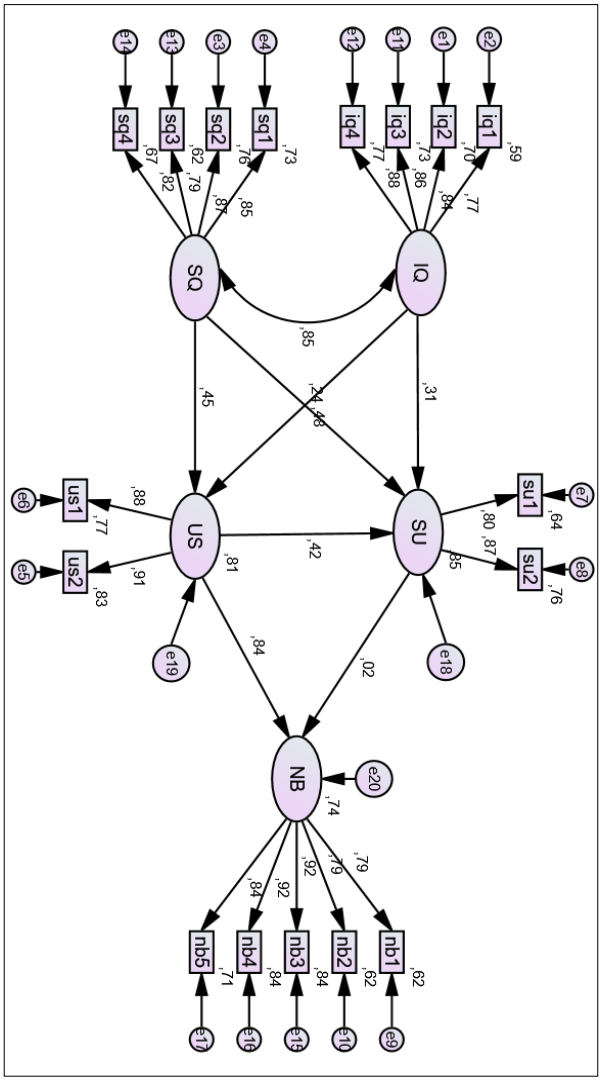


Figure 3. Path analysis

Table 5 shows the results of testing the study hypotheses. All hypotheses except the H6 hypothesis were supported.

Table 5. The results of testing the hypotheses

| Hypotheses | p | $R^2$ | β | Result |
|---|---|---|---|---|
| **$H_1$:** Information Quality → System Usage (S.E.=0.116; C.R.=2.931 | .003 | .85 | .339 | Supported |
| **$H_3$:** System Quality→ System Usage (S.E.=0.099; C.R.=2.328 | .020 | | .231 | Supported |
| **$H_5$:** User Satisfaction → System Usage (S.E.=0.102; C.R.=3.558 | .000 | | .361 | Supported |
| **$H_2$:** Information Quality → User Satisfaction (S.E.=0.105; C.R.=5.726 | .000 | .81 | .604 | Supported |
| **$H_4$:** System Quality → User Satisfaction (S.E.=0.092; C.R.=5.451 | .000 | | .502 | Supported |
| **$H_6$:** System Usage → Net Benefit (S.E.=0.092; C.R.=5.451 | .864 | .74 | .026 | Not Supported |
| **$H_7$:** User Satisfaction → Net Benefit (S.E.=0.092; C.R.=5.451 | .000 | | .821 | Supported |

When relationships proposed in the study model were tested using SEM, the results showed that information quality (β= 0.339; p<0.01), system quality (β= 0.231; p<0,05) and user satisfaction (β= 0.361; p<0.001) had significant, positive effects on system use. These findings supported hypothesis H1, H3 and H5. System quality, information quality and user satisfaction can explain 85% of variance in system use.

Information quality (β= 0.604; p<0.001) and system quality (β= 0.502; p<0.001) had significant, positive effects on user satisfaction. These findings supported hypothesis H2 and H4. Information quality had greater effect on user satisfaction when compared to system quality. Information quality and system quality can explain 81% of variance in user satisfaction.

The use of the system (β= 0.026, p> 0.05) does not have a significant effect on the net benefit obtained from information systems. Hence, the H6 hypothesis was not supported. User satisfaction (β= 0.821, p <0.001) has a significant effect on the net benefit. According to these results, the H7 hypothesis was supported. User satisfaction has a significant and powerful effect on net benefit. User satisfaction can explain 74% of variance in net benefit.

