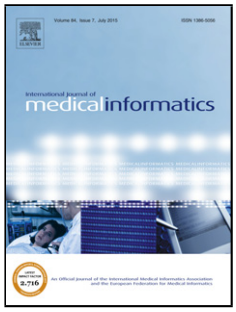


Title: Evaluation of the unified model of information systems continuance (UMISC) in two hospital environments

Authors: Samir Mellikeche, Olivier Boussekey, Guillaume Martin, Eric Campoy, Jean-Patrick Lajonchère, Patrice Degoulet

PII: S1386-5056(18)30535-5
DOI: https://doi.org/10.1016/j.ijmedinf.2018.06.001
Reference: IJB 3709

To appear in: *International Journal of Medical Informatics*

Received date: 11-1-2018
Revised date: 11-5-2018
Accepted date: 3-6-2018

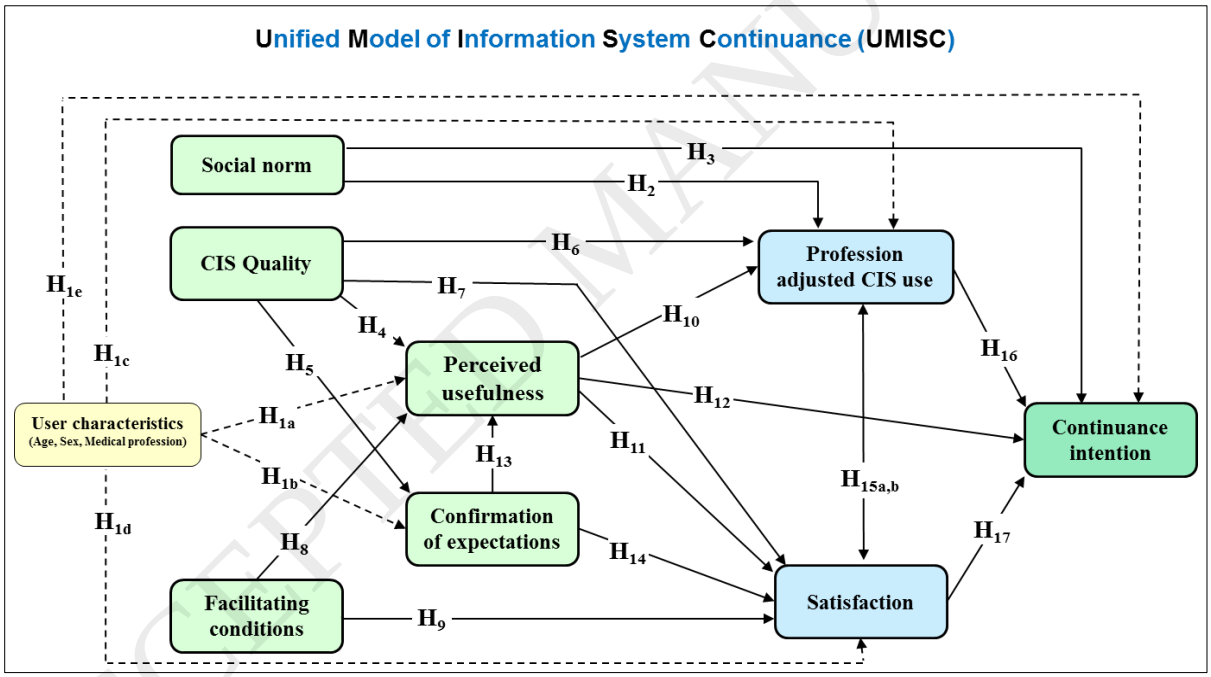
Please cite this article as: Mellikeche S, Boussekey O, Martin G, Campoy E, Lajonchère J-Patrick, Degoulet P, Evaluation of the unified model of information systems continuance (UMISC) in two hospital environments, *International Journal of Medical Informatics* (2018), https://doi.org/10.1016/j.ijmedinf.2018.06.001

Evaluation of the unified model of information systems continuance (UMISC) in two hospital environments

Samir Mellikeche[1,2,3], Olivier Boussekey[4], Guillaume Martin[5], Eric Campoy[6], Jean-Patrick Lajonchère[4], Patrice Degoulet[1,2,3]

[1] *Georges Pompidou European University Hospital (HEGP), Paris, France*
[2] *Inserm-UMRS 1138, CRC, Team 22, Paris, France*
[3] *Paris Descartes University, Paris, France*
[4] *Saint-Joseph Hospital Group, Paris, France*
[5] *CeTIMA, Ilôt Bégin, Saint-Mandé, France*
[6] *DRM (UMR-CNRS 7088), PSL-Paris Dauphine University, Paris, France*

Graphical abstract



Highlights

- Acceptance determinants significantly change over time from early to late and very late post adoption phases.
- In late adoption phases of a CIS deployment, a continuance intention dimension should be added in evaluation models.
- The Unified Model of Information System Continuance (UMISC) can be used as a comparison and explanatory model of CIS use, satisfaction and continuance intention in post-CIS adoption situations..
- Clinical information system quality remains the best determinant of user satisfaction in a very late post adoption phase.
- The bilateral relationship between use and user satisfaction is only significant in the early post adoption phase but disappears over time.
- Disappearance of the relationship between CIS use and continuance intention could be an indicator of CIS maturity.

Abstract

Context: The deployment and long-term acceptance of clinical information systems (CISs) are faced with multiple difficulties. They include insufficient quality of the systems in place and resistance to the multiple changes they induce in care processes. Permanent evaluation of deployed solutions is a prerequisite to their continuous improvement.

Objective: The purpose of this study was twofold: (1) To validate the post-adoption unified model of information system continuance (UMISC) progressively developed at the Georges Pompidou University Hospital (HEGP) in Paris (internal validation); and (2) To compare, using the same evaluation model, the results observed at HEGP with those of the Saint-Joseph Hospital Group (HPSJ), another Paris acute care institution (external validation).

Methods: The UMISC post-adoption model is built around nine dimensions: end-user characteristics, social norm (SN), IS quality (ISQ), facilitating conditions (FC), perceived usefulness (PU), confirmation of expectations (CE), profession-adjusted use (PAU), satisfaction (SAT), and continuance intention (CI). Two semi-quantitative evaluation surveys were performed at HEGP in 2014 and 2015, and one at HPSJ in 2015. Statistical analysis included multiple regression analysis and structural equation modeling (SEM).

Results: The analysis concerned 459 responders, 264 at HEGP and 195 at HPSJ. UMISC indicators, with the exception of SN, are superior at HEGP than at HPSJ, which had a shorter CIS anteriority than HEGP. In SEM analysis, the UMISC model explained 25% and 40% of the CIS use, 92% and 93% of health professionals' satisfaction, and 72% and 71% of continuance intention at HEGP and HPSJ, respectively. Seventeen of the 21 tested UMISC hypotheses were supported in at least one of the two sites.

Conclusion: The UMISC evaluation model can be used as a comparison and explanatory model of CIS use, satisfaction and continuance intention in post-CIS adoption situations that become prevalent in current electronic hospitals.

Keywords: Clinical information system acceptance; clinical information system evaluation; post-adoption evaluation; confirmation of expectations; satisfaction; continuance intention

1. Introduction

The deployment and use of clinical information systems (CISs) in healthcare facilities differ between developed and developing countries [1-4]. In the United States, the HITECH Act enacted under Title XIII of the American Recovery and Reinvestment Act (ARRA) of 2009 was followed by a dramatic increase of CIS coverage in hospitals as well as general practices. According to the Health Information Management System Society (HIMSS), by Q4 2017, 73.1% of US hospitals had reached level 5 to 7 of the HIMSS/EMRAM (Electronic Medical Record Adoption Model) maturity level (32.9% level 5, 33.8% level 6, and 6.4% level 7) [2]. As of May 2017, more than 525,000 healthcare providers received payment for participating in the Medicare and Medicaid EHR Incentive Programs [3]. In Canada, Europe, and Asia, deployments have been much slower, with mean EMRAM scores of approximately 3 or 4 in 2017. Counter positive examples exist in Denmark or the Netherlands, which have reached adoption levels close to the USA [4].

CISs intend to automate the execution of clinical processes so that health professionals can benefit from clinical decision support tools and spend more time with their patients. High CIS maturity achievement is expected to improve institution financial efficiency, increase the quality of care, and reduce the incidence of medical errors. It is also expected to foster clinical and translational research through data reuse directly from the EHR databases or from associated data warehouses [5]. However, benefits are not linearly related to the EMRAM maturity level, and there could be a tipping point around level 5-6 that corresponds to the extensive management of protocols and clinical pathways and to the full coverage of drug ordering and delivery loop processes [6]. This applies to the representation of the top performing hospitals in terms of quality metrics excellence of the Joint Commission [1], the representation of hospitals with a "A" Leapfrog safety grade [7], or the Value-Based Purchasing (VBP) clinical score initiative of the Centers for Medicare & Medicaid Services (CMS) initiative [8].

Achieving a high EMRAM level might be a necessary but insufficient condition of quality improvement. In the 2015 Leapfrog Hospital Survey, for example, hospitals' CPOE systems failed to flag 39% of all potentially harmful drug orders and 13% of potentially fatal orders [7]. If a reduction in medical errors is the major reason for implementing a CPOE, CIS users are now well aware of the unintended and negative consequences of running clinical information systems [9-11]. They include, among others, the excessive time devoted to data entry, particularly when a comprehensive CPOE is used, workflow issues and the risk of asynchronous communication between end-users in an urgency context, as well as alert fatigue in front of overly reactive decision support systems. Physicians who are likely to use the broadest scope of CIS functions are the most prone to resist their deployment [12-15].

In this difficult and slowly evolving context, permanent evaluation of deployed systems is a prerequisite to their continuous improvement. CIS use and acceptance need to be measured for each category of health professional user and at each phase of the CIS lifecycle, i.e., planning, implementation, deployment, and consolidation [14,16-20].

2. Theoretical Background

Multiple models and theories have been developed to explain user acceptance of information technology (IT) in different fields of economics and social sciences with successful applications in the healthcare domain as well. They can be classified according to the phase of deployment of a technology (e.g., pre, per or post-adoption), the targeted health professional categories (e.g., physicians, nurses, secretaries), and/or the evaluation dimensions and their different attributes they are built on as shown in *Table 1*.

Acceptance models consider the use or usage behavior as the main dependent dimension. The Technology Acceptance Model (TAM) of Davis [21], based on the Theory of Reasoned Action (TRA) [22], is the most widely accepted model of user behavioral intention [23,24]. In this model, end-user attitudes

determine the behavioral intention to use and the final actual use, which depend on the IT system perceived utility (PU) and perceived ease of use (PEOU).

Various extensions to the initial TAM model have been proposed [25-28]. Venkatesh proposed and tested TAM2 as an extended model of TAM through a study using longitudinal data regarding four different systems, two involving voluntary usage and two involving mandatory usage. TAM2 explained 40%–60% of the variance in usefulness perceptions and 34%–52% of the variance in usage intentions. Social influence processes and cognitive instrumental processes influenced user acceptance significantly. In the Unified Theory of Acceptance and Use of Technology (UTAUT) and its variants [26-28], the acceptance of technology is influenced by four factors: usefulness, ease of use, social norm and facilitating conditions. In a study conducted on the use of electronic patient record by nurses in acute care settings, the UTAUT model explained 33.6% of the variance of use and 54.9% of users' satisfaction [28]. In another study related to the determinants of mobile Internet (m-Internet) acceptance, the UTAUT model explained 65% of the variance of behavioral intention [26].

Acceptance models can both be applied in pre-adoption (use intention) as well as in per- and post-adoption situations (use behavior and current use).

Continuance intention models apply to post-adoption situations that become prevalent in current electronic hospitals (i.e., EMRAM stage 5-7 hospitals). The main dependent dimension is the intention to continue to use a partially or totally deployed system (*Table 1*). The Expectation Confirmation Model (ECM) developed by Bhattacherjee et al. [29,30] considers satisfaction (SAT) and perceived usefulness (PU) as the intermediary dimensions and the confirmation of expectations (CE) as the independent dimension. Bhattacherjee hypothesized the existence of a direct influence of CE on PU. Through a survey of online banking users, the model explained 20% of the PU variance, 33% of the SAT variance and 41% of the CI variance. The explanatory capacity of the ECM model is demonstrated by several studies carried out in different IS domains [14,31].

The Information Technology Post-Adoption Model (ITPAM) was proposed by Palm et al. [32] on the basis of the ECM but was mainly used as an acceptance model. Two characteristics of the IT system (compatibility with work and perceived ease of use) from the TAM2, a facilitating condition from the UTAUT, and three characteristics of the end-user (age, sex and medical profession) were considered. ITPAM's explanatory capacity was evaluated in two satisfaction surveys carried out simultaneously at the Georges Pompidou University Hospital in Paris (HEGP) [32] and at the Sherbrooke University Hospital in Quebec [33]. They explained 60% and 59% of the user satisfaction variance respectively. An ITPAM2 model of continuance intention was proposed by combining the ITPAM CIS quality criteria into a single construct according to the ISSM model [34,35]. The model explained 78% of the variance of the user satisfaction and 39% of the continuance intention based on a study of two post-adoption surveys conducted at the HEGP [34].

