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Behavioral Intention and Adoption of Clinical Informatics Tools: A Study in Regional Public Municipality Clinics

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Abstract.
Purpose: The healthcare sector is vital for addressing public health emergencies and improving overall health outcomes. This paper aims to explore the factors that influence the adoption of clinical informatics by healthcare professionals in public clinics within a KwaZulu Natal municipality in South Africa. The paper adopted the Unified Theory of Acceptance and Use of Technology (UTAUT) to understand determinants of behavioral intention to use, and actual usage of these clinical informatics tools by the sampled healthcare professionals.
Methods: The paper adopted a mixed-methods approach to answer the research questions, both primary quantitative and secondary qualitative data was collected and analysed. Surveys and interviews were conducted with 67 sampled healthcare professionals including doctors, nurses, administrative staff and 10 managers to obtain the primary quantitative data and secondary qualitative data respectively. SPSS was used to analyse the quantitative data and thematic content analysis was used to analyse for the qualitative data.
Result: Results indicate that the constructs of UTAUT positively influence healthcare workers' intention to use and use of clinical informatics tools, these include in the order of their influence, performance expectancy, effort expectancy, social influence and facilitating conditions. While clinical informatics tools are available and frequently used by healthcare workers, significant challenges are mentioned to impede their effective adoption. These challenges include insufficient hardware, lack of awareness and training about ICT applications, and limited access to data network infrastructure such as Wi-Fi hotspots and routers.
Novelty: The novelty of this research lies in its comprehensive analysis of both the behavioral and infrastructural factors affecting the adoption of clinical informatics in a specific municipal context. Conducted in a municipality that serves both rural and urban communities, this study provides practical recommendations to overcome identified adoption barriers. The findings contribute to developing strategies for the adoption and provision of clinical informatics tools to improve healthcare delivery in South Africa.

Keywords: Clinical informatics, Healthcare delivery, Technology adoption, Unified theory of acceptance and use of technology, South Africa
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INTRODUCTION

Clinical informatics is an interdisciplinary field within health and information science that uses information technology to enhance healthcare delivery, improve patient outcomes, and streamline record management in healthcare operations [1]. This system involve the utilization of electronic health records (EHRs), clinical decision support systems (CDSS), telemedicine, as some examples that facilitate the efficient management of patient information and clinical processes [2]. In modern healthcare, the adoption of clinical informatics by professional healthcare workers can improve patient care and outcomes, optimize the utilization of healthcare resources, and support evidence-based medical practice through data-driven decision making (DDDM).

This paper seeks to measure factors affecting the use of clinical informatics, within a local South African context to understand its adoption and the challenges experienced by professional health-care workers within a municipality, which has seventeen (17) public clinics, two (2) of which are regarded as the main clinics while the remaining fifteen (15) are classed as sub clinics. All these clinics play a crucial role in delivering primary and some specialized healthcare services to the local communities. However, like many public healthcare settings in South Africa, these clinics and their workers face challenges in adopting and

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accessing some clinical informatics tools, which can hinder the effectiveness of healthcare delivery in the country.

Despite the abundance of literature on the importance of clinical informatics for enhancing healthcare efficiency and delivery, it is also well documented that public clinics encounter some challenges in accessing and using clinical informatics tools. These include the lack of data standard integration, poor user interface and system design features, and the high cost of some technology [3]. Digital divides in developing countries like South Africa further exacerbate these barriers [4]. Insufficient hardware and software, inadequate training, lack of awareness about the benefits of clinical informatics tools, and limited access to reliable data infrastructure networks are also listed as reasons that impede the effective use of clinical informatics [5], [6].

