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Technology acceptance and use among nursing staff in Latin American hospitals: A mixed methods study

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ABSTRACT

Background: Digital health technologies can improve health outcomes and the efficiency of healthcare delivery when used appropriately. Nevertheless, the human-computer interaction is a concern in compassionate patient care and nurses' professional well-being.
Objective: To analyze the degree of technological acceptance and use within nurses in two Latin American university hospitals.
Design: A mixed methods study design.
Setting(s): Two Latin American university hospitals, one in Chile and the other in Colombia.
Participants: A total of 53 nurses participated in the study. In phase 1, 31 nurses took part, with 15 from a Chilean hospital and 16 from a Colombian hospital. In phase 2, 22 nurses participated, with 14 in Chile and 8 in Colombia.
Methods: : A mixed methods sequential study was conducted in inpatient services. It was developed in three phases. First, a quantitative one with a call to all nurses in two institutions, in Chile and Colombia. A scale of the unified theory of acceptance and use of technology, adapted to nursing in Spanish, was employed following expert validation both facial and content aspects. Second, a qualitative one with four focus groups with service coordinator nurses and in-depth interviews with nursing managers or supervisors. These sessions were recorded and transcribed verbatim. Quantitative data were analyzed using descriptive statistics and hypothesis testing for mean differences, while qualitative data underwent content analysis. Finally in the third phase, both qualitative and quantitative data were integrated to establish the acceptability and use of the technology.
Results: Quantitative analysis revealed a statistically significant positive correlation between behavioural intention to use the system and facilitating conditions ($r\ (31) = 0.50, p < .01$). Also, there is a positive correlation between behavioural intention to use the system and effort expectancy in Chile ($r(13) = 0.60,\ p < .05$). Additionally, a statistically significant difference

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($p < .05$) exists between the two institutions regarding social influence and facilitating conditions. Qualitative data confirmed these findings. Integration made it possible to specify the factors such as the performance expectancy, facilitating conditions, and anxiety determine the acceptability and use of technology by nurses in the studied institutions.
Conclusions: The degree of technological adoption among nursing staff in two Latin American university hospitals is currently 3.7 ± 0.4 (scale from 1 to 5). Understanding the aspects that affect the acceptance and use of technologies paves the way for achieving their best use in support of nursing care.
Registration: ING-256-2020, January 16, 2023.
Tweetable abstract: Nurses in Latin American show mixed tech acceptance. Understanding barriers is crucial for better care delivery #DigitalHealth #NurseTech

What is already known

Advancements in patient care facilitated by the technological progress.

Availability of a broad portfolio of technologies for patient care, such as digital medical records and biomedical monitoring, and direct care equipment.

Technology as a supportive tool for healthcare management rather than as a competitor.

What this paper adds

Adaptation of the acceptance and use of technology instrument for nursing, validated through interviews and focus groups.

Case studies in two university hospitals in Latin America.

Characterization of factors and categories associated with the acceptance and use of technology in two Latin American university hospitals.

1. Introduction

The term "technology" is defined as the study and knowledge of the practical use, especially industrial, of scientific discoveries (Cambridge University Press, n.d.). This branch of knowledge is related to the creation and use of technical means and its interactions with life, society, and the environment in various fields. The technology is an integral component of a cultural system, that both shapes and reflects its values (Guerrero et al., 2004). The technology has revolutionized labor activities in all fields of knowledge, particularly in healthcare. These technologies are not only an end in themselves, but essential tools for promoting health, preserving global security, and serving vulnerable populations (World Health Organization [WHO], 2019).

Sesa et al. (2020), through a literature review on the use of technology in healthcare practices, highlight that this utilization requires proper preparation and increased interdisciplinary collaboration. They suggest that the utilization of technology has the potential to yield improvements in clinical outcomes, enhance the cost-effectiveness of services, and create more positive experiences for both users and professionals. Sousa et al. (2022) complement these findings by indicating that effective technological management can lead to enhancements in organizational performance, healthcare delivery, clinical decision support, strategic planning, administration, service organization, and the professional practice of nursing.

Brown et al. (2020) conducted a systematic review to evaluate and synthesize the evidence related to nurses' digital competence and strategies to support its effective use in practice. Their findings indicate that nurses primarily use technology to access data, such as clinical reports or medical records, and typically do so at the point-of-care. However, the nursing staff is not homogeneous, with some nurses possessing attributes that make them more inclined toward technology use. Recognizing and strengthening these attributes is essential. In general, their research points out nurses' concerns about the use of technology in their practice and suggest that their perspective should be considered for the improvement of healthcare. That is, nurses demand greater participation in technology use and development, along with continuous training in this field.

Ali et al. (2022) explored, through a literature review, the use of digital health technologies in delivering compassionate nursing care. The authors highlighted that, despite the potential of technologies to improve compassionate nursing care, there is a lack of evidence on their effectiveness in this context. They suggest that more research is needed to evaluate the impact of digital health technologies on the delivery of compassionate patient care in nursing, as well as to elucidate the concept of care in relation to technology and associated competencies for nursing staff. Recent studies complement this information by indicating that, despite lingering acceptance challenges, there is a growing tendency towards a positive reception (Gause et al., 2022). Factors such as the perception of usefulness, ease of use, identification of advantages, testing and observation possibilities, satisfaction, social influence, performance expectations, facilitating conditions and effort expectation are closely related to the acceptance and use of some technological tools. On the contrary, stress has been found to exert a negative influence (Nezamdoust et al., 2022) (Su et al., 2022).