The Unified Model of Information Technology Continuance (UMITC) proposed by Bhattacherjee and Lin [36] makes a distinction between continuance intention and continuance behavior (i.e., post-intention use).

Success models stress the net benefits of an IT solution as the main dependent variable. In the Information System Success Model (ISSM) of Delone and McLean [42,43] and its variants [44,45], the benefits depend on the use and satisfaction dimensions that depend themselves on information quality, system quality, and service quality. Indeed, the benefits can be considered both at the individual (e.g., increased personal efficiency) or at the institution levels (e.g., increased financial efficiency, improved quality of care). In quantitative surveys based on professional end-users, net benefits are frequently replaced by perceived benefits and/or IS perceived usefulness. These later models can be compared to acceptance models, where use becomes an intermediary dimension and perceived usefulness is the dependent variable. ISSM model explained 77.6% of the satisfaction variance of customers according to a study conducted by Choi et al. [44]. Another study based on nurses using an ISSM derived model explained 70% of the nurse satisfaction variance and 25% of the nurse use dependency variance [45].

The Unified model of information system continuance (UMISC) was progressively developed at HEGP from the successive surveys performed between 2004 and 2014 with ITPAM/ITPAM2 and proposed as a unified post-adoption model of acceptance and continuance intention [34,35]. UMISC is a post-adoption model built around nine dimensions: end-user characteristics, social norm (SN), CIS quality (ISQ), facilitating conditions (FC), perceived CIS usefulness (PU), confirmation of expectations (CE), profession-adjusted CIS use (PAU), satisfaction (SAT), and continuance intention (CI).

The aim of this paper is twofold: (1) To validate at HEGP the post-adoption unified model of information system continuance (UMISC) (internal validation); and (2) to compare, using the same evaluation model, the result observed at HEGP with those of the Saint-Joseph Hospital Group (HPSJ), another Paris acute care institution (external validation).

3. Materials and methods

3.1 The HEGP and HPSJ clinical information systems

HEGP is an 800-bed acute care public university hospital located in southwest Paris that opened in July 2000 after the merging of three aging hospitals: the Boucicaut, Broussais, and Laennec acute and postacute care hospitals. Its integrated clinical information system consists of components from different providers integrated by a middleware platform [46]: (1) an Admission, Discharge and Transfer (ADT) component, (2) an Electronic multimedia shared Health Record (EHR), (3) a Computerized Provider Order Entry component (CPOE), (4) a resource and appointment scheduling system (RAS), and (5) an integrated Clinical Data Warehouse (CDW). The first four components are currently based on the DxCare® software suite from Medasys®, and the fifth is based on the Informatics for Integrating Biology and the Bedside (i2b2) [47,48]. Ancillary systems include DxLab® from Medasys® for laboratories, Carestream® for images, and Pharma® from Computer Engineering® for the pharmacy department. The production environment was operational when the hospital opened in 2000, and the CDW was operational in 2010.

HPSJ is a non-profit private group with 630 beds and places, resulting from the merging of three healthcare establishments in the south of Paris: Saint Joseph, Saint Michel and Notre-Dame de Bon Secours hospitals. Its CIS is based on (1) Cerner®'s Axya® software for ADT management, (2) DxCare® from Medasys® for electronic patient records, CPOE, and appointment management, (3) DxLab® from Medasys® for laboratories, and (4) Xplore® from EDL® for the medical imaging service and PACS. The computerized drug circuit was put into production in 2011, while the integrated electronic structured patient record components were fully deployed as of August 2014.

3.2 Satisfaction Surveys

Three satisfaction evaluation surveys were considered for this comparative study: two at the HEGP (2014 and 2015) corresponding to a very late post-adoption period, and one at the HSJ (2015) corresponding to a late post-adoption period. The surveys were conducted through semi-structured questionnaires including 50 structured questions (*Appendix A Table A.1*) and three site-dependent free-answer questions. The questions were selected from constructs previously published and validated in the literature and from the various evaluation studies performed at HEGP between 2004 and 2013 [35]. The number of questions was deliberately limited to allow the questionnaire to be completed in less than 10 minutes. Access to the questionnaires is open to all health professionals of the two hospital facilities working on the CIS and in direct contact with the patients and their electronic files. It is carried out through the intranet of the hospitals, allowing users to complete their questionnaires in several stages. Advertising is done by distributing leaflets in services and posting e-mails. Reminders are done by email. To comply with the internal ethical review boards of the two institutions, responses are processed anonymously but can be chained from one survey to the other to analyze trends.

3.3 Study participants

The respondents selected in this survey included (1) medical staff (MED); (2) nursing staff (NUR), which includes nursing assistants, nurses and nursing staff; and (3) other hospital personnel (OTH), comprising medical secretaries and social workers. Users who did not report regular use of at least one of the CIS functions, adjusted by their professions, or who did not respond to at least one question on the evaluated dimensions of the CIS are excluded. At HEGP, the results obtained are very similar in 2014 and 2015 and have been combined as a single response (average of the two responses), except for the HEGP trend analysis.

3.4 UMISC dimensions

Figure 1 illustrates the nine dimensions of the UMISC evaluation model and the relationships between them [35]. CIS use and satisfaction are considered intermediate dimensions to the continuance intention one, i.e., the dependent dimension of the model.

User characteristics are considered as explanatory factors in the UTAUT and ITPAM models [25,32]. They include age, profession, and gender. Relationships between age and CIS use might be complex. Younger professionals might be accustomed to easily embracing new technologies, but senior professionals are likely to be given larger rights than junior professionals [13,34]. Physicians have access to all CIS functions and are expected to have higher CIS use than other health professionals [49]. Nurses and secretaries have been found to be more satisfied with a CIS than physicians [20,50]. A gender effect has been inconsistently found in the literature but was kept in the UMISC model to test its interrelations with age and profession [20,50,51].

The social norm construct evaluates the influence of the user environment (e.g., colleagues, hierarchy) on professionals' behavior. The perceived social norm is defined as the degree to which a user perceives that others believe he/she should use the CIS [25]. Social norms are considered in TAM2 [52-54], UTAUT [25,28,55,56], ISSM [45], and the original HEGP ITPAM models. In a hospital environment, CIS deployment commonly belongs to the strategic plan of the hospital with top-down incentives from the governance body towards the different health professional groups [57].

In most evaluation models, CIS quality is a major determinant of both CIS use and satisfaction. It is integrated in the TAM, ISSM, and ITPAM2 models under different definitions and denominations. CIS quality components within the UMISC model include quality, reliability, availability and confidentiality of information, compatibility with work, response time, and ease of use [40,42,43].

Facilitating conditions have been introduced in the UTAUT, ITPAM, and ISSM models [25,33,42]. They include in the UMISC model the quality of the support from the IT department and/or software providers as well as the CIS training and coaching processes in place.

The perceived utility (PU) was initially introduced by Davis [39]. PU relates to the way users believe that a system will improve their professional performance [25,40]. In success models, perceived utility/usefulness is often considered a net benefit of the system [42,45].

Confirmation of expectations (disconfirmation in the UMITC model [36]) is a post-adaptation dimension proposed in the ISSM, ITPAM, and UMITC models [29,33,36]. It expresses the change of perception between what was expected before and assessed after using a system.

Satisfaction is a major but highly subjective dimension. It appears in most evaluation models, including ECM, ISSM and ITPAM models, as independent or intermediate constructs. It is determined by the confirmation of expectations and the perceived usefulness [29]. A satisfied customer is likely to have a higher subsequent use of the system [58]. Increasing IT use could also be associated with increasing satisfaction in a bidirectional virtuous loop [5].

In a post-adoption situation, continuance intention corresponds to the behavioral intent of end-users to subsequently use the same system and/or improve their adherence and/or expertise of their IT system [29,35,36]. Continuance intention can be correlated with real system use after predefined laps of time.

3.5 Research hypotheses

Taking into account these dimensions, 17 main dimension relationships derived from the UMISC model were tested in this comparative evaluation (*Figure 1*). They correspond to 22 research hypotheses. Five hypotheses are associated with CIS use (H_{1c}, H_2, H_6, H_{10}, and H_{15a}), six hypotheses with satisfaction (H_{1d}, H_7, H_9, H_{11}, H_{14}, and H_{15b}), and five with continuance intention (H_{1e}, H_3, H_{12}, H_{16}, and H_{17}).

- User characteristics (age, sex, and medical profession) have an influence on perceived usefulness (H_{1a}), confirmation of expectations (H_{1b}), CIS use (H_{1c}), satisfaction (H_{1d}), and continuance intention (H_{1e}) [25,33-35].
- CIS quality positively influences perceived usefulness (H_4), confirmation of expectations (H_5), and both CIS use (H_6) and satisfaction (H_7) [20,42,49,50].
- Social norms positively influence CIS use (H_2) and continuance intention (H_3) [25].
- Facilitating conditions have a positive influence on perceived usefulness (H_8) and satisfaction (H_9) [42].
- Perceived usefulness positively influences CIS use (H_{10}), satisfaction (H_{11}), and continuance intention (H_{12}) [34,40].
- Confirmation of expectations is positively associated with perceived usefulness (H_{13}) and satisfaction (H_{14}).
- The bi-directional relationship between CIS use and satisfaction progressively disappears in late post-adoption situations (H_{15a} and H_{15b}). Disappearance of this relationship could be a maturity indicator of a CIS project [35].
- CIS use is positively associated with continuance intention (H_{16}).
- Satisfaction is positively associated with continuance intention (H_{17}) [29].

Successive surveys were only performed at HEGP, allowing to test trends within the subgroup of end-users who had participated in several surveys and to test two additional hypotheses.

- CIS use and Continuance intension at time *t* are positively associated with CIS use and continuance intention at time *t+x* (H_{18} and H_{19}) [36].

3.6 Data and survey instruments

All end-users were requested to answer to the evaluation survey (see *Appendix A Table A.1*). Participation in the survey was optional, but answers to the 50 questions were mandatory for each participant. Eighteen questions are related to CIS use with scales between 1 and 7 (1=unused, 2=rarely, 3=rather rarely, 4=occasionally, 5=somewhat frequent, 6=frequently and 7=Very frequently). Gross use (GU) is calculated as the average of responses to the 18 use-related questions. Profession-adjusted use (PAU) is the average of the questions considered directly related to the concerned profession. For example, CPOE imaging orders or drug orders functions are taken into account for physicians but not nurses (see *Appendix A Table A.2*).

Nurse transmissions concern nurses but neither physicians nor secretaries. Likert scales for the 25 satisfaction- and continuance-related questions are between 1 and 7 (1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=no opinion, 5=somewhat agree, 6=agree, 7=strongly agree).

3.7 Data analysis

Survey management on statistical data analyses were performed using RedCap®, SPSS® 24/AMOS®, Statview® 5.0 and R®. Cronbach's α coefficient was calculated to test the validity of the grouping of the different construct-related items. Alpha coefficients were considered acceptable for all items ($.72 < \alpha < .92$) (*Appendix A Table A.3*).

Relationships between the different constructs were tested through multiple regression analysis and structural equation modeling (SEM). Structural equation modeling (SEM) was conducted with EQS® version 6.3 and cross-checked with SPSS/AMOS. The SEM assessment was based on the chi-square statistic ($\chi 2$), degrees of freedom (df), the Normed Fit Index (NFI), the Non-Normed Fit Index (NNFI), the Comparative Fit Index (CFI), the goodness-of-fit index (GFI), and the root mean square error of approximation (RMSEA) [59-62]. The results of these assessments are given in *Appendix A, Table A.5 and Table A.7*.

4 Results

4.1 User characteristics

The results were available for 459 users, 264 at the HEGP and 195 at the HPSJ (*Table 2*). The response rates at HEGP and HPSJ were 20.2% and 18.9%, respectively. Of the responders, 75.0% were female, and 43.8% were nurses.

The percentages of responders by gender and occupation in both hospitals are comparable as well as their mean age (42.5 at HEGP and 44.5 at HPSJ). The average anteriority of CIS use differs significantly in the two sites and was higher at HEGP (8.54) than at HPSJ (4.22) ($p<0.001$).

4.2 CIS functional use

The use of a CIS depends on, among others, the functional coverage of the solution deployed and the end-user profession. Use was assessed by profession at each of the two sites (*Table 3*). Profession-adjusted mean use (PAU) is higher at HEGP (4.01) than at HPSJ (3.72), regardless of the functions considered.

Possible delegation from physicians to non-physicians can be approached by evaluating the raw use of physician-specific functions in non-physician subgroups. Delegation rates are low in both sites but significantly higher in HEGP than in HPSJ for three of the four data entry functions considered that concern DRG coding and CPOE (*Table 4 and Appendix A, table A.10*).

