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Facilitators and barriers that influence Nursing Professionals in the Adoption of Information Systems: a systematic review

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Abstract. *Through a systematic literature review, the current research aimed to acknowledge the main facilitators and barriers that influence the adoption of Information Systems by nursing professionals. Furthermore, it listed the principal theoretical models used to measure technology acceptance and the methods used to perform data collection. It was possible to see that TAM was the model with the highest frequency of appearance. It also was possible to identify 19 (nineteen) facilitators and 23 (twenty-three) barriers reported in the selected studies. The findings allowed us to understand better how the phenomenon occurs, what can be worked on to improve technology acceptance, and allow new and in-depth studies to be carried out.*

Keywords. *Technology Adoption; Nursing Information Systems; TAM; Systematic Review*

1. Introduction

Information and Communication Technology (ICT) is changing the way various people perform their work activities in different segments of the world economy. This massive adoption of technology is a reality that is also changing the daily lives of health professionals, especially nursing professionals, who make up a large proportion of health care providers around the world.

Computers have become fundamental parts of the execution of hospital services because they enable the processing of large masses of data quickly, ensuring greater efficiency in the treatment of information and reducing the possibility of human failure. As a result, new information systems emerge every day to help institutions gain competitive advantage, reduce costs, increase performance, productivity, and market response through the improvements offered for service management and quality of the care provided.

[Évora 2007] points out that "nursing professionals need to understand how information technology can change their daily work, and how to enjoy its benefits to create new opportunities and occupy their space in the face of change processes". Also, according to the author, the success of implementing a Nursing Information System (NIS) "lies in its acceptance and viability to initiate a process of change". However,

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[Anne-Maria et al. 2016], [Ifinedo 2016] and [Lin et al. 2016] show that NIS are still not fully adopted in some countries such as Germany, United States, Canada, and China due to factors such as user's resistance to using computers and/or systems.

The choice for such an investigation arose from the importance of identifying and investigating existing knowledge gaps concerning the adoption of technologies to aid the activities of nursing professionals. Identifying the existing barriers and the conditions that may facilitate the adoption process of a NIS is essential because of the specificity of the activities performed by these professionals.

For this reason, through a systematic literature review, the present work sought to identify the main facilitators and barriers that influence nursing professionals in the adoption of Information Systems, regardless of their position (registered nurses, nurse practitioners, nurse aides, etc.).

This analysis kind is important because its results, for example, can serve as a basis for creating new policies, strategies, and incentives that encourage better use of technology in favor of more efficient ways of work by nursing professionals and better management of information from the care provided.

It was possible to identify 19 (nineteen) facilitators and 23 (twenty-three) barriers reported in the selected studies. The findings allowed us to better understand how the phenomenon occurs, what can be worked on to improve technology acceptance, and to identify new and in-depth studies to be carried out.

2. Theoretical Background

Measuring user acceptance of new technologies is a way to predict the intention of use, the use itself, and to identify the problems of a particular technology. In the field of ICT, there are several models of technology acceptance available that apply to the most diverse contexts and with different perspectives (individual or organizational), such as TAM ([Davis 1986]) and UTAUT ([Venkatesh et al. 2003]).

Many studies are interested in investigating the theories and models that can predict and explain the adoption of Information Systems in the health domain ([Ifinedo 2012]; [Lin 2015]; [Hsieh 2015]; [Handayani et al. 2017]; [Heidarizadeh et al. 2017]), and also investigate how to promote the use and identify barriers and facilitators related to the use and intention to use the technology ([Or et al. 2014]; [Hsieh 2015]; [Gartrell et al. 2015b]; [Heidarizadeh et al. 2017]).

According to [Haux 2006], "progress in the field of health information systems is directly related to improved quality and efficiency of care". [Jensen and Aanestad 2007] state that hospital managers already perceive ICT as the key tool to achieve a better flow of information and better services, as well as to meet organizational goals concerning high-quality care and treatment of patients. According to [Urquhart et al. 2009], health information systems play an important role in managing health care institutions, potentially improving the quality of care and services provided to patients. [Lu et al. 2012] support the idea that hospitals need to integrate numerous health information systems (typically distributed and heterogeneous) to provide users with useful, up-to-date, and

real-time information on patient care.