Lake et al. (2018) state that the organizational characteristics of nursing staff and the practice environment are associated with patient outcomes based on available evidence. However, they point out that the required evidence on the optimal organization of nursing talent to support strategic decisions and improve patient outcomes is lacking. Similarly, Moreno-Fergusson et al. (2021) and Galiano et al. (2023), highlight that technology is essential in addressing the challenges of nursing care in emerging economies. Their assertions are complemented by the perspectives of Hughes et al. (2022), who advocate for a redirection of nursing research efforts in Latin America to fill the knowledge gap regarding the use of technologies, especially information and communication technologies, and in matters related to public health and migration.

In order to propose solid alternatives for enhancing the qualification of nursing practice in two university hospitals in Latin America, one in Chile and the other in Colombia, the present study aimed to analyze the challenges related to the acceptance and use of technology by nursing staff in these Latin American university hospitals and its impact on care processes. Thus, we aim to solve the following research question: *What is the degree of acceptance and use of technology among nurses in two Latin American university hospitals?*

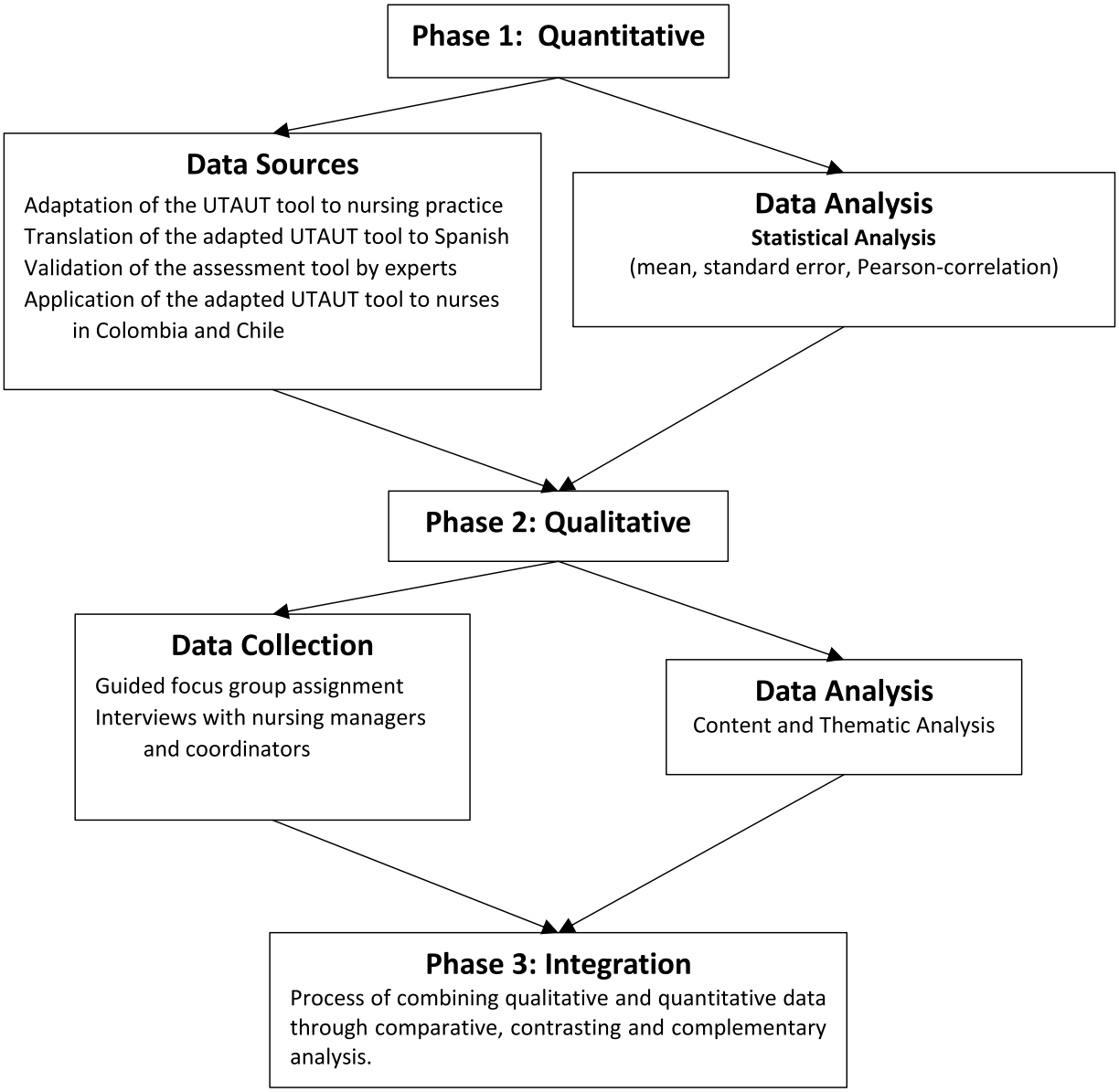

Fig. 1. Methodological framework for the applied sequential mixed methods study. Adapted from (Creswell & Clark, 2017).

2. Methods

2.1. Study design

A sequential mixed methods study (Creswell & Clark, 2017) was conducted from January to April 2023 at two high complexity university hospitals in Latin American, one in Chile and one in Colombia. The Chilean hospital is located in Santiago and has an installed capacity of 22 beds with 16 nurses. The Colombian hospital is located in a municipality near the capital city, with 88 beds and 20 nurses. A total of 53 nurses participated in the study. 31 nurses participated in phase 1 of the study, with 15 from Chilean hospital and 16 from Colombian hospital. 22 nurses participated in Phase 2, 14 in Chile and 8 in Colombia.