4.3 The dimensions of satisfaction

All satisfaction indicators are above the median of the Likert scales (4.0), except PAU at HPSJ (*Table 5*). On the various dimensions of the UMISC model, all indicators, with the exceptions of the response time, data confidentiality and social norm, are superior at HEGP to those measured at HPSJ. The differences are not significant for system quality, confirmation of expectations and overall satisfaction but are significant for the perceived utility, the facilitating conditions and the continuance intention. The social norm is significantly higher at HPSJ than at HEGP ($p<0.05$).

Satisfaction indicators are higher among non-medical professionals than among medical professionals (*Figure 2 and Appendix 1, table A.11*). Confirmation of expectations and overall satisfaction have their lowest values for the medical professionals both at HEGP and HPSJ (CE: 4.05, SAT: 4.40 and CE: 3.47, SAT: 3.81, respectively).

Continuance intension is higher at HEGP than at HPSJ regardless of the profession considered (*Table 5 and Appendix 1, table A.11*).

Determinants of use, satisfaction and continuance intention

In multiple regression analysis, perceived usefulness is correlated positively and significantly with medical profession, CIS quality, confirmation of expectations and overall satisfaction in both sites and negatively and significantly correlated with age at HEGP. Profession-adjusted use (PAU) is correlated positively and significantly with the medical profession (MED) and the social norm (SN) and negatively and significantly correlated with age (*Table 6*). Overall satisfaction is correlated positively and significantly with CIS quality, perceived usefulness and confirmation of expectations. Continuance

intention is correlated positively and significantly with profession-adjusted use, perceived usefulness, facilitating conditions and overall satisfaction. R^2 values are higher at HPSJ, which was not involved in development of the UMISC model, than at HEGP.

Repetition of evaluation surveys at HEGP allows to test the relationships between continuance intention at year N and profession-adjusted use (PAU) and continuance intention at year (N+1 year). The results for year 2014 were correlated with continuance intention values from 2013 and results for year 2015 with those of year 2014. PAU at year (N+1 year) is positively and significantly correlated with medical profession, PAU, CE and SAT at year N (*p<.001*), but not with continuance intention at year N (*Table 7*). Continuance intention at year (N+1 year) is significantly correlated with ISQ and CI but not with PAU at year N.

4.4 SEM evaluation of the UMISC model

Structural equation modeling allows consideration of the direct, indirect and total effects of a given factor.

To test the possible bilateral relationships between profession-adjusted CIS use (PAU) and satisfaction, two SEM analyses were performed at each site, i.e., at the end of the study, under hypothesis $H_{15}a$ (positive relationship between satisfaction and use progressively disappears over time) and under hypothesis $H_{15}b$ (positive relationship between use and satisfaction disappears over time). The results are shown in figures 3 and 4 for hypothesis H_{15a} and in *Appendix A figures A.1 and A.2* for hypothesis $H_{15b.}$

When considering satisfaction as a determinant of use, R^2 coefficients associated with perceived usefulness, confirmation of expectations, CIS use, satisfaction and continuance intention are equal to 0.65, 0.64, 0.25, 0.92, and 0.72 at HEGP and 0.76, 0.75, 0.40, 0.93 and 0.71 at HPSJ, respectively. When considering CIS use as a determinant of satisfaction (under H_{15b}), R^2 coefficients associated with perceived usefulness, confirmation of expectations, CIS use, satisfaction and continuance intention are 0.65, 0.64, 0.25, 0.92, and 0.72 at HEGP and 0.77, 0.75, 0.35, 0.94, and 0.71 at HPSJ, respectively. Facilitating conditions have no significant relationship with PU and SAT at either site.

The R^2 coefficients are slightly higher at HPSJ than at HEGP, which was not involved in the UMISC model development (external validation) than at HEGP. At no site, the bilateral relationship between satisfaction and use is statistically significant.

Medical profession has a significant positive influence on PAU in both hospitals and a significant positive influence on PU at HEGP. Age has a significant negative influence on PAU at both sites and a significant negative influence on PU at HEGP.

Profession-adjusted CIS use is positively associated with the social norm and perceived usefulness at HEGP and only by the social norm at HPSJ. In both sites, satisfaction is predicted by CIS quality, perceived usefulness, and confirmation of expectations. Continuance intention is positively associated with perceived usefulness and satisfaction at HEGP and by PAU, perceived usefulness, and satisfaction at HPSJ.

Appendix A, Table A.6 summarizes the direct, indirect and total effects for all the hypotheses of the UMISC model in each of the two sites.

5 Discussion and conclusion

5.1 Study results

The deployment and long-term acceptance of clinical information systems (CISs) are faced with multiple difficulties. They include insufficient quality of the deployed systems and resistance to the multiple changes in care processes they induce. Permanent evaluation of deployed CIS solutions is therefore a prerequisite to their continuous improvement [34]. It should consider, among other factors, the choice of

the evaluation model with its different constructs, the timing of evaluation regarding the phase of IT project, the exact nature of the IT system, and the target professional end-user population. This paper addresses late and very late CIS post-adoption situations that are becoming prevalent in most hospitals or medical practices. The evaluation concerns the entire CIS considered here a black box and not its CIS parts or components (e.g., the CPOE, the PACS), and a multi-professional group of end-users including physicians, nurses, and secretaries and social workers in direct contact with patient health records. Thanks to usability-driven studies and more and more integrated interfaces and workflows, end-users are unlikely to know which part of a complex system there are using at instant *t*. They are also susceptible to evaluate a system on the basis of its weakest part.

The main objective of this paper was to evaluate the post-adoption unified model of information system continuance (UMISC) in two different environments: (1) the Georges Pompidou University Hospital (HEGP), where it was progressively developed from six successive surveys [34] and considered the internal validation site, and (2) an independent not for profit non-university multi-site hospital, HPSJ, considered as the external validation site. Both sites were certified HIMSS level 6 at the time of this comparative study. They both use the same CIS kernel (i.e., the EHR, CPOE, and RAS from Medasys) but different ADT and ancillary subsystems. They differ according to the anteriority of the CIS deployment, which is shorter at HPSJ than at HEGP. However, if the early deployment phases at HEGP were associated with multiple CIS evolutions and versions, HPSJ, which started later, could immediately benefit from a much more mature system than HEGP. The combined 2014 and 2015 HEGP surveys and the 2015 HPSJ survey used the same 50 structured questions and the 9 constructs of the full UMISC model, allowing between-site comparison around the different dimensions of the UMISC model as well as subgroup analysis.

Except for the social norm, mean scores on the evaluation constructs appear to be significantly higher at HEGP than at HPSJ. Differences appear to be in the same direction in the three professional categories but of higher magnitude in the physician subgroup. Four main explanations could be proposed: (1) a longer appropriation period at HEGP than at HPSJ is associated with progressive improvements as observed in our longitudinal survey [34]; (2) lower satisfaction dimension rates at HPSJ in the physician subgroup might reflect a common difficulty of hospitals with a high percentage of non-permanent physicians; (3) the higher density of other secretaries and social workers at HEGP than at HPSJ might be better accepted by physicians who are prone to delegate data entry tasks to trainees and/or less certified personals as observed in these surveys; and (4) the availability of a CDW at HEGP and not at HPSJ allows data reuse and fosters clinical research [48].

Non-permanent physicians are less prone to follow CIS training programs than permanent ones. They are also susceptible to comparing any existing system with a virtual solution that would combine the best of each system they may work in their multisite activity. They may underrate solutions that do not facilitate the reuse of EHR data in both university and non-university environments. Higher acceptance rates in non-medical professionals than in medical professionals confirm the results of our previous studies as well as those of the literature [63,64].

Despite the smaller number of completed surveys in this 2014-2015 surveys, R^2 coefficients appear to be higher for PU, CE, PAU, satisfaction and continuance intention than the respective values of our two previous studies [34,35]. More interestingly, the UMISC model fit is still better at HPSJ than at HEGP, both showing higher explanation capacities than in previously published surveys (i.e. 92-93% of the overall satisfaction variance vs. 33% in ECM [29], 55% in UTAUT [28], 78% in ITPAM2 [34] and 77.6% in ISSM [44], and 71-72% of the continuance intention variance vs. 41% in ECM [29] and 39% in ITPAM2 [34]. Two main explanations need to be discussed. First, a strict coherence between surveys was observed here, which combined with the mandatory nature of structured questions could improve the strength of between dimension correlations. Second, the broader scope of dimensions considered in UMISC (9 vs. 6 in our previous ITPAM2 model or less in other models) could have improved the explanatory power of the evaluation model. This could concerns, among other factors, the integration

within the UMISC model of end-user characteristics (age, medical profession), of the social norm, and the (behavioral) use in association [35].

High R^2 coefficients for PAU and CI in both sites allow a better understanding of their determinants. In late post-adoption, disappearance of the bilateral relationship between satisfaction and use was proposed as a possible maturity index of a CIS deployment project [34] and is confirmed in this study. This also applies to the HPSJ site, which followed a more aggressive deployment strategy but also benefitted from an improved CIS when starting its deployment project. In both sites, PAU was correlated with end-user characteristics (age, profession) but also with the social norm. Interestingly, continuance intention appears to be positively and significantly related with satisfaction and perceived usefulness but not with the social norm as if end-users were expressing some form of independence with their sociologic environment when discussing their future behavior. Lack of relationship between continuance intention and the social norm (in both sites) but also between continuance intention and PAU (at HEGP) could also be considered as an indirect indicator of CIS maturity, two relationships that could progressively disappear over time.

5.2 Limitations of the study

Several limitations of the study can be emphasized. First, the response rates in the two sites are low, a situation common in online surveys. The repetition of surveys at HEGP could have a negative impact on users, who may consider such repetition unnecessary. However, differences between HEGP and HPSJ that was performing its first evaluation survey were minimal in this study, allowing between-site comparison, even if the observed mean rates should be interpreted with caution in such a situation. This might not be the case for the multidimensional and SEM analyses.

PAU in the current survey is limited to the solutions that have received explicit organizational approval of their institutions. They do not cover other applications deployed by department other than IT, frequently grouped under the term of shadow IT, and that could influence satisfaction and continuance intention as well.

5.3 Conclusion and perspectives

The UMISC evaluation model developed at HEGP was validated in an external independent site, the Saint Joseph hospital environment. It can be proposed as a comparison and explanatory model of CIS use, satisfaction and continuance intention in post-CIS adoption situations that become prevalent in current electronic hospitals. Similar conclusions were observed in two different hospital environments, a public university hospital and a private multi-site nonprofit hospital group both located in Paris and sharing the same CIS core environment. They should be verified by studies performed in other hospitals, CIS environments, and countries but also possibly extended to the possible role of the shadow IT area of applications [65].

Author contribution

SM made a substantial contribution to the conception and design of this study, acquisition, analysis and interpretation of data, and drafting of the article. OB made substantial contributions to all the data acquisition steps at the Saint-Joseph hospital group. GM made substantial contributions to the data management steps. EC made substantial contributions to the statistical analysis and interpretation of results. JPL as Saint-Joseph Group chief executive officer was particularly involved in the promotion of the survey and data interpretation. PDG as PhD mentor of SM, made substantial contributions to framing the research objectives, the analysis and interpretation of data, and critically revising the article.

Conflict of interest

Samir Mellikeche first author of the article, and on behalf of other authors declare that there is no conflict of interest in the present paper.