## 4. DISCUSSION

The ISSM measures success of an information system at 3 stages which interact with each other. In the first stage, system and information quality are measured to assess success of system design. In the second stage, system usage and user satisfaction are measured to assess success of service provided by information system. In final stage, benefit gained from system is measured to assess outcome success of information system. Each dimension is rated by system users. The success of system design affects service success provided by system, which, in turn, influences on benefit gained from system [34]. In this manuscript, design, service and outcome success of hospital information system was assessed using ISSM based on view of healthcare providers.

Based on our results, the system quality, quality of information produced and user satisfaction had positive effect on system use. In information system, being user-friendly, ease to use, being adaptive and guiding, providing sufficient, complete and accurate information contribute to positive intention for system use [35-37]. Thus, system use will be improved by enhanced user satisfaction [24]. Failure to seek support and approval of users will lead preventative attitudes against system use; thus, failure of system [15]. In HIMS use, the most common problem is failure in data transmission and communication due to incorrect data input. Another problem is transmitting patient data by paper despite presence of electronic patient registry in use. It is warranted to provide education of healthcare providers about HIMS use and to develop safe applications for documentation and data transfer [38-40].

In HIMS, system quality and quality of information produced had positive effect on user satisfaction. Positive effect of information quality was greater than system quality. Users of information system place more emphasis on achieving complete, accurate, reliable, open, up-to-date and functional information from system when compared to ease to use system use, rapid and adaptive design [29, 36, 41]. On contrary, in a study on municipal employees, it was found that system quality had greater effect on user satisfaction when compared to information quality [42] The primary goal for information systems is to produce data related to organization targets. In this context, information systems should have good quality regarding both functionality and data [10]. In order to improve user satisfaction, both system and information quality should be improved in HIMS.

While user satisfaction has a positive effect on the net benefits obtained from HIMS, the use of the system does not have a significant effect. There are several studies reporting contradictory results about net benefit. A similar result was found in a study conducted with municipal employees, while user satisfaction was found to be a strong predictor of net benefit, while the effect of system use on net benefit was found to be insignificant [42]. In a study conducted on the first 500 companies in Taiwan, it was concluded that the use of the system has no effect on the net benefit [43]. There are several studies reporting contradictory results about net benefit. In a study by electronic human resources system, it was found that system use had most potent, direct and overall effect on net benefit perceived, suggesting that importance of system use in promoting net benefit perceived by staff [41]. However, system use is a stipulation for staff to take advantage of the system. At level of net benefit, purpose of

information system and individual satisfaction level have positive effect on individual and organizational benefit from system [21].

## 5. CONCLUSION AND RECOMMENDATIONS

In healthcare services, use of medical and information technologies have become widespread and obligatory in order to meet altered and increased demand. HIMS is a common and important information technology used in hospitals. This study was aimed to assess the success of information systems used in hospitals. For this purpose, ISSM developed by Dole and MacLean was used in our study. Except for H6 hypothesis, all hypotheses proposed in the research model were supported.

In the study, it was concluded that "information quality, system quality, user satisfaction, system usage, and perceived net benefit" are valid measures for using to evaluate the success of HIMS. It was found that these variables used in distinct information system could also be used for information management systems used in hospitals.

In the context of results obtained in the study, there may be some implications for hospitals, administrators, educators, healthcare providers and companies developing healthcare information systems. To enhance net benefit perceived by users, hospitals should have to improve HIMS by better information and system quality. This affects system use behaviors and user satisfaction; thus, net benefit perceived. It may be helpful to provide training about use of information technologies, data analysis and decision-making process in order to improve voluntary use of HIMS during healthcare provision, user satisfaction and benefit. In addition, curricula in all health education departments should have to include information managements systems used in hospitals. Such educations in curricula may improve attitudes towards using information systems and satisfaction level. HIMS producing organizations should allow the system they have developed to be used as educational material in schools providing health education. This will allow generalizing HIMS use and receiving feedback from students about information system.

In Turkey, HIMS services are outsourced. Taking opinions of hospital administrators and healthcare providers during selection of health information technologies is important to develop positive attitude towards system use and adaptation. ISSMs can be used to assess the HIMS services provided. In general, information systems are assessed by technical staff. However, considerations of users will make a significant contribution to the development and success of system.

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