The methodological framework in Fig. 1 guided our study design. The study employed a sequential mixed methods study design to analyse the technology acceptance and use among nursing staff in two Latin American hospitals. The study was developed in three phases: (i) A quantitative study was performed using the Unified Theory of Acceptance and Use of Technology (UTAUT) model, adapted to nursing practice and translated to Spanish, followed by a statistical analysis; (ii) A qualitative study was conducted based on focus group and in-deep interviews; and (iii) An integration process of combining qualitative and quantitative data to stipulate a comprehensive understanding of the acceptability and use of the technology by the nursing staff in Chilean and Colombian hospitals. This process goes beyond the validation to synthesize findings from different methods, creating a unified narrative that captures the complexity of the phenomenon under study. In subsequent sections, each phase will be described in detail.

The study was conducted by an interdisciplinary research team consisting of engineers, nurses, and professors. The study and informed consent procedures were approved by the Ethical Board of both institutions (No. CEIA02 082022 in Colombia, CEC202051 in Chile).

Table 1
A comparison between Chile and Colombia hospitals – Survey results.

		Colombia		Chile		Overall	
Construct		Mean	SE	Mean	SE	Mean	SE
Performance Expectancy (PE)	PE1	3.75	0.21	3.93	0.12	3.84	0.12
	PE2	3.38	0.26	3.80	0.24	3.58	0.18
	PE3	3.44	0.22	3.60	0.24	3.52	0.16
	PE4	3.50	0.20	3.87	0.22	3.68	0.15
	Total	3.52	0.90	3.95	0.80	3.65	0.15
Effort Expectancy (EE)	EE1	3.94	0.19	4.27	0.12	4.10	0.12
	EE2	3.81	0.19	4.00	0.24	3.90	0.15
	EE3	4.13	0.20	3.73	0.23	3.94	0.15
	EE4	4.25	0.11	3.80	0.26	4.03	0.14
	Total	4.03	0.71	3.95	0.85	3.99	0.14
Attitude towards using Technology (AT)	AT1	4.13	0.15	4.33	0.16	4.23	0.11
	AT2	3.69	0.18	3.67	0.25	3.68	0.15
	AT3	3.25	0.25	3.53	0.27	3.39	0.18
	AT4	3.81	0.21	3.73	0.21	3.77	0.14
	Total	3.72	0.70	3.82	0.91	3.77	0.15
Social Influence (SI)	SI1	3.75	0.17	4.13	0.19	3.94	0.13
	SI2	3.88	0.15	3.87	0.26	3.87	0.14
	SI3	3.81	0.19	4.40	0.19	4.10	0.14
	SI4	3.69	0.20	4.40	0.16	4.03	0.14
	Total	3.78	0.76	4.20	0.80	3.98	0.14
Facilitating Conditions (FC)	FC1	3.56	0.22	4.33	0.16	3.94	0.15
	FC2	3.75	0.23	4.27	0.18	4.00	0.15
	FC3	3.56	0.26	3.87	0.29	3.71	0.19
	FC4	3.44	0.27	4.27	0.18	3.84	0.18
	Total	3.58	1.00	4.18	0.81	3.87	0.17
Self-Efficacy (SE)	SE1	3.69	0.22	4.13	0.19	3.90	0.15
	SE2	3.56	0.22	4.13	0.19	3.84	0.15
	SE3	3.63	0.15	4.07	0.21	3.84	0.13
	SE4	3.50	0.26	3.93	0.23	3.71	0.17
	Total	3.59	0.85	4.07	0.78	3.82	0.15
Anxiety (AN)	AN1	2.81	0.32	2.40	0.27	2.61	0.21
	AN2	2.81	0.34	2.80	0.37	2.81	0.25
	AN3	3.06	0.28	2.93	0.30	3.00	0.20
	AN4	2.88	0.34	2.87	0.34	2.87	0.24
	Total	2.89	1.26	2.75	1.23	2.82	0.22
Behavioural Intention to use the system (BI)	BI1	3.69	0.25	3.80	0.35	3.74	0.21
	BI2	3.69	0.27	3.87	0.36	3.77	0.22
	BI3	4.06	0.25	4.27	0.28	4.16	0.19
	Total	3.81	1.02	3.98	1.29	3.89	0.21

2.2. Quantitative phase

The quantitative phase involved an intentional sample of 31 nurses from the Medical-Surgical Unit, 15 from a Chilean hospital and 16 from a Colombian hospital, all of whom signed informed consent. A Unified Theory of Acceptance and Use of Technology (UTAUT) scale was applied, which had been adapted from the instrument proposed in (Venkatesh et al., 2003) for nursing practice and translated into Spanish, after apparent and content validation with experts (see supplementary file 1, Table 1).

The adapted UTAUT tool seeks to support the assessment and monitoring of the technological acceptance and use based on various dimensions, including identification data, Performance Expectancy (PE), Effort Expectancy (EE), Attitude towards using Technology (AT), Social Influence (SI), Facilitating Conditions (FC), Self-Efficacy (SE), Anxiety (AN), and Behavioral Intention to use the system (BI). This tool is self-administered and consists of two parts: (i) sociodemographic data, and (ii) a survey with 31 questions, answered on a 5-category Likert-type scale (strongly agree, agree, neutral, disagree, strongly disagree). The questions are grouped into the dimensions mentioned earlier. Each dimension contains 4 questions, except for BI dimension with 3 questions. Then, each dimension is evaluated for clarity, coherence, relevance, and sufficiency, with ratings of 1 (does not comply), 2 (low level), 3 (moderate level), or 4 (high level), along with space for observations and suggestions. The scale's reliability was evaluated using the Cronbach's Alpha coefficient. The scale showed clarity with a content validity index (CVI) of 0.95 and a Cronbach's Alpha coefficient of 0.82 ± 0.02 (see supplementary file 1, Table 2).