References

1. The Joint Commission (TJC) 2017. Pioneers in Quality. [https://www.jointcommission.org/].
2. HIMSS Analytics 2017. [http://himssanalytics.org/emram].
3. Hightech Answers 2017. [https://www.hitechanswers.net/ehr-incentive-program-status-report-june-2017/].
4. HIMSS Analytics Europe 2017. [http://www.himss.eu/analytics/about-analytics-europe].
5. Degoulet P. The virtuous circles of clinical information systems: a modern utopia. *Yearb Med Inform*. 2016; 10(1): 256-263.
6. Daniels JH 2016. Healthcare IT Adoption, Function, Value & beyond. [http://www.himssconference.org/sites/himssconference/files/pdf/VCS3.pdf].
7. Leapfrog 2017. Preventing medication errors in hospitals. Data by hospital on nationally standardized metrics. [http://www.leapfroggroup.org/sites/default/files/Files/Leapfrog-Castlight%20Medication%20Safety%20Report.pdf]..
8. CMS 2015. Hospital Value-based purchasing. [https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/Hospital_VBPurchasing_Fact_Sheet_ICN907664.pdf].
9. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system related errors. *J Am Med Inform Assoc.* 2004; 11(2):104-112.
10. Ash JS, Sittig DF, Dyskstra R et al. The unintended consequences of computerized provider order entry: Findings from a mixed methods exploration. *Int J Med Inform.* 2009; 78(suppl 1): S69-S76.
11. Koppel R, Metlay JP, Cohen A, Abaluck B, Localio AR, Kimmel SE, Strom BL. Role of computerized physician order entry systems in facilitating medication errors. *JAMA*. 2005; 293(10): 1197-1203.
12. Hsiao JL, Chen RF. Critical factors influencing physicians' intention to use computerized clinical practice guidelines: an integrative model of activity theory and the technology acceptance model. *BMC Med Infor Dec Mak.* 2016; 16:3. doi: 10.1186/s12911-016-0241-3.
13. Bhattacharya I, Ramachandran A. A path analysis study of retention of healthcare professionals in urban India using health information technology. *Human Resources Health* 2015;13: 65. doi:10.1186/s12960-015-0055-x.
14. Lin C, Lin IC, Roan J. Barriers to physicians' adoption of healthcare information technology: An empirical study on multiple hospitals. *J Med Syst*. 2012; 36: 1965-1977.
15. Chen RF, Hsiao JL. An investigation on physicians' acceptance of hospital information systems: A case study. *Int J Med Inform.* 2012; 81(12): 810-820.
16. Cho KW, Bae SK, Ryu JH, Kim KN, An CH, Chae YM. Performance evaluation of public hospital information systems by the information system success model. *Health Inform Res.* 2015; 21(1): 43-48.
17. Tilahun B, Fritz F. Modeling antecedents of electronic medical record system implementation success in low-resource setting hospitals. *BMC Med Infor Dec Mak*. 2015 Aug 1; 15:61. doi: 10.1186/s12911-015-0192-0.
18. Likourezos A, Chalfin DB, Murphy DG, Sommer B, Darcy K, Davidson SJ. Physician and nurse satisfaction with an electronic medical record system. *Emerg Med*. 2004; 27(4); 419-424.
19. Hung CJ, Chang HH, Eng CJ, Wong KH. Service quality and perceived value of technology-based service encounters: evaluation of clinical staff satisfaction in Taiwan. *HIM J*. 2013; 42(1): 29-36.
20. Palm JM, Colombet I, Sicotte C, Degoulet P. Determinants of User Satisfaction with a Clinical Information System. *AMIA Annu Symp Proc.* 2006; 614-618.
21. Davis FD. A technology acceptance model for empirically testing new end-user information systems: theory and results. *MIT Sloan School of Management. Cambridge. MA*. 1985. Doctoral dissertation.
22. Fishbein M, Ajzen I. Belief, Attitude, Intention, and Behavior: an Introduction to Theory and Research. *Reading, MA: Addison-Wesley Pub*. 1975.
23. Ma Q, Liu L. The technology acceptance model: A meta-analysis of empirical findings. *J Organ End User Comput*. 2004; 16(1): 59-72.
24. King WR, He J. A meta-analysis of the technology acceptance model. *Information & Management.* 2006; 43(6): 740-755.
25. Venkatesh V, Morris M, Davis G. User acceptance of information technology: toward a unified view. *Manag Inform Syst Q*. 2003; 27: 425-478.

26. Wang HY, Wang SH. User acceptance of mobile internet based on the unified theory of acceptance and use of technology: investigating the determinants and gender differences. *Social Behavior and Personality*. 2010; 38(3): 415-426.

27. Lin CP, Bhattacherjee A. Learning online social support: an investigation of network information technology based on UTAUT. *Cyberpsychol Behav*. 2008; 11(3): 268-272.

28. Maillet E, Mathieu L. Modeling factors explaining the acceptance, actual use and satisfaction of nurses using an Electronic Patient Record in acute care settings: An extension of the UTAUT. *Int J Med Inf*. 2015; 84: 36-47.

29. Bhattacherjee A. Understanding information systems continuance: an expectation-confirmation model. *MIS Quart*. 2001; 25(3): 351-370.

30. Bhattacherjee A, Premkumar G. Understanding changes in belief and attitude towards information technology usage: a theoretical model and longitudinal test. *MIS Quart*. 2004; 28(2): 229-254.

31. Lee MC. Explaining and predicting users' continuance intention toward e-learning: An extension of the expectation–confirmation model. *Computers & Education*. 2010; 54: 506-516.

32. Palm JM, Dart T, Dupuis I, et al. Clinical information system post-adoption evaluation at the Georges Pompidou university hospital. *AMIA Annu Symp Proc*. 2010; 582-586.

33. Palm JM, Grant A, Moutquin JM, et al. Determinants of clinical information system post-adoption success. *Stud Health Technol Inform*. 2010; 160: 213-217.

34. Hadji B, Martin G, Dupuis I, Compoy E, Degoulet P. 14 Years longitudinal evaluation of clinical information systems acceptance: The HEGP case. *Int J Med Inf*. 2016; 86: 20-29.

35. Hadji B, Degoulet P. Information system end-user satisfaction and continuance intention: A unified modeling approach. *JBI*. 2016; 61: 185-193.

36. Bhattacherjee A, Lin CP. A unified model of IT continuance: three complementary perspectives and crossover effects. *Europ Jour Infor Sys*. 2015; 24(4): 364-373.

37. Ajzen I. From intentions to actions: a theory of planned behavior. in: Kuhl J, Beckmann J (Eds.), *Action Control. From Cognition to Behavior*. Springer, Berlin: Springer Verlag. 1985; pp. 11-39.

38. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 1991; 50: 179-211.

39. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quart*. 1989; 13(3): 319-340.

40. Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*. 2000; 46(2): 186-204.

41. Rogers EM. Diffusion of innovation. *Free press, (4th ed.), New York, USA*. 1995.

42. Delone WH. The DeLone and McLean model of information systems success: a ten-year update. *J Manag Inform Syst*. 2003; 19: 9-30.

43. DeLone WH, McLean ER. Information systems success: the quest for the dependent variable. *Inform. Syst. Res*. 1992; 3: 60-95.

44. Choi W, Rho MJ, Park J, Kim KJ, Kwon YD, Choi IY. Information system success model for customer relationship management system in health promotion centers. *Healthc Inform Res*. 2013; 19(2): 110-120.

45. Garcia-Smith D, Effken JA. Development and initial evaluation of the Clinical Information Systems Success Model (CISSM). *Int J Med Inf*. 2013; 82: 539-552.

46. Degoulet P, Marin L, Lavril M, et al. The HEGP component-based clinical information system. *Int J Med Inf*. 2003; 69: 115-26.

47. Zapletal E, Rodon N, Grabar N, et al. Methodology of integration of a clinical data warehouse with a clinical information system: the HEGP case. *Stud Health Technol Inform*. 2010; 160:193-7.

48. Jeannot AS, Zapletal E, Avillah P, Mamzer MF, Burgun A, Degoulet P. The Georges Pompidou university clinical data warehouse: A 8-years follow-up experience. *Int J Med Inform*. 2017; 102: 21-28.

49. Lee F, Teich JM, Spurr CD, Bates DW. Implementation of Physician Order Entry: User Satisfaction and Self-reported Usage Patterns. *J Am Med Inform Assoc*, 1996; 3(1): 42-55.

50. Wilson JP, Bulatao PT, Rascati KL. Satisfaction with a computerized practitioner order-entry at two military health care facilities. *Am J Healt Syst Pharm*. 2000; 57(23): 2188-2195.

51. Ifinedo P. The moderating effects of demographic and individual characteristicson nurses' acceptance of information systems: A Canadian study. *Int J Med Inform*. 2016; 87(1): 27–35.

52. Wu JH, Wang SC, Lin LM. Mobile computing acceptance factors in the healthcare industry: a structural equation model. *Int J Med Inform*. 2007; 76(1): 66-77.

53. Aggelidis VP, Chatzoglou PD. Using a modified technology acceptance model in hospitals. *Int. J. Med. Inf.* 2009; 78(2): 115-126.

54. Buenestado D, Elorz J, Pérez-Yarza EG, Iruetaguena A, Segundo U, Barrena R, Pikatza JM. Evaluating acceptance and user experience of a guideline-based clinical decision support system execution platform. *J Med Syst. 2013*; 37(2): 9910.

55. Chiu TM, Eysenbach G. Stages of use: consideration, initiation, utilization, and outcomes of an internet-mediated intervention. *BMC Med Inform Decis Mak*. 2010; 10:73.

56. Gagnon MP, Orruño E, Asua J, Abdeljelil AB, Emparanza J. Using a modified technology acceptance model to evaluate healthcare professionals' adoption of a new telemonitoring system. *Telemed J E-Health*. 2012; 18(1): 54-59.

57. Degoulet P, Luna D, de Quiros FGB. Clinical information systems. *Global Health Informatics*. 2017; 129-151.

58. Danaher PJ, Rust RT. Indirect financial benefits from service quality. *Quality Management Journal*. 1996; 3(2): 63-75.

59. Steiger JH. Understanding the limitations of global fit assessment in structural equation modeling. *Pers. Indiv. Differ*. 2007; 42(1): 893-898.

60. Gefen D, Straub DW, Boudreau MC. Structural equation modeling and regression: guidelines for research practice. *Commun. Assoc. Inform. Syst*. 2000; 4(1): 2-77.

61. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate Data Analysis, *7th Edition*. *2010. Prentice Hall*.

62. Chin WW, Todd PA. On the use, usefulness, and ease of use of structural equation modeling in MIS research: a note of caution. *MIS Quart.* 1995; 19(1): 237-246.

63. Pynoo B, Devolder P, Voet T. Assessing hospital physicians' acceptance of clinical information systems: a review of the relevant literature. *Psychologica Belgica.* 2013; 53: 15-31. DOI: 10.5334/pb-53-2-15.

64. Abdekhoda M, Ahmadi M, Dehnad A, Hosseini AF. Information technology acceptance in health information management. *Methods Inf Med*. 2014; 53(1):14‑20.

65. Silic M, Back A. Shadow IT – A view from behind the curtain. *Computers & security*. 2014; 45: 274-283.

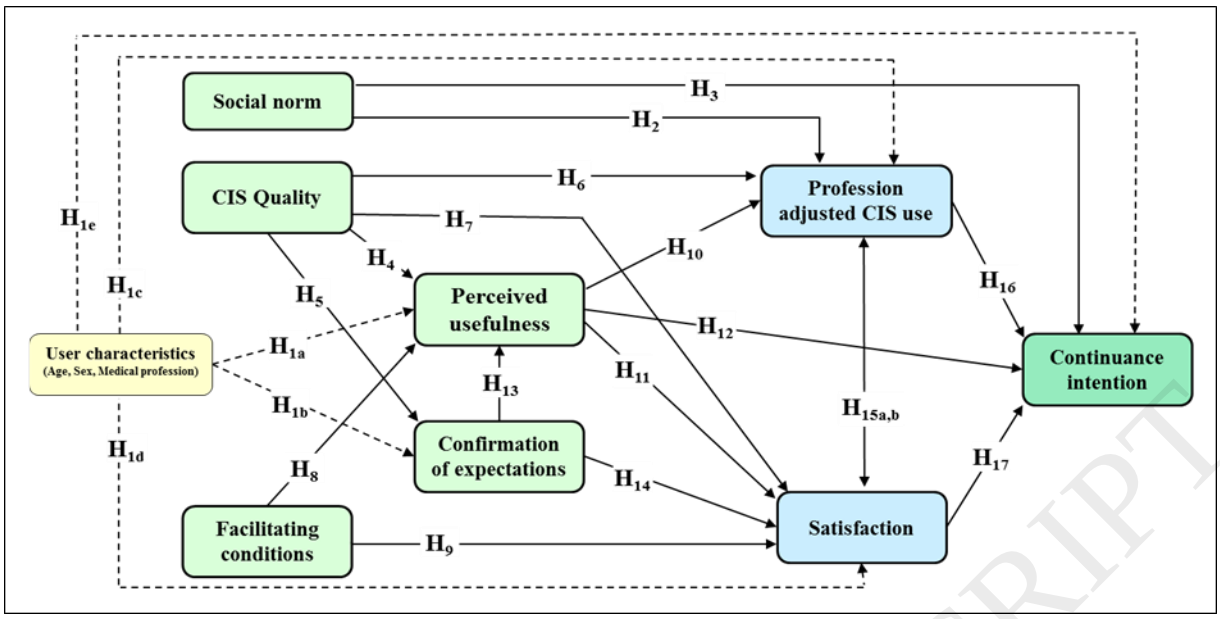


Figure 1. Research hypotheses within the UMISC model

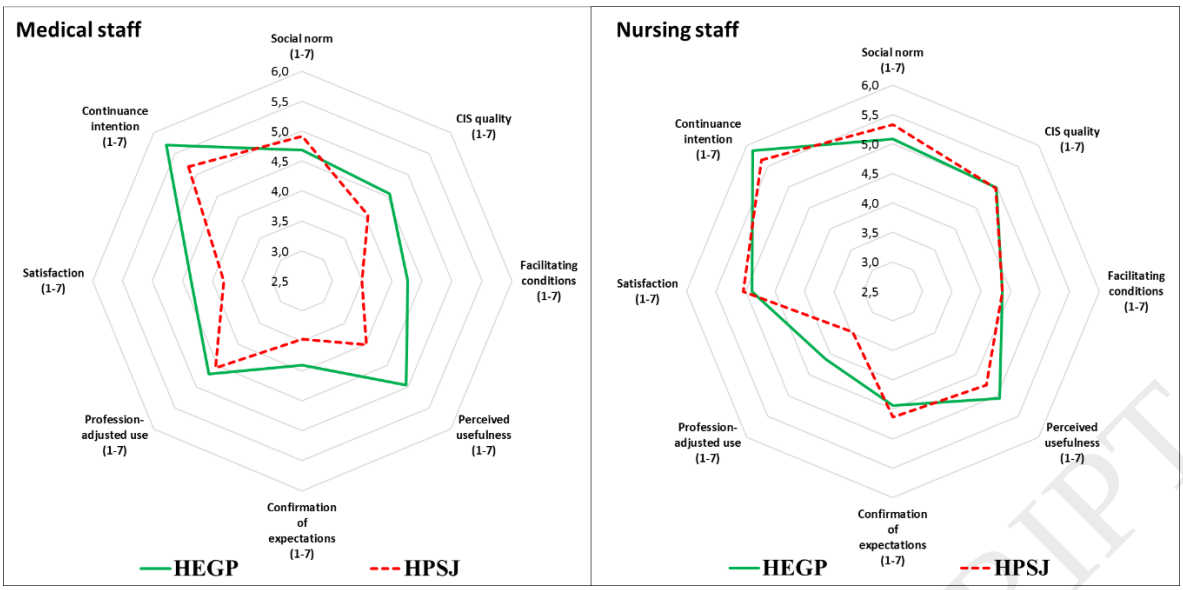


Figure 2. Dimensions of use and satisfaction of medical and nursing staff (HEGP vs. HPSJ)