To [Bjarnadottir et al. 2017], the use of Nursing Information Systems can improve the documentation of activities performed in care, thus increasing the accuracy and integrity of data and the ability of health professionals to diagnose and treat their patients appropriately. To [Chau and Hu 2002], the unique characteristics of each health professional imply different behaviors related to the adoption of ICT.

However, to use information systems efficiently, [Laudon and Laudon 2010] state that it is necessary to understand their organizational, human, and technological dimensions.

3. Method

Systematic Literature Review (SLR) is a rigorous, verifiable, and replicable method that aims to scan the literature for a certain topic of interest to answer research questions [Kitchenham 2004]. [Medina and Pailaquilén 2010] point out that "researchers need the SLR to summarize existing data, refine hypotheses, estimate sample sizes and help define future work agendas". To achieve these objectives, [Kitchenham 2004] defines that the execution of an SLR should consist of the following phases: planning, conducting, and reporting the review.

3.1. SLR Planning

As previously presented, the objective of this work is to perform an SLR to summarize the main facilitators and barriers that influence nursing professionals in the adoption of Information Systems. To achieve this objective, the following research questions (RQ) were defined:

- RQ1. What methods are used for data collection?
- RQ2. What models are used to measure technology adoption?
- RQ3. What facilitators influence nursing professionals in the adoption of Information Systems?
- RQ4. What are the barriers that influence nursing professionals in adopting Information Systems?

As suggested by [Kitchenham 2004], electronic means were used to facilitate and expand data collection. Databases and indexing sources were used to gather the main means of publication of relevant scientific papers in the area of technology adoption: ACM Digital Library, Science Direct, Scopus, Springer Link and Web of Science.

Combinations of keywords were used to feed the search engines of the selected platforms to create unique logical expressions for each tool. The search string contains three themes, as presented in Table 1, and it was structured as following: (acceptance OR adoption) AND ("electronic health records" OR "electronic medical records" OR "electronic patient records" OR "hospital information system" OR "health information technologies" OR "health information system" OR "clinical information system" OR "nursing information system" OR "information system") AND (nurse OR nursing OR "healthcare professional").

Table 1: Terms used to search the databases.

Themes	Search Terms
Technology Adoption	Acceptance
	Adoption
Nursing Information Systems	Information System
	Electronic Health Records (EHR)
	Electronic Medical Records (EMR)
	Electronic Patient Records (EPR)
	Hospital Information System (HIS)
	Health Information Technologies (HIT)
	Health Information System (HIS)
	Clinical Information System (CIS)
	Nursing Information System (NIS)
Nursing	Nurse
	Nursing
	Healthcare professional

The terms “Electronic Health Records (EHR)”, “Electronic Medical Records (EMR)”, “Electronic Patient Records (EPR)”, “Hospital Information System (HIS)” and “Health Information Technologies (HIT)” were extracted from [Garavand et al. 2016].

The search string used could be even narrower, involving terms such as “BARRIER” or “FACILITATOR”, for example, but not including such terms was a decision made to make the search broad enough to ensure that relevant information would not be lost due to inadequacy of the query term.

The following inclusion, exclusion, and quality criteria were defined to guide the selection process:

- Inclusion Criteria (IC): IC1 - Articles that satisfy the search string used; IC2 - Articles written in English; IC3 - Articles in the field of Computer Science; IC4 - Articles that satisfy the quality criteria defined.
- Exclusion Criteria (EC): EC1 - Duplicate articles; EC2 - Secondary or tertiary studies; EC3 - Articles that do not describe the use of qualitative, quantitative or multi-method methods for data collection; EC4 - Articles whose results do not deal with barriers and/or facilitators for the adoption of Technologies exclusively in nursing.
- Quality Criteria (QC): QC1 - Articles reviewed by pairs; QC2 - Articles with more than ten references; QC3 - interrater reliability to avoid subjectivity.