To understand these challenges and promote the utilization of clinical informatics, it is crucial to study the factors that influence local healthcare professionals' behavioral intentions to adopt and use these tools. The Unified Theory of Acceptance and Use of Technology (UTAUT) model was adopted for this purpose due to its well documented predictive capacity for the acceptance and use of IT tools and applications. Owolabi (2016) demonstrated that the model can be successfully used in determining medical doctors' and nurses' adoption behavior in respect to clinical informatics [7]. Therefore, using this theory allowed this study to also identify the factors that influence the adoption and use of clinical informatics tools in public clinics. According to Thomas, Singh and Gaffar (2013) the purpose of the UTAUT model "is to explain technology acceptance, based on eight prominent technology acceptance theories" [8].

The paper aimed at exploring the factors that influence the adoption and use of clinical informatics tools by healthcare professionals in public clinics within a peri-urban regional municipality in South Africa. By identifying these key determinants of behavioral intention and usage behavior, this research will provide insights that can enhance user acceptance and facilitate the integration of clinical informatics tools in local healthcare settings. Therefore, answering the following two research questions.

Firstly, what are the key UTAUT determinants and their relationships among healthcare professionals that influences their behavioral intention to adopt and use clinical informatics tools? Secondly, what other challenges exist for the the actual usage of clinical informatics tools in these clinics?

This study contributes to the body of knowledge on healthcare technology adoption by applying the UTAUT to a specific municipal context. The findings will offer practical implications for healthcare administrators and policymakers aiming to improve the adoption and utilization of clinical informatics tools in public clinics. By addressing the identified barriers and leveraging the key determinants of behavioral intention, this research seeks to support the efficient adoption of clinical informatics tools, ultimately enhancing healthcare delivery and patient outcomes in the healthcare facilities of the Municipality.

Numerous studies have explored the factors influencing the adoption of clinical informatics tools in healthcare settings. The key factors that significantly predict adoption among nurses and physicians, respectively are highlighted to be perceived service level, computer self-efficacy, and perceived risk as important antecedents of these perceptions [9], [10]. Emphasis on the need for electronic health records (EHRs) to align with physicians' workflow and practice needs was also highlighted in some studies [11], [12]. Other studies highlighted the influence of individual characteristics and organizational changes on adoption attitudes [13]. Further literature stressed the importance of EHRs in improving patient care and healthcare outcomes [14]. Authors suggest that younger and more tech-savvy healthcare professionals are more likely to perceive these clinical informatics tools as useful and easy to use [13]. Although, challenges such as poor EHR optimization and concerns about trust and interpersonal relationships [15] have also been recorded to hinder their adoption.

Studies have further identified the key factors influencing the adoption of clinical informatics tools in healthcare settings. Effort and performance expectancy, facilitating conditions and social influence, all have been found to significantly impact healthcare professionals' behavioral intentions to use these tools [6], [16], [17]. Social influence and support from colleagues, along with the hierarchy among staff and educational levels, play a vital role in the acceptance of new technologies in clinical settings. However, common barriers to the use of clinical informatics, include privacy and security concerns, cost, and the need for adequate training [18]–[20]. Additionally, the availability of necessary resources, such as hardware,

software, and technical support, significantly impacts the successful implementation of many clinical informatics systems [21], [22]. Challenges among healthcare professionals include their resistance to change [23], concerns about data privacy and security [24], and perceived threats to user autonomy [25]. Other barriers documented include the lack of computer experience [23], and the lack of perceived usefulness and ease of use of clinical informatics tools [23]. The specific adoption of electronic health records (EHRs) and big data analytics, is also influenced by factors like technical limitations, user support, and trust in the information system [23], [26]. All these documented challenges underscore the need for proactive targeted interventions to promote the widespread utilization of clinical informatics tools in local healthcare settings.

A person's behavioral intention to use a certain technology is a crucial predictor of the actual technology use, thus understanding the factors that shape this intention is vital for promoting the adoption of clinical informatics tools. Studies have shown that healthcare professionals behavioral intention to adopt a certain technology is influenced by a combination of cognitive, affective, and contextual factors or constructs. For example these authors, [6], [27], [28] found that healthcare professionals' attitudes towards technology, the perceived norms, and the perceived control over technology use significantly influenced their intentions to adopt clinical decision support systems (CDSS) within their working environment.