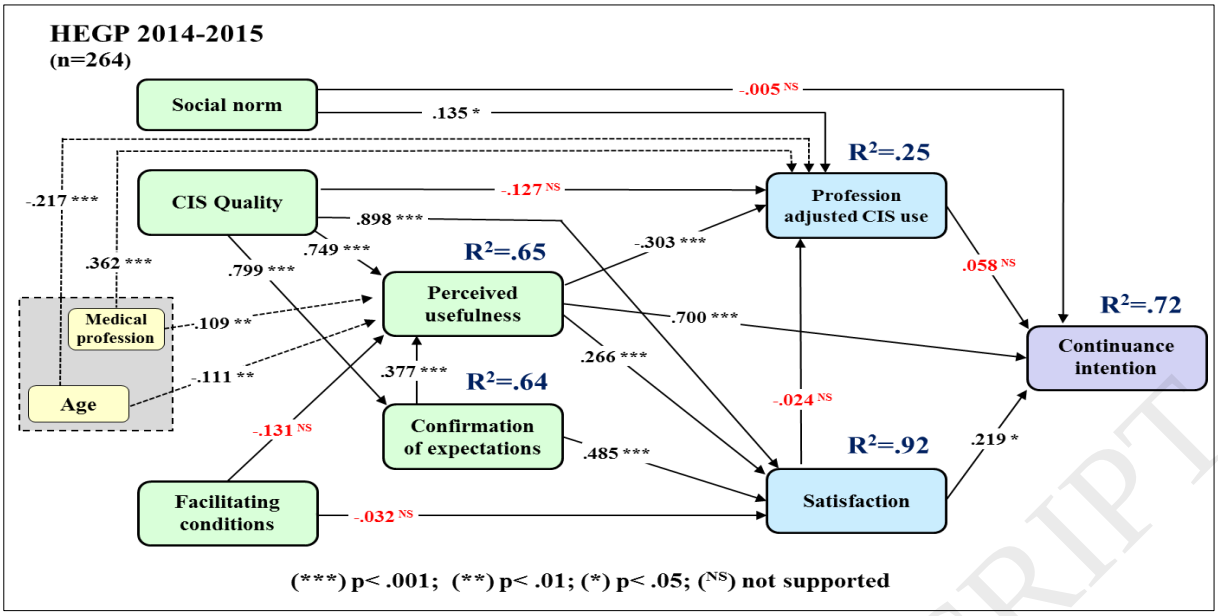


Figure 3. Results of the structural equation modeling analysis (HEGP 2014-2015)

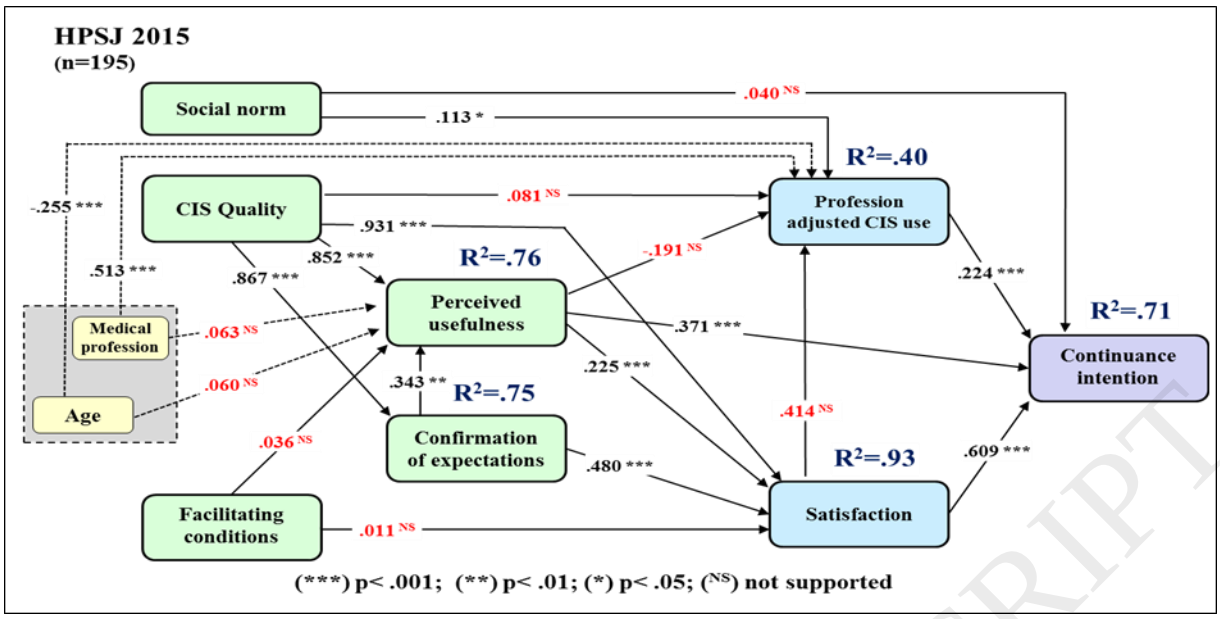


Figure 4. Results of the structural equation modeling analysis (HPSJ 2015)

Table 1. Examples of acceptance and continuance evaluation models

Theories and models	Dimensions		
	Independent	Intermediary	Dependent
Theory of reasoned action (TRA) [22]	Attitude, subjective norms	Intention	Use
Theory of planned behavior (TPB) [37,38]	Attitude, subjective norms, control perception	Intention	Use
Technology acceptation model (TAM/TAM2) [21,39,40]	Perceived utility, perceived facility	Attitude, intention	Use
Innovation diffusion theory (IDT) [41]	Relative advantage (perceived utility), ease of use, compatibility, testability	Intention	Behavior (use, usage)
Expectation confirmation model (ECM) [29]	Confirmation of expectations	Perceived usefulness, satisfaction	Continuance intention
Information system success model (ISSM) [42]	Information quality, system quality, service quality	Use intention, satisfaction	Net benefits
Unified Theory of Acceptance and Use of Technology (UTAUT) [25]	Performance expectancy, effort expectancy, social influence, facilitating conditions, individual characteristics	Intention	Use
Information technology post-adoption model (ITPAM) [32]	User characteristics, CIS compatibility, ease of use, CIS support, confirmation of expectations, perceived usefulness	Satisfaction	Use
Unified model of information Technology Continuance (UMITC) [36]	Subjective norm, perceived usefulness, confirmation of expectations (disconfirmation)	Continuance intention, satisfaction, use habit	Continuance behavior
Unified model of information system continuance (UMISC) [35]	User characteristics, system quality, confirmation of expectations, perceived usefulness, social norm	Satisfaction, use	Continuance intention

Table 2. Respondent characteristics

Respondent characteristics	**HEGP (n=264)** *Frequency (%)*	**HPSJ (n=195)** *Frequency (%)*	**Total (n=459)** *Frequency (%)*	***p-value***
Gender				
Male	67 *(25.38%)*	48 *(24.62%)*	115 *(25.05%)*	*0.852*
Female	197 *(74.62%)*	147 *(75.38%)*	344 *(74.95%)*	
Profession				
Physicians	93 *(35.23%)*	62 *(31.79%)*	155 *(33.77%)*	*0.443*
Nurses	107 *(40.53%)*	94 *(48.21%)*	201 *(43.79%)*	
Others	64 *(24.24%)*	39 *(20.00%)*	103 *(22.44%)*	
Mean users age, (*SD**)	42.54 *(10.60)*	44.51 *(12.29)*	43.38 *(11.38)*	*0.065*
Mean anteriority of CIS use, (*SD**)	8.54 *(8.48)*	4.22 *(6.45)*	6.71 *(7.97)*	*<0.001*

SD : standard deviation*

Table 3. Profession-adjusted CIS use

Profession-adjusted use (Scales 1 to 7)*	**HEGP (n=264)****	**HPSJ (n=195)****	**Total (n=459)****	***p-value***
ID-ADT	3.54 (2.43)	2.79 (2.17)	3.21 (2.35)	*0.0058*
Report visualization	5.29 (1.89)	4.58 (2.23)	4.99 (2.07)	*0.0002*
Clinical data visualization	3.78 (2.33)	4.05 (2.68)	3.90 (2.49)	*0.2561*
Drug order visualization	4.98 (2.06)	3.73 (2.40)	4.45 (2.30)	*<0.0001*
Biology visualization	5.32 (2.09)	4.91 (2.33)	5.15 (2.20)	*0.0454*
Imaging visualization	3.45 (2.55)	2.93 (2.34)	3.23 (2.48)	*0.0259*
Imaging report visualization	4.35 (2.39)	3.12 (2.30)	3.83 (2.43)	*<0.0001*
Flowcharts visualization	4.14 (2.47)	4.37 (2.53)	4.24 (2.49)	*0.3284*
Care plans visualization	3.79 (2.46)	3.97 (2.45)	3.87 (2.45)	*0.4442*
Nurse transmissions visualization	4.84 (2.16)	4.07 (2.34)	4.51 (2.27)	*0.0003*
Nurse transmission entry	3.18 (2.62)	3.45 (2.74)	3.30 (2.67)	*0.4172*
Report entry	4.16 (2.75)	4.03 (2.84)	4.12 (2.78)	*0.7248*
Diagnosis-acts entry	3.10 (2.58)	4.33 (2.81)	3.43 (2.69)	*0.0028*
Biology prescriptions	3.34 (2.67)	4.56 (2.49)	3.66 (2.68)	*0.0029*
Imaging prescriptions	3.49 (2.68)	3.09 (2.41)	3.38 (2.61)	*0.3199*
Nursing prescriptions	2.35 (2.22)	2.78 (2.53)	2.51 (2.35)	*0.0763*
Drug prescriptions	3.15 (2.50)	5.07 (2.44)	3.66 (2.62)	*<0.0001*
Appointment scheduling	2.68 (2.52)	2.48 (2.37)	2.60 (2.45)	*0.4752*
Average Adjusted use	**4.01 (1.50)**	**3.72 (1.41)**	**3.88 (1.47)**	***0.0381***

**: 1=unused, 2=rarely, 3=rather rarely, 4=occasionally, 5=somewhat frequent, 6=frequently and 7=Very frequently;*
***: Average (standard deviation)*

Table 4. Raw use rate in the nursing group for four (4) physician-related functions

CIS use function (Scales 1 to 7)*	**Mean (*SD*)**			***p-value***
	HEGP (n=106)	HPSJ (n=94)	Total (n=200)	
DRG coding	5.01 *(1.22)*	1.92 *(1.99)*	3.55 *(2.24)*	*<.001*
Biology prescriptions	1.50 *(1.36)*	1.15 *(.59)*	1.33 *(1.08)*	*.024*
Imaging prescriptions	1.66 *(1.62)*	1.33 *(1.29)*	1.51 *(1.48)*	*.115*
Drug prescriptions	1.83 *(1.90)*	1.34 *(1.30)*	1.60 *(1.66)*	*.039*

**: 1=unused, 2=rarely, 3=rather rarely, 4=occasionally, 5=somewhat frequent, 6=frequently and 7=Very frequently; SD: Standard deviation*