The search strategy prioritized applying the search string in the title, abstract, and keywords fields only. The search string was only applied in the entire text in those tools that did not support this type of filter.

The selection process was carried out in three phases:

- 1st Phase: data was stored in a single repository and treated to ensure no repetitions between returned jobs.

- 2nd Phase: application of the inclusion/exclusion/quality criteria from the reading of the titles and abstracts of the works.
- 3rd Phase: application of the inclusion/exclusion/quality criteria from the complete reading of the work.

3.2. Conduct of the SLR Protocol

Database searches returned a total of 539 works. In possession of the returns, the selection of works began. As indicated by the protocol, during the first phase the results were stored in a single repository and treated so that it was possible to maintain standardization of returns and identify repeated works. This step resulted in the removal of 39 works among the initial 539. Springer Link was used as the primary basis for concentrating the largest number of results.

After applying the inclusion, exclusion, and quality criteria from the reading of the titles and abstracts, 403 articles were eliminated and the remaining 97 were submitted to the same criteria in the full text. At the end of the SLR conduction phase, 24 (4.45%) papers were selected. The conduct of the SLR Protocol can be seen in Table 2.

Table 2: Conduct of the SLR Protocol

Databases and indexing sources	Total Found	Total Selected	Selected Works
ACM Digital Library	61	5	[Hsiao et al. 2009], [Michel-Verkerke and Hoogeboom 2012], [Hung et al. 2014], [Karimi et al. 2015], [Ifinedo 2017]
Science Direct	48	3	[Maillet et al. 2015], [Saleem et al. 2015], [Ifinedo 2016]
Scopus	45	4	[Mehdi et al. 2012], [Gartrell et al. 2015b], [Hüsers et al. 2017], [Frank et al. 2018]
Springer Link	295	1	[Or et al. 2014]
Web of Science	90	11	[Gardner and Lundsgaarde 1994], [Lee et al. 2008], [Lee et al. 2009], [Vezyridis et al. 2012], [Hsu et al. 2013], [Garcia-Smith and Effken 2013], [Collins et al. 2015], [Gartrell et al. 2015a], [Lin 2017], [Heidarizadeh et al. 2017], [Jones and Seckman 2018]

4. Results

The protocol defined that information from each work would be used to conclude the systematic review. From the selected articles, it was possible to summarize the extracted

data to synthesize information regarding the nature of the studies and techniques used and group the main factors influencing the adoption of technology pointed out by the authors. The selected papers can be seen in Appendix A.

4.1. Selected Studies Profile

From the analysis of Table A.1 (Appendix A), it was possible to see that the years 2012, 2015, and 2017 concentrated the largest quantities of selected studies, with 13 in total. These figures suggest that the field of study of this research is still little explored, which possibly indicates the existence of many gaps to be investigated.

"CIN-Computers Informatics Nursing" headed the list of journals that concentrate the main studies in the area with a total of 7 papers, followed by the International Journal of Medical Informatics with 5.

It was also possible to identify that most of the selected studies were carried out by the Asian continent (11), followed by North America (10), Europe (3), and Oceania (1). This data demonstrates the concentration of research on these two continents, as well as the absence of work carried out by South America and Africa. It is important to highlight that [Or et al. 2014] applied research in institutions in Canada and China. For this reason, their participation in the Asian continent and North America was computed.

Most of the studies were applied in China (9) followed by the USA (6), Canada (4), Iran (2). Germany (1), Austria (1), Netherlands (1), Cook Islands (1), and England (1). It is relevant to point out that two studies were applied in more than one country: [Or et al. 2014] (China and Canada) and [Hüsers et al. 2017] (Germany and Austria).