In the context of healthcare, the behavioral intentions of healthcare professionals have been examined through various lenses, including the impact of organizational culture, leadership support, and individual characteristics. Research conducted by [29] indicated that a supportive organizational culture and strong leadership commitment are important for fostering positive attitudes towards technology adoption. Additionally, individual biographical factors such as age, gender, and prior experience with technology have been shown to moderate the relationships leading to behavioral intentions to use and actual usage [30]. The novelty of this research paper lies in its comprehensive analysis of both the behavioral intentions of healthcare professionals and infrastructural resources affecting the adoption of clinical informatics in a local municipal context. Conducted in a municipality that serves both rural and urban communities, this study provides practical recommendations to overcome identified adoption barriers. The findings contribute to developing strategies for the adoption and provision of clinical informatics tools to improve healthcare delivery in South Africa.

Theoretical frameworks

The UTAUT was adopted as the theoretical framework of the paper and provided a robust basis for analyzing the factors influencing the behavioral intention, adoption and use of clinical informatics tools by healthcare professionals in local clinics in South Africa.

The UTAUT as depicted in Figure 1 was formulated by Venkatesh et al. [31] to consolidate previous research of eight technology adoption theories. UTAUT identifies four key constructs that influence behavioral intention and usage behavior, namely: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). Performance expectancy is similar to perceived usefulness in the Technology Adoption Model (TAM), referring to the degree to which an individual believes that using the technology will help them achieve gains in job performance [31].

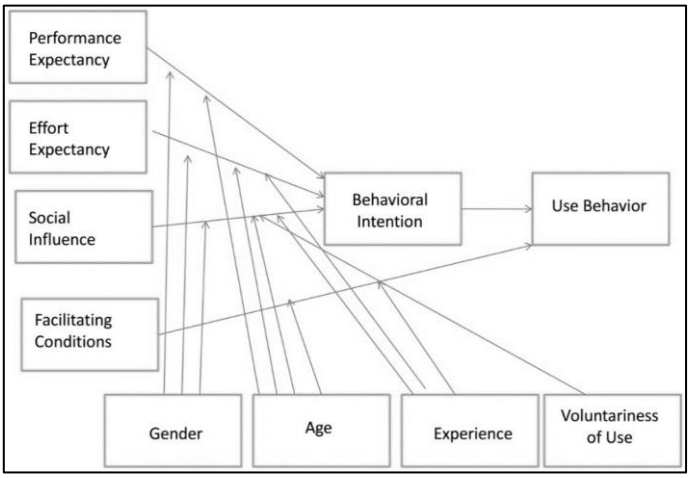

Figure 1. The UTAUT Model [31]

Effort expectancy aligns with perceived ease of use of TAM, described as the degree of ease of access and use technology [31]. Social influence is defined as the extent to which individual allow opinions of others to influence his/her decision to use the technology [31]. Facilitating conditions refer to the extent to which an individual believes that there is an enabling environment in terms of organizational and technical infrastructure to access and support the use of the system [31]. UTAUT also depicts moderating factors such as age, gender, experience, and voluntariness of use as moderators that influence the four key constructs on behavioral intention and use behavior. The original UTAUT model was adopted for this research together with a post-positivism paradigm. Thus, research questions on UTAUT's constructs were crafted rather than hypotheses of their relationships with behavioral intention and use behavior.

METHODS

The paper adopted a robust mixed methods approach and a validated UTAUT theoretical framework. The findings aim to provide comprehensive insights into the behavioral intentions and adoption of clinical informatics tools in public clinics within a specific municipality in South Africa, thus contributing to knowledge in the field of clinical informatics adoption.