Finally, a descriptive statistical analysis that included the mean, the standard error and the Pearson-correlation coefficients was conducted calculated to identify patterns and differentiating factors in nurses' acceptance and use of technology based on the context (Chile and Colombia). Also, strengths in this domain were identified and analyzed in each hospital.

2.3. Qualitative phase

The qualitative phase aimed to describe the perceptions of nursing managers and coordinators regarding the technology acceptance and use by the nurses under their supervision. Data collection took place between January and April 2023 via guided focus groups sessions and in-depth interviews. A guide was developed to delve deeper into the dimensions of the UTAUT instrument. Three focus groups were formed, two in Chile and one in Colombia. Each group comprised 6 to 7 nurses each who held positions as coordinators or supervisors within hospitals, with lengths of employment ranging from 2 months to 10 years approximately. Likewise, three in-depth interviews were conducted with nursing managers of the two hospitals. The in-depth interviews lasted between 20 to 40 minutes. On the other hand, the focus group discussions were more extensive, lasting between 1 to 2 hours.

In the planning phase, a script of questions was prepared to guide the discussion on the perception of the nursing staff's ability to use technology, their technology acceptance, and the context of technological use. Prior to each session, participants signed the informed consent, accepting their participation in the research.

Both focus group sessions and in-depth interviews were recorded and transcribed verbatim. Afterward, two researchers independently conducted a content analysis of the data from each interview and focus group, through an iterative line by line coding process, leading to categorization to identify central themes. They used the methodology proposed by Erlingsson & Brysiewicz (2017). Researchers then met to define code names and their grouping into categories. Transcripts allowed the researchers to identify the units of analysis and codes, which were registered in thematic tables. These tables organize the data by categories and main themes. Finally, a fourth focus group was carried out with nursing managers from both hospitals to validate the results of the analysis.

2.4. Integration

To gain deeper understanding of the phenomenon studied, an integration of the qualitative and quantitative data was conducted, following the guidelines of Creswell et at. (2017) and Fetters et al. (2013). Data integration was conducted through a narrative, using a contiguous approach: the analysis of quantitative and qualitative data was conducted separately, considering how each responded to the research question. At the end, the central theme, categories, and subcategories that emerged from the qualitative data were used as a framework to support the results of the quantitative data, a process that was represented in a graph. The findings of the data set were intertwined in the discussion section to develop a deeper interpretation of the factors that influence the acceptance and use of technology by nursing staff.

3. Results

3.1. Quantitative results

The sociodemographic characteristics of the study participants from Colombia and Chile reveal distinct profiles. In Colombia, the average age was 30.7 years, with a range between 22 and 42 years, and participants had an average of 7.25 years of work experience, ranging from 1 to 13 years. Notably, 29.4% of the Colombian participants had completed graduate studies. In contrast, the Chilean participants were younger, with an average age of 27.9 years (25-38 years), and had less work experience, averaging 3.16 years (1-10 years). Additionally, 13% of the participants from Chile had pursued graduate studies. These differences reflect varying educational attainment and work experience levels between the two groups.

Table 3 in supplementary material details the frequency distribution of survey responses for each level of the Likert scale. When comparing the average evaluation scores and standard errors (se) in the UTAUT tool, in Colombia, factors with the highest evaluations

Table 2
Construct correlation matrix for the constructs with data of both hospitals.

	PE			EE			AT			SI			FC			SE			AN			BI		
	COL	CHILE	TOTAL	COL	CHILE	TOTAL	COL	CHILE	TOTAL	COL	CHILE	TOTAL	COL	CHILE	TOTAL	COL	CHILE	TOTAL	COL	CHILE	TOTAL	COL	CHILE	TOTAL
PE	1.00	1.00	1.00																					
EE	0.34	0.54**	0.41**	1.00	1.00	1.00																		
AT	0.69*	0.63**	0.65*	0.16	0.84*	0.55*	1.00	1.00	1.00															
SI	0.54**	0.49	0.54*	0.01	0.73*	0.39**	0.73*	0.87*	0.78*	1.00	1.00	1.00												
FC	0.35	0.61**	0.49*	0.05	0.86*	0.36**	0.50	0.88*	0.63*	0.89*	0.84*	0.86*	1.00	1.00	1.00									
SE	0.67*	0.48	0.61*	0.02	0.51	0.24	0.57**	0.72*	0.63*	0.85*	0.71*	0.80*	0.77*	0.66*	0.76*	1.00	1.00	1.00						
AN	0.16	-0.02	0.06	-0.32	-0.19	-0.24	0.38	-0.22	0.06	0.38	-0.23	0.03	0.25	-0.16	0.05	0.37	-0.19	0.07	1.00	1.00	1.00			
BI	0.22	0.13	0.18	-0.37	0.60**	0.26	0.29	0.57**	0.46*	0.47	0.51	0.49*	0.35	0.72*	0.50*	0.52**	0.44	0.46*	0.29	0.08	0.16	1.00	1.00	1.00

Abbreviations: Performance Expectancy (PE), Effort Expectancy (EE), Attitude towards using Technology (AT), Social Influence (SI), Facilitating Conditions (FC), Self-Efficacy (SE), Anxiety (AN), and Behavioral Intention to use the system (BI).
*$p<.01$
**$p<.05$

are related to effort expectancy (total average score of 4.03 with a se 0.7) (see Table 1). Conversely, factors with the lowest average ratings include performance expectancy (3.52 se 0.9), facilitating conditions (3.58 se 1.0), and anxiety (2.89 se 1.3). Analysis at the item level reveals statistically significant findings where items scoring below 4.0 (indicating agreement) are associated with technology attitude towards interest (AT 2, 3.69) and enjoyment in using computer systems (AT 3, 3.25), suggesting a lack of interest and enjoyment. Additionally, three items related to self-efficacy scored statistically below 4 ($p < .05$), including support for technology use (SE2, 3.56), usage time (SE3, 3.63), and support from a help program (SE4) (3.50). The SE1 item has an average score below 4, but there is no statistically significant evidence for this. The most variable responses were observed in the anxiety factor (Total, se 1.3) and technology usage intention (Total, se 1.0).