Table 5. The dimensions of satisfaction

Dimensions (Scales 1 to 7)*	**HEGP (n=264)****	**HPSJ (n=195)****	**Total (n=459)****	***p-value***
Use	3.51 (1.26)	3.11 (1.20)	3.34 (1.25)	*0.0007*
Profession-adjusted Use (PAU)	4.01 (1.50)	3.72 (1.41)	3.88 (1.47)	*0.0381*
CIS quality (ISQ)	4.85 (1.05)	4.70 (1.12)	4.79 (1.08)	*0.1579*
Information quality	*5.09 (1.13)*	*4.67 (1.43)*	*4.91 (1.29)*	*0.0005*
Reliability	*5.09 (1.17)*	*4.79 (1.31)*	*4.97 (1.24)*	*0.0092*
Availability	*5.04 (1.25)*	*4.80 (1.35)*	*4.94 (1.30)*	*0.0524*
Compatibility with work	*4.76 (1.41)*	*4.49 (1.60)*	*4.65 (1.50)*	*0.0512*
Response time	*4.23 (1.63)*	*4.45 (1.53)*	*4.32 (1.59)*	*0.1565*
Ease of use	*4.87 (1.33)*	*4.77 (1.65)*	*4.83 (1.47)*	*0.4893*
Data confidentiality	*4.94 (1.31)*	*4.96 (1.44)*	*4.95 (1.37)*	*0.8795*
Perceived usefulness (PU)	5.09 (1.15)	4.56 (1.44)	4.87 (1.31)	*<0.0001*
Facilitating conditions (FC)	4.46 (1.15)	4.13 (1.38)	4.30 (1.24)	*0.0045*
Confirmation of expectations (CE)	4.37 (1.12)	4.19 (1.37)	4.29 (1.28)	*0.1319*
Social norm (SN)	4.90 (1.07)	5.15 (1.08)	5.00 (1.08)	*0.0133*
Overall satisfaction (SAT)	4.74 (1.21)	4.60 (1.45)	4.68 (1.31)	*0.2731*
Continuance intention CI)	5.85 (1.10)	5.43 (1.25)	5.68 (1.19)	*0.0002*

**: 1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=no opinion, 5=somewhat agree, 6=agree, 7=strongly agree;*
***: Average (standard deviation)*

Table 6. Determinants of use, satisfaction and continuance intention

Dimensions	Multiple Regression					
	HEGP 2014-2015 (n=264)		HPSJ 2015 (n=195)		HEGP & HPSJ (n=459)	
	Coef.	*p-value*	Coef.	*p-value*	Coef.	*p-value*
Perceived Usefulness						
Age	-.131	*.006*	.053	*.267*	-.066	*.045*
Sex	.009	*.857*	.010	*.840*	.015	*.675*
Medical profession (MED)	.099	*.053*	.050	*.341*	.079	*.030*
CIS Quality (ISQ)	.370	*<.001*	.385	*<.001*	.335	*<.001*
Confirmation of Expectations (CE)	.406	*<.001*	.450	*<.001*	.431	*<.001*
Facilitating conditions	-.035	*.565*	.054	*.393*	.045	*.299*
Adjusted R^2	**.678**	***< .001***	**.799**	***< .001***	**.734**	***< .001***
Profession-adjusted Use						
Age	-.248	*<.001*	-.251	*<.001*	-.278	*<.001*
Sex	.021	*.728*	.107	*.112*	.074	*.104*
Medical profession (MED)	.377	*<.001*	.492	*<.001*	.419	*<.001*
CIS Quality (ISQ)	-.009	*.929*	.072	*.572*	-.017	*.824*
Social Norm (SN)	.124	*.045*	.133	*.045*	.105	*.020*
Perceived Usefulness (PU)	-.157	*.049*	-.134	*.216*	-.107	*.095*
Confirmation of expectations (CE)	.025	*.806*	.079	*.542*	.067	*.408*
Facilitating conditions	.101	*.178*	-.209	*.019*	-.009	*.873*
Satisfaction (SAT)	-.122	*.309*	.217	*.152*	.009	*.928*
Adjusted R^2	**.221**	***<.001***	**.310**	***< .001***	**.224**	***< .001***
Satisfaction						
Age	.041	*.196*	-.025	*.455*	.010	*.644*
Sex	-.068	*.033*	-.021	*.523*	-.045	*.045*
Medical profession (MED)	-.008	*.812*	-.043	*.282*	-.018	*.473*
Profession-adjusted Use (PAU)	-.033	*.309*	.051	*.152*	.002	*.928*
CIS Quality (ISQ)	.308	*<.001*	.241	*<.001*	.295	*<.001*
Perceived Usefulness (PU)	.190	*<.001*	.250	*<.001*	.198	*<.001*
Confirmation of expectations (CE)	.373	*<.001*	.418	*<.001*	.414	*<.001*
Facilitating conditions	.127	*.001*	.054	*.212*	.075	*.009*
Social Norm (SN)	.009	*.781*	.037	*.253*	.033	*.147*
Adjusted R^2	**.787**	***< .001***	**.838**	***< .001***	**.807**	***< .001***
Continuance Intention						
Age	.011	*.804*	-.017	*.747*	-.025	*.464*
Sex	.056	*.236*	.009	*.863*	.035	*.305*
Medical profession (MED)	.006	*.905*	.079	*.204*	.047	*.225*
Profession-adjusted Use (PAU)	.053	*.270*	.129	*.022*	.096	*.007*
CIS Quality (ISQ)	.072	*.343*	.196	*.044*	.111	*.060*
Perceived Usefulness (PU)	.486	*<.001*	.265	*.002*	.413	*<.001*
Social Norm (SN)	-.035	*.466*	.064	*.205*	.010	*.776*
Confirmation of Expectations (CE)	.074	*.337*	-.047	*.636*	.027	*.663*
Facilitating conditions	-.122	*.035*	-.268	*<.001*	-.193	*<.001*
Satisfaction (SAT)	.291	*.002*	.552	*<.001*	.396	*<.001*
Adjusted R^2	**.543**	***< .001***	**.605**	***< .001***	**.562**	***< .001***

Table 7. Relationships between continuance intention at year N and profession-adjusted CIS use and continuance intention at year (N+1 year)

Prediction dimensions at year N	**PAU at year (N+1 year) (n=170)**		**Continuance intention at year (N+1 year) (n=170)**	
	Coef.	*p-value*	*Coef.*	*p-value*
Age	-.077	*.089*	-.051	*.417*
Medical profession	.168	***<.001***	-.018	*.779*
PAU	.741	***<.001***	-.086	*.180*
CIS Quality	-.019	*.809*	.227	***.034***
Perceived Usefulness	.078	*.234*	-.135	*.140*
Confirmation of expectations	.104	***.037***	.015	*.822*
Satisfaction	-.180	***.017***	-.053	*.610*
Continuance intention	-.075	*.185*	.663	***<.001***
Adjusted R^2 (p-value)	**.750**	*<.001*	**.521**	*<.001*

***PAU**: Profession-adjusted CIS Use*

Appendix A:

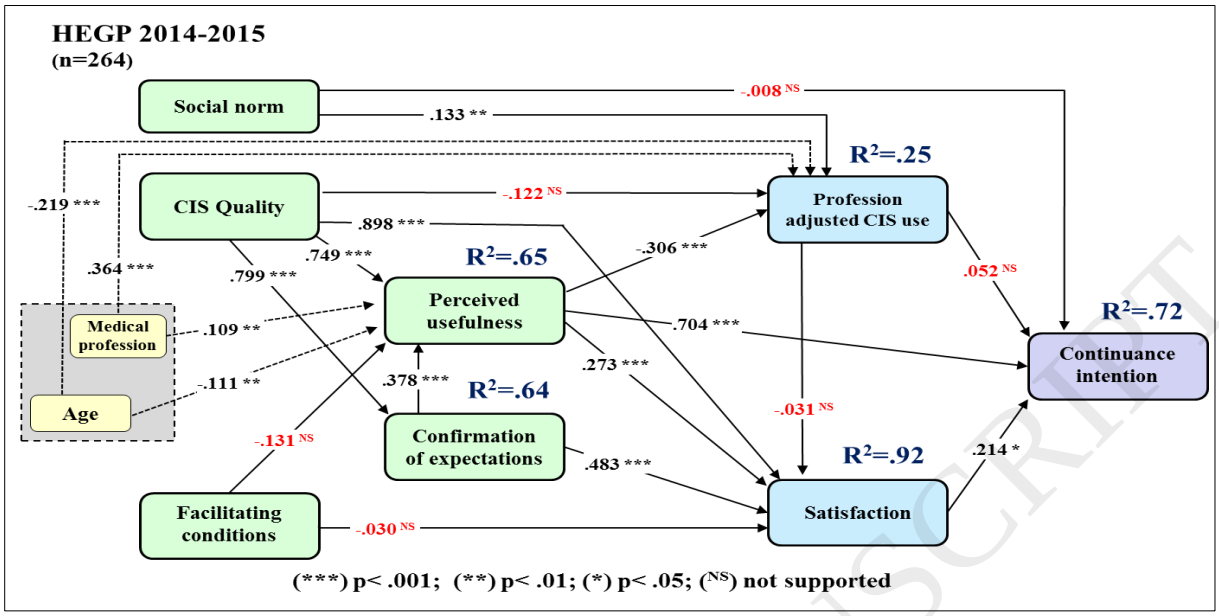


Figure A.1. SEM evaluation of the path Profession-adjusted CIS use to Satisfaction of the UMISC model - Results of the structural equation model (HEGP 2014-2015)

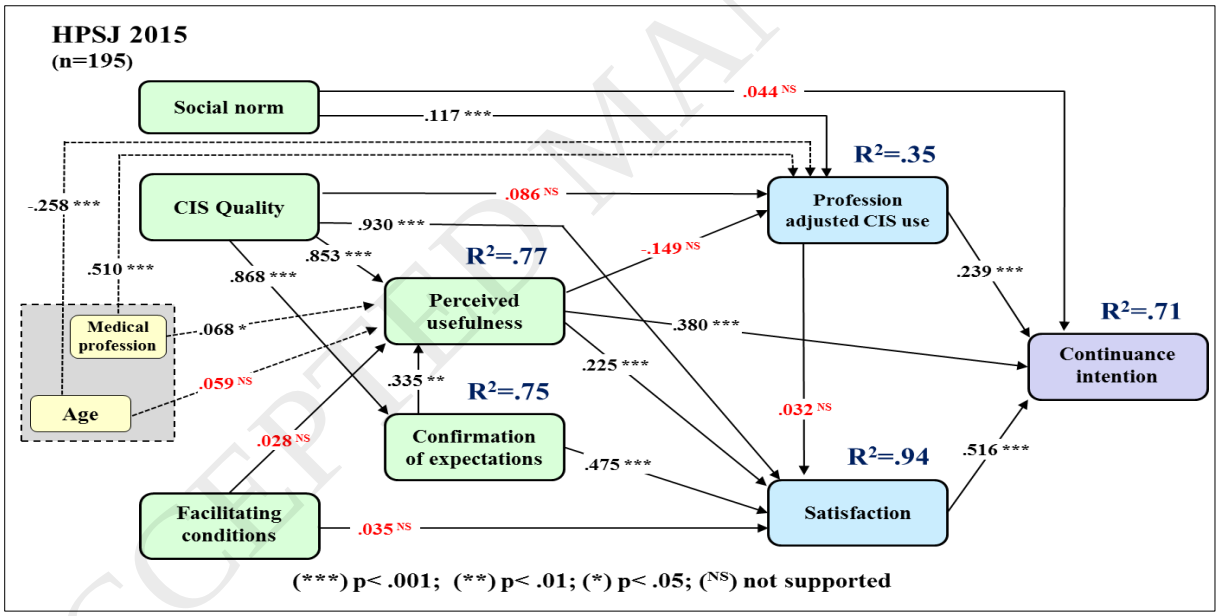


Figure A.2. SEM evaluation of the path Profession-adjusted CIS use to Satisfaction of the UMISC model - Results of the structural equation model (HPSJ 2015)