Research design

This paper adopted a post-positivism paradigm to provide in-depth results, from qualitative and quantitative research approaches in both their data collection and analysis [32]. Triangulation, allowed for the demonstration of the relationships between different data sets in clinical informatics tools, and healthcare professionals behavioral intention to use them. The study focused on selected clinics in a particular municipal area as a case study.

Population and sample

The target population for this study included two groups: operational staff (N=160) and senior managers (N=10) in public clinics within the municipality understudy. A sample of (n=67) healthcare professionals including doctors, nurses, administrative staff and managers (n=10) provided the primary quantitative data and secondary qualitative data respectively.

Following Kalusopa and Ngulube (2011) [33], the entire population of healthcare workers was considered a census due to its manageable size. Semi-structured interviews were conducted with all ten senior managers, while self-administered questionnaires were distributed to the 160 operational staff. Out of the 160 questionnaires distributed, 92 were completed and returned, with 25 identified as spoilt, leaving 67 for analysis.

Data collection methods

Quantitative data were collected through structured questionnaires, which were personally distributed and administered to the selected sample of healthcare professionals. The instrument adopted validated questions to measure key constructs from the UTAUT, including performance expectancy, effort expectancy, social

influence, and facilitating conditions. The questionnaire also includes demographic questions and items related to the frequency and context of clinical informatics tool usage.

Qualitative data was gathered through semi-structured interviews with 10 participant senior managers. The interview included open-ended questions aimed at exploring the challenges, facilitators, and personal experiences related to the adoption and use of clinical informatics tools within their clinics. Interviews were conducted either in person or via video conferencing, depending on participants' availability and preference.

Data analysis techniques

The primary quantitative data (n=67) collected from the surveys were analyzed using Statistical Programme for Social Sciences (SPSS). Descriptive statistics that is mean, median and standard deviation are used to summarize the demographic characteristics of the sample and the key variables of interest.

The secondary qualitative data (n=10) from the interviews are analyzed using thematic content analysis. This involves transcribing the interview recordings, coding the transcripts to identify key themes and patterns, and interpreting the findings in the context of the research questions. Thematic analysis helps to uncover the nuanced experiences and perspectives of healthcare professionals, providing a deeper understanding of the factors influencing the adoption of clinical informatics tools.

Validity and reliability

To ensure the validity of the survey instrument, a less formal field pilot study consisting of a small number of fifteen (15) participants was conducted to check the reliability of the adopted instruments. The small sample for the pilot study, consisting of healthcare professionals not included in the main study. Feedback from the pilot test refined the survey items for clarity and relevance. Content validity was established through expert review in clinical informatics and healthcare management. Consistency and accuracy in data collection were maintained using digital voice recordings and field notes, with recorded data from face-to-face interviews transcribed to ensure factual and unbiased documentation.

The reliability or consistency of data was ensured by obtaining permission from research participants, which addressed ethical considerations and ensured the accurate representation of their responses. Aligning the research objectives and questions ensured that data accurately reflected the intended constructs, further enhancing the repeatability of the study.

Ethical considerations

Ethical approval for the research was obtained from the relevant institutional research and ethics committee. Informed consent was secured from all participants, ensuring that they were aware of the researcher's purpose, procedures, and their right to withdraw at any time. Confidentiality and anonymity of participants were maintained by assigning unique identifiers to their responses and securely storing all data.

RESULTS AND DISCUSSIONS

Descriptive statistics were used to depict the results of healthcare professionals self evaluation of their behavioral intentions and usage behavior of clinical informatics tools in their local clinics. The closed-ended survey questions utilized a 1-5 Likert scale rating to assess validated statements related to the acceptance and use of clinical informatics tools. The scale was designed as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. This scale was used to capture the range of responses from healthcare professionals, enabling the study to measure quantitatively their perceptions and intentions regarding the use of clinical informatics tools. The use of the scale is consistent with various other studies on technology acceptance that also adopted the UTAUT model to examine perceived factors influencing the adoption and use of ICTs.