Another observation extracted from the results of the survey was the nature of each institution involved: 54% (13 studies) were applied in public institutions, 17% (4 studies) were applied in private institutions, and 12% (3 studies) corresponded to works in which the type of institution was not informed. [Gartrell et al. 2015a], [Collins et al. 2015], [Hüsers et al. 2017] and [Jones and Seckman 2018] did not apply the research in institutions.

4.2. Answers to SLR Questions

All selected papers were thoroughly analyzed to identify the aspects related to the respondents, the models/theories/frameworks used and the methods of data collection applied, as well as the type of studies (whether qualitative, quantitative, or multi-method).

The analysis performed was fundamental for the construction of Table A.1 (Appendix A) which is a compilation of all the main aspects of the selected studies and the basis for answering two of the research questions (RQ1 and RQ2) defined in the protocol.

More than half of the selected studies (14) were classified as type quantitative and the use of questionnaires proved to be the main method of data collection, regardless of the type of study. 06 (six) studies used a qualitative approach, and the other 04 adopted a multi-method (quali-quantitative) approach. Qualitative studies focused on data collection through questionnaires with open questions, interviews, mostly semi-structured, and ethnographic methods.

[Gardner and Lundsgaarde 1994] and [Karimi et al. 2015] were selected, although the sample indicates the existence of other health professionals since they present individual results for each professional group and reveal interesting factors when comparing them, such as, for example, the differences in perceptions and priorities of these users.

To answer RQ2 it was necessary to count the frequency of appearance of the models among the selected works. This counting took into consideration not only the actual use of the model/theory/framework, but also its use for the development of a new framework. With this, it was possible to realize that the TAM was the model with the highest frequency of appearance, even if it was not the core of the studies.

As previously presented, RQ3 and RQ4 are related to facilitators and barriers that influence nursing professionals to adopt Information Systems. After individual analysis of the selected works, it was possible to identify 19 facilitators and 23 barriers reported in the studies. The factors already consolidated in the theories/models (e.g., 'perceived ease of use' and 'perceived usefulness' of the TAM) were not considered. All papers were analyzed without considering the perspective (individual or organizational) of the technology adoption models.

The facilitators and the barriers found were grouped in the Information Systems dimensions defined by [Laudon and Laudon 2010] to facilitate understanding the phenomenon. They can be seen in Appendix B.

5. Discussion

The systematic review of the presented literature considered a total of 539 papers from which, after applying the inclusion, exclusion, and quality criteria, 24 were selected. All selected papers were thoroughly analyzed to identify the aspects related to the samples, the models/theories used and the methods of data collection employed, as well as the types of studies (whether qualitative, quantitative or multi-method) and the facilitators and barriers that influence nursing professionals in the adoption of Information Systems.

The analysis of the selected documents resulted in the identification of 19 facilitators and 23 barriers that were grouped in the three dimensions of Information Systems (organizational, technological, and human) defined by [Laudon and Laudon 2010]. These figures reflect that the field of study of this research is still little explored and suggest the existence of several gaps to be investigated and addressed, which could lead to the fuller adoption of nursing information systems.

Of the 24 works analyzed during the SLR, only 4 (16.67%) used a multi-method approach. Most studies used a purely quantitative approach (58.33%) and the others were purely qualitative studies (25%).

The fact that the facilitators and barriers identified in the SLR seem generic at first glance points to the possibility of their application in other user groups and opens space for new research that can contribute to discoveries in the area of Technology Adoption.

By analyzing the identified facilitators, we found that "Efficient communication and interdisciplinary cooperation" (OF01), "Continuous training program" (OF04) and

"Quality support service" (TF07), followed by "IT infrastructure availability" (TF05) and "Previous experience with technology" (HF01) are the factors with the highest frequencies of appearance.

When we analyze the dimension of the facilitators identified, it can be noted that 11 (57.89% of the total of 19), are issues related to the organization or human factors and not specifically technological. This fact was also highlighted in the research conducted by [Lin et al. 2016], whose result pointed out that supervisors of the nursing department need to be aware of other factors besides the technological functionalities provided by the systems. Corroborating this observation, the results of the study carried out by [Kanungo 1998] demonstrated that organizational culture is a significant influence of user satisfaction with the use of information systems. Regarding adequate training, the work developed by [Lin and Lin 2016] also highlighted the importance of training the nursing team, including the adoption of mobile technology.