Table A.1. Questionnaire items used in the surveys

N	Constructs	Questions	Item Type
1	**User characteristics**		
		1.1. Profession category	Structured
		1.2. Service/unit attachment	Free text
		1.3. Gender	Structured
		1.4. Age	Structured
		1.5. Education status (training/graduate)	Structured
		1.6. Employment status (full time/on partial time)	Structured
		1.7. Seniority at work (years)	Structured
2	**CIS use**		
		2.1. Manage patient ID, Admissions and Transfer (ADT)	Use level (1-7)
		2.2. Consult reports (hospitalizations and consultations)	Use level (1-7)
		2.3. Consult clinical data	Use level (1-7)
		2.4. Consult drug prescriptions	Use level (1-7)
		2.5. Consult biology results	Use level (1-7)
		2.6. Consult radiology images	Use level (1-7)
		2.7. Consult radiology reports	Use level (1-7)
		2.8. Consult patient charts	Use level (1-7)
		2.9. Consult patient care plans	Use level (1-7)
		2.10. Consult nurse transmissions	Use level (1-7)
		2.11. Enter nurse transmissions	Use level (1-7)
		2.12. Enter patient reports (hospitalization. consultation. etc.)	Use level (1-7)
		2.13. Do DRG coding (PMSI)	Use level (1-7)
		2.14. Enter biology orders	Use level (1-7)
		2.15. Enter radiology orders	Use level (1-7)
		2.16. Enter (nursing) care prescriptions	Use level (1-7)
		2.17. Enter drug prescriptions	Use level (1-7)
		2.18. Manage scheduling appointments	Use level (1-7)
3	**CIS quality**		
		3.1. I'm satisfied with the quality of information available in the CIS	Likert scales (1-7)
		3.2. I'm satisfied with the reliability of the CIS	Likert scales (1-7)
		3.3. The CIS is always available when I need it	Likert scales (1-7)
		3.4. The CIS use is compatible with all aspects of my work	Likert scales (1-7)
		3.5. I'm satisfied with speed of the CIS	Likert scales (1-7)
		3.6. The CIS use is easy for me	Likert scales (1-7)
		3.7. I'm satisfied with the confidentiality offered by the CIS	Likert scales (1-7)
4	**Perceived CIS usefulness**		
		4.1. The use of CIS improve my efficiency in my professional practice	Likert scales (1-7)
		4.2. The use of CIS improve my decision making	Likert scales (1-7)
		4.3. The CIS is generally useful in my professional practice	Likert scales (1-7)
5	**Facilitating conditions**		
		5.1. I'm satisfied with the training on the use of the CIS	Likert scales (1-7)
		5.2. I am satisfied with the informatics support services	Likert scales (1-7)
6	**Confirmation of expectations**		
		6.1. The CIS quality is better than I was expecting	Likert scales (1-7)
		6.2. The CIS usability is better than I was expecting	Likert scales (1-7)
		6.3. The CIS usefulness in my practice is better than I was expecting	Likert scales (1-7)
		6.4. The quality of support is better than I was expecting	Likert scales (1-7)
7	**Social norm**		
		7.1. The hospital hierarchy prompts me to use the CIS	Likert scales (1-7)
		7.2. My colleagues encourage me to use the CIS	Likert scales (1-7)
		7.3. I found the help needed to use the CIS within my colleagues	Likert scales (1-7)
8	**Satisfaction**		
		8.1. Generally I'm satisfied with my experience with the CIS use	Likert scales (1-7)
		8.2. I'm satisfied with the improvements made to the CIS	Likert scales (1-7)
		8.3. I am satisfied with my computing experience in the hospital	Likert scales (1-7)
9	**Continuance intention**		
		9.1. If I had the choice I will continue to use the CIS and not return to a paper-based system	Likert scales (1-7)
		9.2. I will continue to use the CIS in the future	Likert scales (1-7)
		9.3. I want to improve in the future my skill in the use of the CIS	Likert scales (1-7)

Table A.2. Employment Adjustment Matrix

CIS use function	MED	NUR	OTH
Manage patient ID, Admissions and Transfer		X	X
Report visualization	X	X	X
Drug order visualization	X	X	X
Biology visualization	X	X	X
Image visualization	X	X	X
Flowcharts visualization	X	X	X
Clinical data visualization	X	X	X
Imaging report visualization	X	X	X
Care plans visualization	X	X	X
Nurse transmission visualization	X	X	X
Nurse transmission entry		X	
Report entry	X		X
Diagnosis-acts entry	X		
Biology prescriptions	X		
Imaging prescriptions	X		
Nursing prescriptions	X	X	
Drug prescriptions	X		
Appointment scheduling		X	X

Table A.3. Validity of the survey instrument - Cronbach alpha (HEGP-HPSJ, n=459)

Evaluation construct	Number of items	Cronbach's α
Profession adjusted-use	18	0.825
CIS Quality	7	0.867
Perceived CIS usefulness	3	0.885
Confirmation of expectations	4	0.917
Social norm	3	0.715
Global Satisfaction	3	0.889
Intention to continue	3	0.833

Table A.4. Influence of the professional categories on the evaluation dimensions

Hospital	HEGP				HPSJ			
Dimensions (Scales 1 to 7)*	**MED (n=93)****	**NUR (n=107)****	**OTH (n=64)****	***p-value***	**MED (n=62)****	**NUR (n=94)****	**OTH (n=39)****	***p-value***
Raw use	4.17 *(1.44)*	3.35 *(0.88)*	2.81 *(1.04)*	*<0.001*	3.96 *(1.31)*	2.83 *(0.96)*	2.45 *(0.76)*	*<0.001*
Profession-adjusted Use (PAU)	4.70 *(1.68)*	4.12 *(1.10)*	2.81 *(1.04)*	*<0.001*	4.55 *(1.47)*	3.47 *(1.26)*	2.99 *(1.01)*	*<0.001*
CIS Quality (ISQ)	4.56 *(1.18)*	4.98 *(1.00)*	5.06 *(0.85)*	*0.003*	4.05 *(1.07)*	4.97 *(0.95)*	5.11 *(1.12)*	*<0.001*
Perceived Usefulness (PU)	4.97 *(1.36)*	5.08 *(1.08)*	5.30 *(0.92)*	*0.213*	4.01 *(1.66)*	4.74 *(1.25)*	5.02 *(1.25)*	*<0.001*
Social Norm (SN)	4.68 *(1.07)*	5.08 *(1.07)*	4.91 *(1.01)*	*0.031*	4.91 *(0.89)*	5.33 *(1.13)*	5.09 *(1.20)*	*0.056*
Confirmation of expectations (CE)	4.05 *(1.12)*	4.43 *(1.11)*	4.74 *(1.05)*	*<0.001*	3.47 *(1.35)*	4.63 *(1.24)*	4.31 *(1.26)*	*<0.001*
Satisfaction (SAT)	4.40 *(1.31)*	4.85 *(1.18)*	5.04 *(0.96)*	*0.002*	3.81 *(1.46)*	5.04 *(1.26)*	4.80 *(1.36)*	*<0.001*
Continuance Intention (CI)	5.76 *(1.20)*	5.95 *(1.07)*	5.83 *(1.02)*	*0.473*	5.19 *(1.49)*	5.65 *(1.05)*	5.32 *(1.25)*	*0.066*

**: 1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=no opinion, 5=somewhat agree, 6=agree, 7=strongly agree; **: Average (standard deviation)*

Table A.5. Structural equation model parameters (Path: Satisfaction → Profession-adjusted CIS Use)

SEM parameters	χ^2	df	*p-value*	$\chi 2$/df	NFI	NNFI	CFI	RMSEA
Recommended value	-	-	<.0001	<3	>.8	>.8	>.8	<.8
HEGP (2014-2015)	752.13	333	<.0001	2.26	.784	.845	.865	.069
HPSJ (2015)	750.28	333	<.0001	2.25	.786	.847	.866	.080

Table A.6. Direct, indirect and total effect of the UMISC dimensions model

Hypothesis (from→to)	Direct effect factor			irect effect factor			al effect factor			bservations
	Parameter mate	z-value	*p-value*	rameter mate	alue	*alue*	rameter mate	alue	*alue*	
HEGP 2014-2015										
ISQ → PU	.711	4.22	*<.001*	1	2	*01*	9	1	*01*	pported ***
ISQ →CE	.799	8.53	*<.001*				9	3	*01*	Supported ***
ISQ →SAT	.539	4.47	*<.001*	5	2	*01*	3	9	*01*	Supported ***
ISQ → CI	-	-	-	4	6	*01*	4	6	*01*	Supported ***
ISQ → PAU	.206	.649	*.258*	44	484	*8*	27	79	*2*	Not Supported
PU → SAT	.231	3.89	*<.001*				5	9	*01*	Supported ***
PU → CI	.590	5.30	*<.001*	1	25	*0*	0	4	*01*	Supported ***
PU → PAU	-.330	-2.39	*.008*	06	09	*6*	03	07	*01*	Supported ***
CE → PU	.440	3.72	*<.001*				7	2	*01*	Supported ***
CE → SAT	.389	5.01	*<.001*	0	3	*4*	5	2	*01*	Supported ***
CE → CI	-	-	-	3	1	*01*	3	1	*01*	Supported ***
CE → PAU	-	-	-	23	383	*3*	23	383	*3*	Not Supported
FC → PU	-.131	-.938	*.174*				31	38	*4*	Not Supported
FC → SAT	.002	.076	*.469*	35	36	*3*	32	42	*0*	Not Supported
FC → CI	-	-	-	01	02	*3*	01	02	*3*	Not Supported
FC → PAU	-	-	-	9	7	*9*	9	7	*9*	Not Supported
SAT →CI	.227	1.886	*.029*	01	09	*6*	9	99	*8*	Supported *
SAT → PAU	-.031	-.108	*.456*				24	08	*6*	Not Supported
PAU → CI	.046	1.405	*.080*				3	05	*0*	Not Supported
SN → PAU	.135	2.30	*.010*				5	0	*0*	Supported *
SN → CI	-.018	-.290	*.385*	3	69	*1*	05	07	*7*	Not Supported
MP → PU	.109	2.42	*.007*				9	2	*7*	Supported **
MP → SAT	-	-	-	9	14	*7*	9	14	*7*	Supported *
MP → CI	-	-	-	9	0	*4*	9	0	*4*	Supported **
MP → PAU	1.258	7.02	*<.001*	33	394	*9*	2	1	*01*	Supported ***
AGE →PU	-.111	-2.66	*.003*				1	36	*3*	Supported **
AGE →SAT	-	-	-	30	00	*2*	30	00	*2*	Supported *
AGE →CI	-	-	-	02	53	*5*	02	53	*5*	Supported **
AGE → PAU	-.036	-4.42	*<.001*	4	9	*8*	7	51	*01*	Supported ***
HPSJ 2015										
ISQ → PU	.721	4.40	*<.001*	7	0	*3*	2	9	*01*	Supported ***
ISQ →CE	.867	14.34	*<.001*				7	34	*01*	Supported ***
ISQ →SAT	.486	4.18	*<.001*	0	8	*01*	1	0	*01*	Supported ***
ISQ → CI	-	-	-	3	9	*01*	3	9	*01*	Supported ***
ISQ → PAU	-.077	-.278	*.390*	3	2	*3*	1	8	*5*	Not Supported
PU → SAT	.215	3.09	*<.001*				5	9	*01*	Supported ***
PU → CI	.304	2.36	*.009*	3	96	*5*	1	5	*01*	Supported ***
PU → PAU	-.269	-1.592	*.055*	3	95	*7*	01	259	*4*	Not Supported
CE → PU	.385	2.80	*.002*				3	0	*2*	Supported **
CE → SAT	.432	5.12	*<.001*	7	8	*3*	0	7	*01*	Supported ***
CE → CI	-	-	-	3	8	*01*		8	*01*	Supported ***
CE → PAU	-	-	-	1	2	*8*	1	2	*8*	Not Supported
FC → PU	.036	.726	*.233*				5	6	*3*	Not Supported
FC → SAT	.004	.088	*.464*	3	0	*1*	1	0	*3*	Not Supported
FC → CI	-	-	-	5	0	*4*	5	0	*4*	Not Supported
FC → PAU	-	-	-	06	32	*9*	06	32	*9*	Not Supported
SAT →CI	.551	4.02	*<.001*	2	70	*5*	9	6	*01*	Supported ***
SAT → PAU	.409	1.495	*.067*				4	95	*7*	Not Supported
PAU → CI	.241	4.56	*<.001*				4	6	*01*	Supported ***
SN → PAU	.113	1.750	*.040*				3	50	*0*	Supported *
SN → CI	.048	.288	*.386*	5	26	*1*	0	9	*2*	Not Supported
MP → PU	.063	1.323	*.092*				3	23	*2*	Not Supported
MP → SAT	-	-	-	4	40	*7*	4	40	*7*	Not Supported
MP → CI	-	-	-	1	3	*01*	1	3	*01*	Supported ***
MP → PAU	1.681	8.39	*<.001*	2	022	*3*	3	1	*01*	Supported ***
AGE →PU	.060	1.380	*.083*				0	80	*3*	Not Supported
AGE →SAT	-	-	-	3	97	*5*	3	97	*5*	Not Supported
AGE →CI	-	-	-	32	252	*5*	32	252	*5*	Not Supported
AGE → PAU	-.030	-4.34	*<.001*	1	33	*2*	35	39	*01*	Supported ***

ISQ: CIS quality; **PU**: Perceived Usefulness; **CE**: Confirmation of Expectations; **SAT**: Satisfaction; **IC**: Intention to Continue; **PAU**: Profession-adjusted CIS Use**; MED:** Medical Profession; **AGE:** Age. **(***) supported < .001; (**) supported < .01; (*) supported < .05**

Table A.7. Structural equation model parameters
(Path: Profession-adjusted CIS Use → Satisfaction)

SEM parameters	χ^2	df	*p-value*	$\chi 2$/df	NFI	NNFI	CFI	RMSEA
Recommended value	-	-	<.0001	<3	>.8	>.8	>.8	<.8
HEGP (2014-2015)	751.16	333	<.0001	2.26	.784	.845	.865	.069
HPSJ (2015)	751.43	333	<.0001	2.26	.785	.847	.866	.080

Table A.8. Direct, indirect and total effect
(Path: Profession-adjusted CIS Use → Satisfaction)