Demographic information of respondents

This demographic data of respondents depicted in Table 1 provides a comprehensive overview of the sample, it highlights the diversity and experience levels of healthcare professionals in the public clinics within the municipality, which is crucial for better understanding their perspectives on clinical informatics tools.

The survey collected responses from 92 sampled healthcare professionals out of a total population of 160 operational staff working in public clinics within the municipality. The demographic analysis revealed that

the sample comprised a mix of doctors, nurse clinicians, professional nurses, enrolled nurses, and administrators/receptionists. Additionally, ten senior managers participated in the study, providing valuable insights from a management perspective.

Table 1: Distribution of the demographic data of the respondents [N=67]

Category	Subcategory	Percentage	Count (Out of 67)
Position	Doctors	45%	30
	Nurses	40%	27
	Administrative Staff	15%	10
Age Distribution	Below 30 years	25%	17
	30-50 years	60%	40
	Above 50 years	15%	10
Professional Experience	More than 5 years	70%	47
	Less than 5 years	30%	20

Out of the 92 completed questionnaires, 25 were identified as spoilt, leaving 67 valid responses for analysis. The demographic breakdown of the operational staff showed that 45% were doctors, 40% were nurses, and 15% were administrative staff. The age distribution indicated that 60% of respondents were aged between 30-50 years, 25% were below 30 years, and 15% were above 50 years. In terms of professional experience, 70% of participants had more than 5 years of experience, while 30% had less than 5 years.

Key determinants of behavioral intention

Performance expectancy

Performance expectancy is the degree to which healthcare workers believe that using clinical informatics resources will help them attain gains in their work performance. Table 1 presents the descriptive statistics for the five performance expectancy indicators evaluated in the survey. The descriptive statistics of the five (5) individual indicator statements are shown on the table, which are as follows:

1) Indicator statement one (PE1.1): Clinical Informatics resources enable me to accomplish tasks more quickly.
2) Indicator statement two (PE1.2): Clinical Informatics resources increase my work performance.
3) Indicator statement three (PE1.3): Clinical Informatics resources make my work easier.
4) Indicator statement four (PE1.4): Using Clinical Informatics resources is useful.
5) Indicator statement five (PE1.5): Using Clinical Informatics resources increases the quality of my work.

Table 2: Descriptive statistics of healthcare workers' performance expectancy indicators

Statistics						
		PE1.1	**PE1.2**	**PE1.3**	**PE1.4**	**PE1.5**
N	**Valid**	58	58	58	58	58
	Missing	9	9	9	9	9
Mean		3.98	3.98	4.02	4.00	3.95
Mode		5	5	5	5	4
Std. Deviation		1.100	1.100	1.177	1.060	1.067
Skewness		-.784	-.866	-1.171	-.916	-.882
Std. Error of Skewness		.314	.314	.314	.314	.314
Kurtosis		-.384	-.230	.511	.051	-.035
Std. Error of Kurtosis		.618	.618	.618	.618	.618

The descriptive statistics reveal that four out of the five performance expectancy indicators (PE1.1, PE1.2, PE1.3, and PE1.4) have a mode of five, indicating that the majority of healthcare workers strongly agreed that the use of clinical informatics resources was useful in attaining performance gains in public clinics in the municipality. The mean values for these indicators range from 3.95 to 4.02, further supporting the positive perception of clinical informatics resources in enhancing work performance.

The standard deviations, which range from 1.060 to 1.177, indicate a moderate spread of responses, suggesting some variability in the degree of agreement among healthcare workers. The skewness values are negative, ranging from -0.784 to -1.171, indicating that the distribution of responses is skewed towards higher agreement levels. This negative skewness is consistent across all five indicators, reinforcing the overall positive attitude towards the performance benefits of clinical informatics tools. Kurtosis values,

ranging from -0.384 to 0.511, suggest a distribution close to normal for most indicators, with PE1.3 showing a slightly higher peak. This indicates that responses are relatively consistent, with few extreme outliers.