In the case of barriers, technology itself is pointed out as the main barrier of adoption (43.48%), followed by organizational factors (39.13%). "Hardware problems" (TB07), "IT equipment shortage" (TB04), and "Insufficient technical support" (TB10) were the most pointed out technological barriers.

The human dimension concentrated the smallest number of factors for facilitators (1) and barriers (4). According to [Kanungo 1998] and [Kim and Kankanhalli 2009], this dimension is directly related to the behavioral aspect of users.

Regarding the models/theories used, it was possible to identify that [Gardner and Lundsgaarde 1994], [Lee et al. 2009], [Vezyridis et al. 2012], [Gartrell et al. 2015a], [Collins et al. 2015] and [Saleem et al. 2015] did not employ models/theories of technology adoption for the evaluation of the published results. However, among the other works, it was possible to identify some that used more than one model/theory to elaborate their framework or even to evaluate their data.

[Garavand et al. 2016] also highlighted the TAM model as the most widely used to identify the factors that influence the adoption of information technologies in the health system. However, the selection of articles for analysis was much more restrictive, excluding articles with less than 30 references, in addition to limiting database searches to only ten years (from 2004 to 2014). The clear identification of facilitators and barriers was not detailed, and groupings into categories were not suggested or evaluated. The method of data collection, samples, and type of study were also not analyzed.

Finally, it was noted that none of the works selected during the SLR analyzed all of the facilitators and barriers identified. [Maillet et al. 2015] included the largest number of facilitators studied (4), but no barriers were analyzed. [Lee et al. 2009] and [Saleem et al. 2015] contemplated half of the barriers analyzed. However, both treated only one technological facilitator.

6. Conclusion

This work identified the main facilitators and barriers that influence nursing professionals in adopting Information Systems, through a systematic literature review.

The results obtained in this work, allied to those suggested by the researched works, demonstrate that the analysis of the Adoption of Technologies is fundamental to understand the Technological, Human and Organizational aspects that influence the effective use of Information Systems. Identifying barriers and facilitators of this process is fundamental for the success of the implementation, achieving the intended objectives, the return on investment, and, especially, the end-user's satisfaction with the reduction of the cognitive load necessary for the execution of their work activities.

Among the main discoveries, the below stand-out:

- The Technology Acceptance Model (TAM) is the most frequently used model to measure the adoption of technology by nursing professionals;
- Among the group of facilitators that influence nursing professionals in the adoption of Information Systems, the most outstanding are "Efficient communication and interdisciplinary cooperation", "Continuous training program", "Quality support service", "Availability of IT infrastructure" and "Previous experience with technology";
- The distribution of barriers is concentrated in three factors of the technological grouping: "Hardware problems", "IT equipment shortage" and "Insufficient technical support";
- The main facilitators found for adoption are within the organizational dimension, while the main barriers are apparently technological, and;
- Research in this sector is predominantly quantitative, and the questionnaire is the primary method of data collection.

Limitations to research are imposed to make the execution of the research viable and should be perceived as opportunities for the construction of new work. Among the main limitations faced are:

- The use of only databases related to computer science;
- There was no distinction between the perspectives (individual or organizational) of the technology adoption models used in the selected papers;
- This study did not focus on any specific technology and the search terms used may not cover all existing nomenclatures for nursing information systems.

Future studies should seek to overcome the shortcomings observed in this study. Studies that employ a similar approach and design can be conducted to increase knowledge in the area, as well as the development of studies to verify the adherence of the factors identified among the different professionals who work in the provision of health services, both at individual and organizational levels.

Summary Points

What was already known on the topic:

- Nursing professionals constitute a large share of healthcare providers around the world.
- Information technology (IT) has become a significant part in providing consistent care quality.