Hypothesis (from→to)	Direct effect factor			Indirect effect factor			Total effect factor			Observations
	rameter imate	z-value	*p-value*	Parameter estimate	z-value	*p-value*	Parameter estimate	z-value	*p-value*	
HEGP 2014-2015										
ISQ → PU	.709	4.23	*<.001*	.302	3.24	*<.001*	.749	3.92	*<.001*	Supported ***
ISQ → CE	.799	8.55	*<.001*	-	-	-	.799	8.55	*<.001*	Supported ***
ISQ → SAT	.538	4.48	*<.001*	.505	4.68	*<.001*	.898	4.88	*<.001*	Supported ***
ISQ → CI	-	-	-	.682	4.45	*<.001*	.682	4.45	*<.001*	Supported ***
ISQ → PAU	.190	1.013	*.155*	-.229	-2.33	*.009*	-.122	-.641	*.260*	Not Supported
PU → SAT	.227	3.86	*<.001*	.009	1.00	*.158*	.273	4.00	*<.001*	Supported ***
PU → CI	.593	5.35	*<.001*	.040	1.211	*.112*	.704	6.89	*<.001*	Supported ***
PU → PAU	-.341	-3.16	*<.001*	-	-	-	-.306	-3.16	*<.001*	Supported ***
CE → PU	.441	3.74	*<.001*	-	-	-	.378	3.74	*<.001*	Supported ***
CE → SAT	.383	4.99	*<.001*	.103	2.69	*.003*	.483	6.11	*<.001*	Supported ***
CE → CI	-	-	-	.347	4.63	*<.001*	.347	4.63	*<.001*	Supported ***
CE → PAU	-	-	-	-.115	-2.28	*.011*	-.115	-2.28	*.011*	Supported *
FC → PU	-.131	-.948	*.171*	-	-	-	-.131	-.948	*.171*	Not Supported
FC → SAT	.005	.182	*.427*	-.036	-.884	*.188*	-.030	-.620	*.267*	Not Supported
FC → CI	-	-	-	-.091	-.911	*.181*	-.091	-.911	*.181*	Not Supported
FC → PAU	-	-	-	.040	.939	*.173*	.040	.939	*.173*	Not Supported
SAT → CI	.222	1.827	*.033*	-	-	-	.214	1.827	*.033*	Supported *
PAU → SAT	-.024	-1.062	*.144*	-	-	-	-.031	-1.062	*.144*	Not Supported
PAU → CI	.047	1.448	*.073*	-.007	-.878	*.189*	.052	1.225	*.110*	Not Supported
SN → SAT	-	-	-	-.004	-.921	*.178*	-.004	-.921	*.178*	Not Supported
SN → CI	-.022	-.342	*.366*	.007	1.061	*.144*	-.008	-.176	*.430*	Not Supported
SN → PAU	.133	2.27	*.011*	-	-	-	.133	2.27	*.001*	Supported **
MP → PU	.109	2.43	*.007*	-	-	-	.109	2.43	*.007*	Supported **
MP → SAT	-	-	-	.018	.963	*.167*	.018	.963	*.167*	Not Supported
MP → CI	-	-	-	.097	2.54	*.005*	.097	2.54	*.005*	Supported **
MP → PAU	1.266	7.00	*<.001*	-.033	-1.911	*.028*	.364	6.05	*<.001*	Supported ***
AGE → PU	-.111	-2.66	*.003*	-	-	-	-.111	-2.66	*.003*	Supported **
AGE → SAT	-	-	-	-.023	-1.359	*.087*	-.023	-1.359	*.087*	Not Supported
AGE → CI	-	-	-	-.091	-2.47	*.006*	-.091	-2.47	*.006*	Supported **
AGE → PAU	-.036	-4.43	*<.001*	.034	2.15	*.015*	-.219	-3.62	*<.001*	Supported ***
HPSJ 2015										
ISQ → PU	.735	4.39	*<.001*	.291	2.61	*.004*	.853	3.64	*<.001*	Supported ***
ISQ → CE	.868	14.33	*<.001*	-	-	-	.868	14.33	*<.001*	Supported ***
ISQ → SAT	.474	4.14	*<.001*	.546	5.15	*<.001*	.930	4.99	*<.001*	Supported ***
ISQ → CI	-	-	-	.753	4.44	*<.001*	.753	4.44	*<.001*	Supported ***
ISQ → PAU	.263	1.503	*.066*	-.127	-.998	*.159*	.086	.331	*.370*	Not Supported
PU → SAT	.217	3.16	*<.001*	-.005	-.778	*.218*	.225	3.09	*<.001*	Supported ***
PU → CI	.301	2.34	*.009*	.083	1.354	*.087*	.380	3.36	*<.001*	Supported ***
PU → PAU	-.140	-.960	*.168*	-	-	-	-.149	-.960	*.168*	Not Supported
CE → PU	.377	2.70	*.003*	-	-	-	.335	2.70	*.003*	Supported **
CE → SAT	.425	5.06	*<.001*	.075	1.915	*.027*	.475	5.82	*<.001*	Supported ***
CE → CI	-	-	-	.334	4.51	*<.001*	.334	4.51	*<.001*	Supported ***
CE → PAU	-	-	-	-.050	-.995	*.159*	-.050	-.995	*.159*	Not Supported
FC → PU	.028	.521	*.301*	-	-	-	.028	.521	*.301*	Not Supported
FC → SAT	.031	.740	*.229*	.006	.518	*.302*	.035	.825	*.204*	Not Supported
FC → CI	-	-	-	.026	.840	*.200*	.026	.840	*.200*	Not Supported
FC → PAU	-	-	-	-.004	-.483	*.314*	-.004	-.483	*.314*	Not Supported
SAT → CI	.553	3.95	*<.001*	-	-	-	.516	3.95	*<.001*	Supported ***
PAU → SAT	.032	1.107	*.134*	-	-	-	.032	1.107	*.134*	Not Supported
PAU → CI	.239	4.64	*<.001*	.017	1.112	*.133*	.239	4.55	*<.001*	Supported ***
SN → SAT	-	-	-	.004	.987	*.161*	.004	.987	*.161*	Not Supported
SN → CI	.050	.303	*.380*	.028	1.646	*.049*	.044	.748	*.227*	Not Supported
SN → PAU	.350	8.30	*<.001*	-	-	-	.117	8.30	*<.001*	Supported ***
MP → PU	.068	1.759	*.039*	-	-	-	.068	1.759	*.039*	Supported *
MP → SAT	-	-	-	.032	1.686	*.045*	.032	1.686	*.045*	Supported *
MP → CI	-	-	-	.151	3.92	*<.001*	.151	3.92	*<.001*	Supported ***
MP → PAU	1.665	8.30	*<.001*	-.010	-.863	*.194*	.510	7.77	*<.001*	Supported ***
AGE → PU	.059	1.374	*.084*	-	-	-	.059	1.374	*.084*	Not Supported
AGE → SAT	-	-	-	.005	.390	*.348*	.005	.390	*.348*	Not Supported
AGE → CI	-	-	-	-.037	-1.380	*.083*	-.037	-1.380	*.083*	Not Supported
AGE → PAU	-.030	-4.40	*<.001*	-.009	-.820	*.206*	-.258	-4.40	*<.001*	Supported ***

ISQ: CIS quality; **PU**: Perceived Usefulness; **CE**: Confirmation of Expectations; **SAT**: Satisfaction; **IC**: Intention to Continue; **PAU**: Profession-adjusted CIS Use**; MED:** Medical Profession; **AGE:** Age. **(***): supported < .001; (**) : supported < .01; (*): supported < .05**

Table A.9. Hypothesis supported by hospitals

Hypothesis Path (From → to)		HEGP	HPSJ	HEGP and HPSJ	HEGP or HPSJ	None
	Frequency (n)	15	14	12	17	04
MP → PU	H_{1a1}	X			X	
AGE → PU	H_{1a2}	X			X	
MP → PAU	H_{1c1}	X	X	X	X	
AGE → PAU	H_{1c2}	X	X	X	X	
SN → PAU	H_2	X	X	X	X	
SN → CI	H_3					X
ISQ → PU	H_4	X	X	X	X	
ISQ → CE	H_5	X	X	X	X	
ISQ → PAU	H_6					X
ISQ → SAT	H_7	X	X	X	X	
FC → PU	H_8					X
FC → SAT	H_9					X
PU → PAU	H_{10}	X			X	
PU → SAT	H_{11}	X	X	X	X	
PU → CI	H_{12}	X	X	X	X	
CE → PU	H_{13}	X	X	X	X	
CE → SAT	H_{14}	X	X	X	X	
SAT → PAU	H_{15a}	X	X	X	X	
PAU → SAT	H_{15b}		X		X	
PAU → CI	H_{16}		X		X	
SAT → CI	H_{17}	X	X	X	X	

Table A.10. Raw use rate in the nursing group for four (4) physician-related functions

- *Grouped by scales*

CIS use function (Scales 1 to 7)*	No delegation *(scale = 1)*		Occasional delegation *(1 < scale ≤ 4)*		Regular delegation *(4 < scale ≤ 7)*		*Khi-2*	*p-value*
	HEGP (n=106)	HPSJ (n=94)	HEGP (n=106)	HPSJ (n=94)	HEGP (n=106)	HPSJ (n=94)		
DRG coding	0	76	34	5	72	13	*138.30*	*<.001*
Biology prescriptions	92	87	5	6	9	1	*5.93*	*.052*
Imaging prescriptions	88	87	7	2	11	5	*4.33*	*.115*
Drug prescriptions	85	87	8	2	13	5	*6.48*	*.039*

**: 1=unused, 2=rarely, 3=rather rarely, 4=occasionally, 5=somewhat frequent, 6=frequently and 7=Very frequently; SD: Standard deviation*

Table A.11. Influence of the professional categories on the evaluation dimensions

Profession	**MED**				**NUR**				**OTH**			
Dimensions (Scales 1 to 7)*	**HEGP (n=93)****	**HPSJ (n=62)****	**Total (n=155)****	***p-value***	**HEGP (n=107)****	**HPSJ (n=94)****	**Total (n=201)****	***p-value***	**HEGP (n=64)****	**HPSJ (n=39)****	**Total (n=103)****	***p-value***
Use	4.17 *(1.44)*	3.96 *(1.31)*	4.09 *(1.39)*	*0.339*	3.35 *(0.88)*	2.83 *(0.96)*	3.11 *(0.95)*	*<0.001*	2.81 *(1.04)*	2.45 *(0.76)*	2.67 *(0.96)*	*0.060*
Profession-adjusted Use (PAU)	4.70 *(1.68)*	4.55 *(1.74)*	4.64 *(1.60)*	*0.558*	4.12 *(1.10)*	3.47 *(1.26)*	3.82 *(1.22)*	*<0.001*	2.81 *(1.04)*	2.99 *(1.01)*	2.88 *(1.03)*	*0.405*
CIS Quality (ISQ)	4.56 *(1.18)*	4.05 *(1.07)*	4.36 *(1.16)*	*0.008*	4.98 *(1.00)*	4.97 *(0.95)*	4.97 *(0.97)*	*0.932*	5.06 *(0.85)*	5.11 *(1.14)*	5.08 *(0.96)*	*0.801*
Perceived Usefulness (PU)	4.97 *(1.36)*	4.01 *(1.66)*	4.58 *(1.56)*	*<0.001*	5.08 *(1.08)*	4.74 *(1.25)*	4.92 *(1.17)*	*0.037*	5.30 *(0.92)*	5.02 *(1.25)*	5.19 *(1.06)*	*0.192*
Facilitating conditions (FC)	4.28 *(1.16)*	3.50 *(1.18)*	3.97 *(1.22)*	*<0.001*	4.52 *(1.21)*	4.36 *(1.37)*	4.44 *(1.28)*	*0.394*	4.64 *(1.01)*	4.55 *(1.42)*	4.61 *(1.17)*	*0.706*
Social Norm (SN)	4.68 *(1.07)*	4.91 *(0.89)*	4.77 *(1.01)*	*0.165*	5.08 *(1.07)*	5.33 *(1.13)*	5.20 *(1.10)*	*0.106*	4.74 *(1.05)*	4.31 *(1.26)*	4.58 *(1.15)*	*0.404*
Confirmation of expectations (CE)	4.05 *(1.12)*	3.47 *(1.35)*	3.82 *(1.24)*	*0.004*	4.43 *(1.11)*	4.63 *(1.24)*	4.52 *(1.17)*	*0.226*	4.91 *(1.01)*	5.09 *(1.20)*	4.98 *(1.08)*	*0.062*
Satisfaction (SAT)	4.40 *(1.31)*	3.81 *(1.46)*	4.16 *(1.40)*	*0.010*	4.85 *(1.18)*	5.04 *(1.26)*	4.94 *(1.22)*	*0.281*	5.04 *(0.96)*	4.80 *(1.36)*	4.95 *(1.13)*	*0.302*
Continuance Intention (CI)	5.76 *(1.20)*	5.19 *(1.49)*	5.53 *(1.35)*	*0.010*	5.95 *(1.07)*	5.65 *(1.05)*	5.81 *(1.06)*	*0.045*	5.83 *(1.02)*	5.32 *(1.25)*	5.64 *(1.13)*	*0.024*

**: 1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=no opinion, 5=somewhat agree, 6=agree, 7=strongly agree; **: Average (standard deviation)*