In Chile, the highest evaluations are attributed to social influence (total average score of 4.2 se 0.8) and facilitating conditions (4.18 se 0.8). Conversely, the lowest-rated conditions include performance expectancy (3.95 se 0.8), technology attitude (3.82 se 0.9), and anxiety (2.75 se 1.2). There was no evidence suggesting that the average rating of any questionnaire item fell below the "agree" level. The most variable responses were observed in the anxiety factor (Total, se 1.2) and technology usage intention (Total, se 1.3).

In both contexts, correlation between factors is estimated using correlation coefficients (see Table 2). In Colombia, positive correlations were found between technology attitude, social influence, facilitating conditions, and self-efficacy, with coefficients ranging from 0.50 to 0.89. Lower scores in social influence and facilitating conditions were associated with decreased self-efficacy. Additionally, effort expectancy positively correlated with technology attitude (0.69) and self-efficacy (0.67). A weak correlation was observed between anxiety and effort expectancy (0.32), suggesting that higher effort expectancy leads to increased anxiety. Similarly, weak negative correlations were found between anxiety and technology attitude, social influence, and self-efficacy, indicating that these factors are associated with lower anxiety levels. Furthermore, a weak negative correlation existed between effort expectancy and usage intention. Moderate positive correlations were observed between behavioral intention to use the system and self-efficacy and social influence.

In Chile, positive correlations were observed between effort expectancy, technology attitude, social influence, facilitating conditions, and self-efficacy, with coefficients ranging from 0.51 to 0.88. Lower scores in social influence and facilitating conditions were associated with decreased technology attitude. Additionally, a positive correlation was found between performance expectancy and technology attitude (0.63), and between performance expectancy and facilitating conditions (0.61). No clear correlation was identified between anxiety and any evaluated factors. Behavioral intention to use the system positively correlated with facilitating conditions (0.72), effort expectancy (0.6), technology attitude (0.57), and social influence (0.51). These correlations exhibit the interrelation of various factors influencing nurses' perceptions and intentions regarding technology adoption in healthcare settings.

Despite Chilean healthcare systems boasting more modern technology and robust infrastructure, few differences were discerned between the two institutions. Regarding behavioral intention to use the system, Chile scored slightly higher with an average of 3.98 compared to Colombia's 3.81, although statistical analysis didn't reveal a significant difference in means. Notably, a higher percentage of respondents in Chile (87%) agreed or strongly agreed with planning system usage compared to Colombia (69%). Factors such as performance expectancy, technology attitudes, and self-efficacy showed minimal variation between the institutions. However, significant differences emerged in effort expectancy, with Colombia scoring higher (mean 4.03, se 0.71) compared to Chile (mean 3.95, se

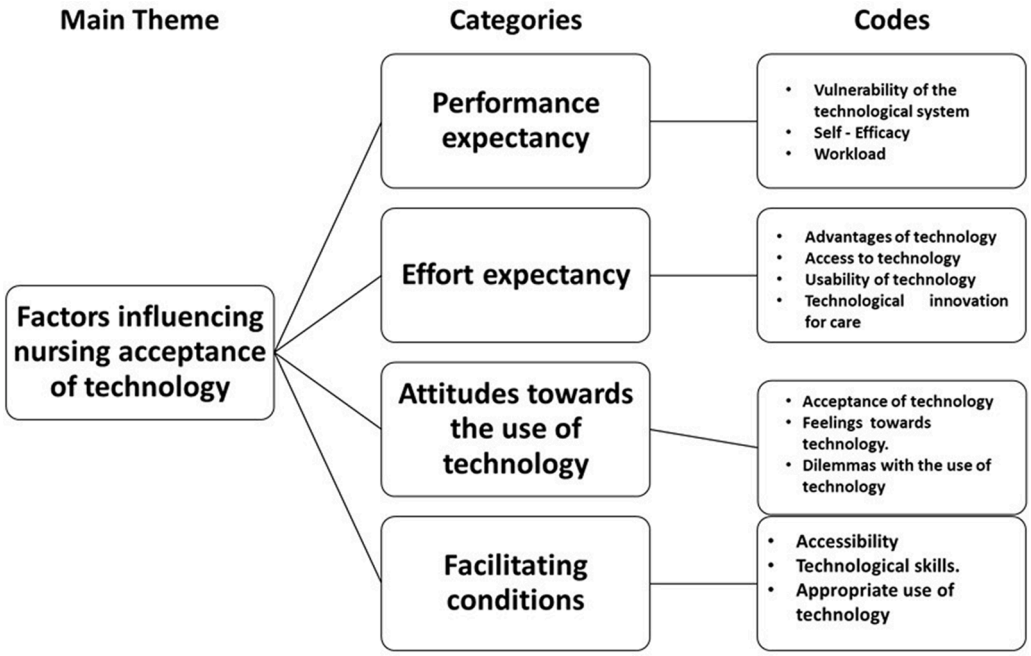

Fig. 2. Factors influencing nursing acceptance of technology.