- Research shows that Nursing Information Systems are still not well adopted in some countries.

What this study adds:

- The Technology Acceptance Model (TAM) is the most frequently used model to measure technology acceptance by nursing professionals.
- There is a fairly regular distribution of facilitators that influence the acceptance of nursing information systems. However, the most prominent are effective communication, interdisciplinary cooperation, and quality support service.
- The distribution of barriers in technology acceptance by nursing professionals is concentrated on two factors: hardware problems and the shortage of IT equipment.
- The main facilitators found in technology acceptance are in the category of corporate management, while the main barriers are technological.

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A. Summary of Identified Studies

Table A.1: Summary of Identified Studies.

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Gardner and Lundsgaarde	Journal of the American Medical Informatics Association	1994	37	374 nurses 246 physicians	It does not use frameworks / models / technology adoption theories to evaluate the results. Statistical analyses were performed on the data collected.	Questionnaires with closed and open questions	Multi-method
Lee et al.	International Journal of Medical Informatics	2008	37	1163 nurses	Theory of Diffusion of Innovations	Questionnaires	Multi-method

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Hsiao et al.	Journal of Medical Systems	2009	45	84 nursing directors	A framework developed from the Integrated Model of Information Systems Adoption in Small Business and Theory of Diffusion of Innovations	Questionnaires	Quantitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Lee et al.	CIN-Computers Informatics Nursing	2009	38	623 nurses (questionnaire) 24 nurses (interviews) 22830 observed activities	It does not use frameworks / models / technology adoption theories to evaluate the results. Statistical analyses were performed on the questionnaire applied and a qualitative approach to identify themes to be evaluated.	Interviews, observations, and questionnaires	Multi-method

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Mehdi et al.	Information	2012	25	112 nurses	It does not use frameworks / models / technology adoption theories to evaluate the results. Statistical analyses were performed on the data collected.	Questionnaires	Quantitative
Michel-Verkerke and Hoogeboom	Proceedings of the 2012 45th Hawaii International Conference on System Sciences	2012	25	130 nurses	USE IT Model	Questionnaires and semi-structured interviews	Multi-method

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Vezyridis et al.	CIN-Computers Informatics Nursing	2012	56	22 nurses	It does not use frameworks / models / technology adoption theories to evaluate the results. The data collected was evaluated through thematic analysis.	Semi-structured interviews	Qualitative
Garcia-Smith and Effken	International Journal of Medical Informatics	2013	30	234 nurses	Clinical Information Systems Success Model (CISSM), based on Information Systems Success Model (ISSM), TAM2 e UTAUT	Questionnaires	Quantitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Hsu et al.	CIN-Computers Informatics Nursing	2013	44	720 nurses	Theory of Diffusion of Innovations	Questionnaires	Quantitative
Hung et al.	Decision Support Systems	2014	76	768 nurses	Model-based on the Theory of Reasoned Action (TRA) and Technology Acceptance by Individual Professionals Framework	Questionnaires	Quantitative
Or et al.	Journal of Medical Systems	2014	61	18 nurses	Healthcare Socio-Technical Framework (HSTF)	Observations and semi-structured interviews	Qualitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Collins et al.	Journal of the American Medical Informatics Association	2015	30	12 nurses	It does not use frameworks / models / technology adoption theories to evaluate the results. The interview data were analyzed iteratively using Grounded Theory techniques	Semi-structured interviews	Qualitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Gartrell et al.	CIN-Computers Informatics Nursing	2015a	52	183 nurses	It does not use frameworks / models / technology adoption theories to evaluate the results. Statistical analyses were performed on the data collected.	Questionnaires	Quantitative
Gartrell et al.	Applied Clinical Informatics	2015b	93	847 nurses	Electronic Personal Health Record (ePHR) Acceptance Model among Nurses, adapted from TAM	Questionnaires	Quantitative
Karimi et al.	Journal of Biomedical Informatics	2015	99	203 nurses 112 physicians	The Disconfirmation Paradigm	Questionnaires	Quantitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Maillet et al.	International Journal of Medical Informatics	2015	71	616 nurses	Theoretical model adapted from UTAUT	Questionnaires	Quantitative
Saleem et al.	International Journal of Medical Informatics	2015	25	69 nurses	It does not use frameworks / models / technology adoption theories to evaluate the results. The data analysis followed a process of abstraction of qualitative observations.	Ethnography	Qualitative
Ifinedo	International Journal of Medical Informatics	2016	62	197 nurses	TAM	Questionnaires	Quantitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Heidarizadeh et al.	CIN-Computers Informatics Nursing	2017	50	18 nurses	TAM	Semi-structured interviews	Qualitative
Hüsers et al.	Journal of Medical Systems	2017	39	534 nursing directors	A framework built from Socio-Technical-Material Framework	Questionnaires	Quantitative
Ifinedo	International Journal of Technology Diffusion	2017	63	197 nurses	Theory of Planned Behavior (TPB)	Questionnaires	Quantitative
Lin	CIN-Computers Informatics Nursing	2017	42	531 nurses	TAM and ISSM	Questionnaires	Quantitative
Frank et al.	Electronic Journal of Information Systems in Developing Countries	2018	39	18 nurses	TAM	Semi-structured interviews	Qualitative

Continuation of Table A.1

Author(s)	Place of Publication	Year	Total References	Sample	Model / Theory / Framework Used	Data Collection Method	Method
Jones and Seckman	CIN-Computers Informatics Nursing	2018	28	24 nurses	TAM	Questionnaires	Quantitative

B. Facilitators and Barriers who Influence Nursing Professionals in the Adoption of IS.

Table B.1: Facilitators who influence nursing professionals in the adoption of IS.

Dimension	Id	Facilitators	Reference
Organizational	OF01	Efficient communication and interdisciplinary cooperation (IT, Nursing and other hospital areas)	[Lee et al. 2008], [Lee et al. 2009], [Vezyridis et al. 2012], [Mehdi et al. 2012], [Hung et al. 2014], [Gartrell et al. 2015a], [Karimi et al. 2015], [Maillet et al. 2015], [Jones and Seckman 2018]
	OF02	Existence of legislation to be complied with	[Hüsers et al. 2017]
	OF03	Defined workflow	[Vezyridis et al. 2012], [Garcia-Smith and Effken 2013], [Or et al. 2014], [Heidarizadeh et al. 2017]
	OF04	Ongoing training program	[Gardner and Lundsgaarde 1994], [Lee et al. 2008], [Hung et al. 2014], [Karimi et al. 2015], [Ifinedo 2016], [Ifinedo 2017], [Jones and Seckman 2018]

Continuation of Table B.1

Dimension	Id	Facilitators	Reference
	OF05	Clear definition of users' roles in the use of the software	[Lee et al. 2009]
	OF06	Existence of a Nurse Coordinator dedicated to the implementation and promotion of the use of the system	[Collins et al. 2015], [Gartrell et al. 2015b], [Saleem et al. 2015], [Jones and Seckman 2018]
	OF07	Existence of a deployment strategy that encompasses the entire strategic plan of the organization	[Collins et al. 2015]
	OF08	Existence of pilot project/laboratory to carry out tests	[Gardner and Lundsgaarde 1994], [Hsu et al. 2013], [Jones and Seckman 2018]
	OF09	Explanation of the guiding principles of the deployment strategy	[Collins et al. 2015]
	OF10	Inclusion of nurses in implementation committees	[Mehdi et al. 2012], [Gartrell et al. 2015a], [Collins et al. 2015], [Ifinedo 2017]
Technology	TF01	System adherence to workflow	[Maillet et al. 2015]
	TF02	Automation of repetitive tasks	[Hsu et al. 2013], [Saleem et al. 2015]
	TF03	Low software unavailability	[Michel-Verkerke and Hoogeboom 2012]
	TF04	Compatibility between existing systems	[Vezyridis et al. 2012], [Garcia-Smith and Effken 2013], [Hsu et al. 2013], [Hung et al. 2014], [Maillet et al. 2015]