0.79). Particularly, in item EE4 related to system ease of use, all Colombian professionals agreed or strongly agreed, while only 67% did in Chile. Social influence exhibited significant disparity, with Chile scoring higher (mean 4.20, se 0.80) than Colombia (mean 3.78, se 0.76), mainly due to differences in perceptions regarding system utility for patient care. Facilitating conditions also varied, with Chile scoring higher (mean 4.18, se 0.81) compared to Colombia (mean 3.58, se 0.97). These differences were attributed to factors like resource availability, knowledge, and support, with higher agreement rates in Chile (89%) compared to Colombia (56%). Furthermore, correlation analysis revealed notable differences, including a positive correlation between effort expectancy and behavioral intention to use the system in Chile (0.6), contrasting with a weak negative correlation in Colombia (-0.37). Similarly, correlations between effort expectancy and facilitating conditions, social influence, and technology attitudes were significant in Chile but not in Colombia. Anxiety levels exhibited weak correlations with various factors in Colombia, while no evidence of such correlations was found in Chile.

3.2. Qualitative

Focus group analysis is meant to obtain deeper understanding of the factors that influence nursing acceptance of technology. Fig. 2 summarizes these results. The Fig. 2 shows the central theme or main category on the left. In the next row are the four subcategories that make up the main category, and on the right are the nominal codes related to each subcategory. We also provide some quotes that support each factor in the following sections. Each quote is coded with two numbers, for example, 2.37. These stand for the number of participants and the selected unit of analysis.

3.2.1. Performance expectancy

Participants are convinced of the advantages and usefulness of technology; this leads to a reduction in clinical risks and the promotion of process safety by registering evidence. Technology favors the organization of nursing care, the systematization of records, their legibility, and the ability to analyze them to further our knowledge. Another advantage is that it enhances communication between different units and groups within the service and the institution.

> "*I find the systematization of records tremendously useful; it removes factors like the non-legibility of the documents, and everything that we all experienced when the files were paper. I also find that if you want to obtain data to do research, to make a publication, it is a wonderful tool." (2.37)*

One factor that affects performance expectations is the perception of overload.

> "*because (nurses) spend a lot of time in front of the computer, making records or doing administrative activities.*" *(3.33)*

The perception of overload is related to the excess time required to perform administrative activities, the need to use multiple applications and the inefficiency of the system. For this reason, it is necessary to optimize processes and record care activities at the time they are carried out, avoiding delays and incomplete records. The lack of connectivity between systems, and their technological complexity, make their appropriation difficult and create management reprocesses. Participants perceive this as a waste of time that creates overload; additionally, the technology allows us to exceed accepted limits by communicating outside working hours.

Finally, nursing professionals frequently face a workload that does not correspond to them:

> *"It may also be at the time of discharge, that the patient wants to leave, and the medical discharge indication doesn't appear, because the patient didn't fill it out. Then the nurse has to call the resident, but if they are busy and can't sign it to deliver it... it delays... it delays the entire process." (3.3.1)*

Nurses say that some care processes such as hospital discharge or medication administration stop when information is incomplete in the system. This information may be incomplete because other professionals forget to fill it in or to give the corresponding authorizations. This situation requires the nurses who are in front of the users to look for alternatives to solve these situations, which ends up causing delays in the management of care.

3.2.2. Effort expectations

The expectation of effort is related to the ease and usability of technological systems, which may be simple in some cases and complex in others. The appropriate use of technology requires fostering a culture that cultivates the following: knowledge and rational use of tools, establishing limits and prioritizing. For this reason, there is a difference in the perception of technological usability. While some find the tools useful, friendly, easy to use and streamlined, other find them costly and they think they slow down the practice. It is essential to have the knowledge required to use this technology, but the intention and motivation to use it are also definitive.

> *"I also believe that, in addition to the motivation of the staff, the technological tools provided must be practical and very simple to use, so that all people can use them in the same way, because due to that same generational gap, some people may find it a little more difficult". (3.66)*

A fundamental aspect that the participants highlight is the need to include nurses in the design of technological tools, so that these adapt to the particular needs of nursing care.

3.2.3. Attitudes towards technology

We identified the following topics for this aspect: acceptance of technology, feelings regarding its use, and dilemmas regarding its use.

The acceptance of technology occurs to the extent that nurses become familiar with it and see its usefulness. This involves understanding that every system can have errors, but that they eliminate many other risks. Adaptation to technology is achieved through motivation, training, habit, and support. It is therefore important to show that change is positive, and that it does not constitute an additional burden. The capacity for innovation based on technology, its future trends, and its potential, are motivations to learn how to use it.

> *"That is a phenomenon of us as human beings, that change always makes us a little afraid... afraid, and suddenly fear will create stress. It is a negative emotion that can be generated within human talent that feels less skilled in doing these types of activities (mediated by technology)." (3.106)*

The use of technology creates different feelings in nurses. Some participants expressed that technology facilitates quality care and gives them personal satisfaction tied to a feeling of having performed well. The older participants expressed negative feelings such as fear of change, fear of making mistakes without being able to rectify them, uncertainty of whether what they do is right or not, anxiety when confronting the unknown (especially for those unfamiliar with technology), embarrassment because they must ask for help repeatedly, and helplessness when errors that cannot be easily solved hinder care processes. All these feelings lead to frustration because the intention to do a good job is confronted with processes that take time away from patient care and increase the risk of errors. This frustration leads nurses to reject a technology that is perceived to be dysfunctional, which creates an additional burden on patient care and can even affect the resources of the institution.

Finally, participants identified some dilemmas with the use of technology. These included a dependence on systems that can shift the focus of care and lead to a loss of critical reasoning, and a decrease in direct attention to the patient. Communication technologies, for their part, create challenges of control, distraction, invasion of worker privacy and ineffectiveness in the exchange of information.

We identified other themes that that limit the acceptability of the use of technology in the qualitative analysis. These included inadequate programming and vulnerabilities in technological systems.