Continuation of Table B.1

Dimension	Id	Facilitators	Reference
	TF05	Availability of IT infrastructure (equipment, network, internet)	[Lee et al. 2009], [Mehdi et al. 2012], [Garcia-Smith and Effken 2013], [Maillet et al. 2015], [Ifinedo 2017], [Lin 2017]
	TF06	Use and troubleshooting manuals	[Ifinedo 2017], [Lin 2017]
	TF07	Quality support service	[Hsiao et al. 2009], [Michel-Verkerke and Hoogeboom 2012], [Garcia-Smith and Effken 2013], [Or et al. 2014], [Maillet et al. 2015], [Ifinedo 2017], [Lin 2017]
	TF08	Use of portable equipment	[Mehdi et al. 2012]
Human	HF01	Previous experience with technology	[Hsu et al. 2013], [Karimi et al. 2015], [Collins et al. 2015], [Ifinedo 2016], [Heidarizadeh et al. 2017], [Jones and Seckman 2018]

Table B.2: Barriers that influence nursing professionals in the adoption of IS.

Dimension	Id	Barriers	Reference
Organizational	OB01	Difficulty in hiring experienced staff in the system to be deployed	[Collins et al. 2015]
	OB02	Lack of cooperation with other areas	[Gardner and Lundsgaarde 1994]
	OB03	Lack of IT staff	[Or et al. 2014]
	OB04	Lack of training	[Collins et al. 2015], [Frank et al. 2018]

Continuation of Table B.2

Dimension	Id	Barriers	Reference
	OB05	No IT Policy	[Or et al. 2014], [Hüsers et al. 2017]
	OB06	Centralization of decision-making	[Hüsers et al. 2017]
	OB07	Lack of coordination and definition of users' roles	[Saleem et al. 2015]
	OB08	Investment cost	[Hüsers et al. 2017]
	OB09	Lack of financial incentive from the government	[Or et al. 2014]
Technology	TB01	High software shutdown rate	[Gardner and Lundsgaarde 1994], [Lee et al. 2008], [Karimi et al. 2015]
	TB02	Low privacy, confidentiality or data security	[Gardner and Lundsgaarde 1994], [Gartrell et al. 2015a], [Gartrell et al. 2015b]
	TB03	Obsolete equipment	[Hsiao et al. 2009], [Or et al. 2014]
	TB04	Shortage of IT equipment	[Gardner and Lundsgaarde 1994], [Lee et al. 2008], [Lee et al. 2009], [Heidarizadeh et al. 2017], [Frank et al. 2018]
	TB05	Poor or non-existent integration with other software	[Saleem et al. 2015]
	TB06	Unintuitive system interface	[Lee et al. 2009]
	TB07	Hardware or Internet connection problems	[Hsiao et al. 2009], [Lee et al. 2009], [Hsu et al. 2013], [Or et al. 2014], [Karimi et al. 2015], [Saleem et al. 2015], [Frank et al. 2018]
	TB08	A system with low usability	[Saleem et al. 2015]
	TB09	Software that does not adhere to the workflow	[Heidarizadeh et al. 2017]

Continuation of Table B.2

Dimension	Id	Barriers	Reference
	TB10	Insufficient technical support	[Or et al. 2014], [Saleem et al. 2015], [Collins et al. 2015], [Frank et al. 2018]
Human	HB01	Low perception of system utility by users	[Or et al. 2014]
	HB02	Low level of education	[Gardner and Lundsgaarde 1994], [Michel-Verkerke and Hoogeboom 2012], [Hsu et al. 2013]
	HB03	Fear/Anxiety to use the computer	[Ifinedo 2017], [Frank et al. 2018]
	HB04	Resistance to change	[Heidarizadeh et al. 2017]