Appropriate use that maximizes the potential of technology depends on it being accessible. The participants in this study expressed difficulties with the programming of the systems, either because they were inoperative, incomplete or because they had errors.

We call the system 'ineffective' when it lacks the expected automation or independence, and we call it 'incomplete' when it is implemented without being fully structured, which generates reprocessing and other administrative errors that affect staff negatively. Errors in the programming of technological systems can occur when the end users (nurses) are not involved. Nurses are then forced to raise the system requirements to streamline administrative processes and respond to the needs of the services. Eventually, these programming errors complicate nursing management processes, slow them down, and sometimes make it necessary to return to manual processes to avoid losing information. Failures associated with technology have an impact on nursing performance, motivation, and acceptance.

Another fundamental aspect that causes great concern among participants is how the system is vulnerable when it does not close automatically after its use**:**

> *"There are distracted people who leave the system open, which encourages others to register with the wrong user. So, since there is no customization with these types of tools, the person directly responsible for the record cannot be identified." (3.7)*

The carelessness of users when making records in technological systems can alter the confidentiality and security of the information. This happens when the professional who registers the information in the system does not close the session. When it remains open, others can make queries, including modifications, without leaving a trace. This leads to a loss of traceability regarding the authorship of the registered information, with ethical and legal repercussions.

3.2.4. Facilitating conditions

According to the participants, the conditions that facilitate the use of technology are: accessibility, technological skills and the perception of support.

Accessibility implies permanent technological updating in accordance with the complexity of the service offered. Having the appropriate technology close to the patient facilitates the recording of information. When the connection is unstable, the system blocks and thus all care processes are delayed, which in turn creates an overload.

> **"***Another difficulty is access to Wi-Fi. This hospital does not have 100% coverage and the internet connection is unstable. That's why sometimes I get stuck and all my work gets delayed." (3.61)*

Technological competence is greater in young nurses, who adapt easily to accelerated changes in technology.

> *"The most adherent people are the youngest..., they learn extremely quickly and implement it easily. For older people, education has been completely different, I don't like it, it's complicated for me." (3.23)*

A generational gap was evident in the focus groups, which determined the competencies for the use of technology and for patient care. While young people are intuitive and find it easier to use technology, older people have clinical experience, sensitivity, and intuition to detect patients' care needs. All participants intend to use technology, with adherence being greater in young people. Other influencing factors are the methodology with which nurses have been educated, technological experience and clinical experience. The technological gap is even greater when people have not had access to innovative technological experiences or when they lack support for their use.

"When the institution does not have a human team of technological support in moments of difficulty, to help clarify doubts and solve problems... it is very frustrating because we may not be able to administer a medication because the system does not allow it." (2.42)

Support from experts is decisive to facilitate the use of technology in care and attention processes. They must support induction processes to teach the use of technological tools to staff. They should also be available 24 hours a day to promptly solve problems that may arise in the system and that, if not solved, could delay the activities, and generate overload for the nurses.

3.3. Integration

Integration of data in this study unveils the factors influencing technology acceptance among nursing staff in hospital institutions across two Latin American hospitals. Analysis of the effort expectancy category indicates that the majority of nurses find systems easy to use and perceive an improvement in nursing care with technology adoption. Only 16% expressed difficulty due to the effort it entails, aligning with findings by Gaugan et al. (2022) suggesting positive experiences and perceptions of nurses with technology use. Strudwick (2015), drawing from the Technology Acceptance Model, emphasizes that healthcare technologies are beneficial only if accepted and intended for use by nurses. The perceived ease of use correlates with perceived usefulness, suggesting that nurses perceive technology as easy to use when they also deem it useful for patient care.

Performance expectancy emerged as one of the lowest-rated categories in both Chile and Colombia. Some participants expressed concerns about losing information when systems are used improperly, difficulties in self-Efficacy processes, and technology not enhancing productivity. Qualitative analysis revealed that system failures or errors delay nursing documentation, leading to reprocessing and increasing workload, as noted by Gaugan et al. (2022). Strudwick (2015) asserts that perceived technology utility directly predicts nursing staff acceptance, regardless of the technology or environment. Nurses are more likely to adopt technology if it is secure, improves care quality, or enhances efficiency in patient care.

Regarding attitudes towards technology use, the greatest variability in responses was observed in the anxiety factor and technology usage intention. Although most participants expressed anxiety or fear when using technology, this perception may be linked to their satisfaction level with technology use. Patient satisfaction may also influence nurse perceptions, as indicated by Ho & Chung (2019). User satisfaction affects perceived technology usefulness, ease of use, enjoyment, and intention to use.

Lastly, in facilitating conditions, quantitative analysis revealed statistically significant differences between the two countries, particularly regarding social influence and self-efficacy constructs. However, in both countries, knowledge and skills required for technology use determine proficiency. Age emerges as a significant factor, with younger nurses generally more adept and intuitive in technology use, while older ones require more support. Institutional support for resolving system use challenges is crucial, as highlighted by Gaugan et al. (2022), emphasizing the need for training, support, and proper interoperability. This acceptance is relevant, as it correlates not only with performance but also with clinical outcomes and patient satisfaction. Findings by Anian et al. (2021) reinforce this notion, indicating that perceptions of system ease, usefulness, and quality positively influence nursing staff acceptance. Fig. 3 summarizes the results of this Integration.

4. Discussion

Participants in this study emphasized the importance of involving nursing staff in the design of technological platforms for digital health. Such involvement allows for a better understanding of real service needs and greater integration of modules or components. As noted by Nie X (2022), nursing participation in these designs enhances performance expectancy, as well as satisfaction perceptions, both for nurses and their patients. Heidarizadeh et al. (2017) suggest that perceived utility encompasses subjective norms and experienced benefits, while perceived difficulty is more associated with rationalization and challenges in accepting change. Highlighting the benefits of technology use and providing adequate support during the transition from familiar to more innovative systems is recommended to alleviate concerns, as proposed by the authors. Strudwick (2015) underscores the role of training in influencing technology use in nursing, particularly high-quality training, which can positively impact technology acceptance. They also point out that conditions that reduce anxiety improve perceptions related to ease of use, including personality traits like optimism, high innovativeness, personal security, and the ability to achieve desired outcomes using technology. Conversely, a predisposition to discomfort may negatively affect this perception. Ho & Chung (2019) studied the relationship between perceived ease of use, perceived usefulness, and perceived system quality among nurses, indicating a significantly positive influence on perception. Strudwick (2015) identifies facilitating conditions such as physical and technical infrastructure supporting technology. Nurses believe their organizations eliminate barriers to successfully use the available healthcare technology by improving technical support, the equipment availability, and promote their involvement in decision-making processes. Further, these nurses exhibit higher technology acceptance levels. Lastly, Krick et al. (2019) stress the increasing need to continue studying technology acceptance and use among nursing staff, recommending careful examination of evaluation methods applied in specific environments and with specific groups. This suggests a direction for future research in ensuring effective technology implementation in nursing practice.

4.1. Limitations

- Some factors were not considered in the research: these are risk management and overload reduction strategies. This provides opportunity for future work since they are not considered in traditional instruments.
- The study was limited to two hospitals, and exploration in a broader context should be considered.

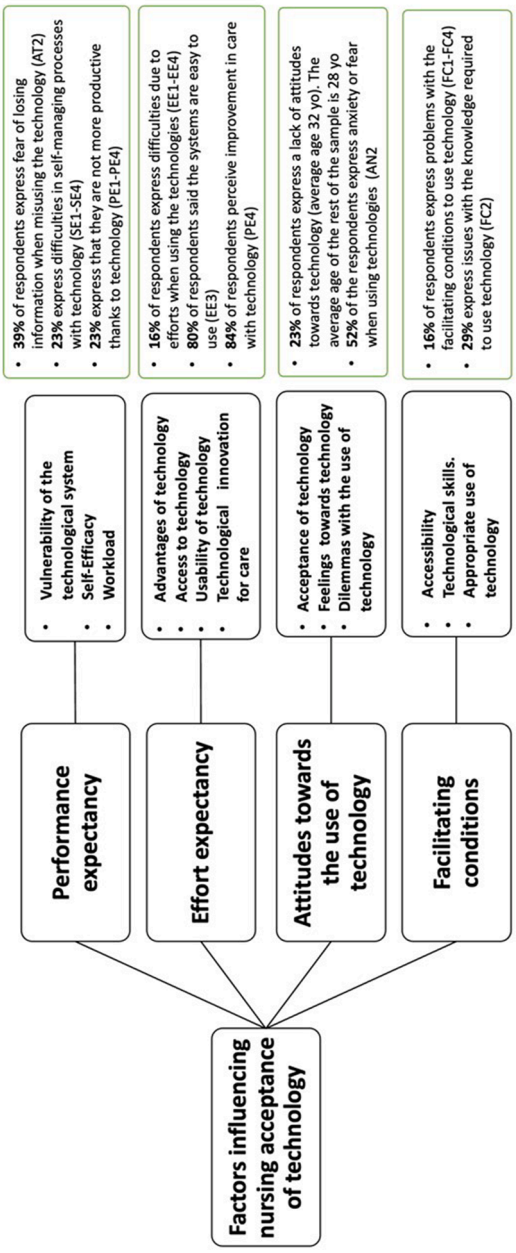

Fig. 3. Integration results. Data integration from quantitative and qualitative approaches through comparative, contrasting and complementary analysis.

5. Conclusions

Thanks to its mixed nature, this study offers a comprehensive view of technology acceptance by nurses in hospital institutions in Chile and Colombia, which is influenced by performance perception, effort expectations, attitudes towards technology, and facilitating conditions, reflected in a current technological adoption degree of 3.7±0.4 (on a scale of 1 to 5) in two Latin American university hospitals. Low performance expectations are linked to the perception of overload, while facilitating conditions, including quality training and constant institutional support, are essential for improving acceptance. Overall, nurses' experiences and perceptions with the use of various technologies are positive, although they also report fear and anxiety, especially among older professionals. Strategies that highlight the benefits, address anxiety, and promote a transition to more user-friendly technologies may be key to improving technology adoption in nursing environments. Likewise, understanding the factors that influence technology acceptance and use will pave the way for better use to support nursing care. It is necessary to focus on modifiable factors that influence technology acceptance, primarily by involving Nursing in the design of these platforms, providing ongoing and high-quality training, ensuring sufficient equipment availability, and having permanent support staff, thus improving the level of nursing management and satisfaction of nurses and patients. These findings provide valuable guidance for driving effective technology implementation, thereby enhancing the efficiency and quality of care provided by Nursing.

Statement

During the preparation of this work the author(s) used ChatGPT to improve the readability of the paper. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

CRediT authorship contribution statement

Juan Manuel Aranda: Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **María Elisa Moreno-Fergusson:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **William Javier Guerrero:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Beatriz Sanchez Herrera:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **María Alejandra Galiano:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Maryory Guevara:** Writing – review & editing, Methodology, Investigation. **Ingrid Xiomara Bustos:** Investigation, Data curation. **Francisca Muñóz:** Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijnsa.2024.100290.

Data availability

All relevant data supporting the findings of this study are included in the manuscript. Any additional data or materials are available upon request from the corresponding author.

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