The descriptive statistics demonstrate that the majority of healthcare workers perceive clinical informatics resources as beneficial in improving their work performance. This is consistent with conclusions reported in other studies [34], [35]. This positive perception aligns with the high mode values and the central tendency measures, reflecting a strong consensus on the usefulness of clinical informatics tools in public clinics in the municipality.

Effort expectancy

Effort expectancy is described as the degree of ease of access and use of the clinical informatics tools and resources in the municipality. The descriptive statistics revealed several insights into healthcare workers' perceptions of effort expectancy, as detailed in Table 2. The descriptive statistics of the four (4) individual indicator statements are shown on the table, which are as follows:

1) Indicator statement one (EE1.1): Using Clinical Informatics resources is easy for me.
2) Indicator statement two (EE1.2) : I find the use of Clinical Informatics resources understandable.
3) Indicator statement three (EE1.3): It is easy for me to become skillful at using Clinical Informatics resources.
4) Indicator statement four (EE1.4): I find it easy to do what I want to do when using Clinical Informatics resources.

Table 3: Descriptive Statistics of healthcare workers' effort expectancy indicators

Statistics					
		EE1.1	**EE1.2**	**EE1.3**	**EE1.4**
N	**Valid**	57	57	57	58
	Missing	10	10	10	9
Mean		3.82	3.81	3.72	3.45
Mode		5	4	4	4
Std. Deviation		1.241	1.187	1.082	1.391
Skewness		-.874	-1.073	-.813	-.578
Std. Error of Skewness		.316	.316	.316	.314
Kurtosis		-.380	.564	.323	-.875
Std. Error of Kurtosis		.623	.623	.623	.618

The mean scores for the effort expectancy indicators range from 3.45 to 3.82, suggesting that healthcare workers generally find the clinical informatics tools relatively easy to use. Three out of the four effort expectancy indicators (EE1.2, EE1.3, and EE1.4) have a mode of 4, indicating that most healthcare workers agree that using clinical informatics tools does not require much effort. The mode of 5 for EE1.1 indicates a significant number of healthcare workers strongly agree with the ease of use.

The standard deviations range from 1.082 to 1.391, showing some variation in responses, but not excessively high, indicating a consistent perception of ease of use among most respondents. The skewness values are all negative, ranging from -0.578 to -1.073, indicating that the distribution of responses is slightly skewed to the left. This suggests that more respondents rated the effort expectancy indicators on the higher end of the scale. The kurtosis values range from -0.875 to 0.564. EE1.2 and EE1.3 have positive kurtosis, indicating a sharper peak compared to a normal distribution, while EE1.1 and EE1.4 have negative kurtosis, indicating a flatter distribution.

The majority of healthcare workers in the public clinics perceive the clinical informatics tools and resources to be easy to access and use. This finding aligns with previous research by [36], [37] which also indicated that the majority of hospital staff found information and communication technology to be faster and easier to use compared to handwritten notes. These insights highlight the general acceptance and perceived ease of use of clinical informatics tools among healthcare workers, which is crucial for successful implementation and integration into clinical workflows.

Social influence

Social influence in this study is defined as the extent to which healthcare workers allow the opinions of others to influence their decision to use clinical informatics tools and resources. The descriptive statistics of the four indicator statements used to measure the effect of social influences on healthcare workers'

behavioral intentions to use clinical informatics tools and resources at the public clinics in the municipality are detailed in Table 3. The descriptive statistics of the four (4) individual indicator statements are shown on the table, which are as follows:

1) Indicator statement one (SI1.1): Professionals promote the use of Clinical Informatics tools.
2) Indicator statement two (SI1.2): I use Clinical Informatics because of the influence of my colleagues.
3) Indicator statement three (SI1.3): Management / staff / patients who influence my behavior think that I should use Clinical Informatics on a regular basis.
4) Indicator statement four (SI1.4): Management / staff / patients who play a role in my job, think that I should use Clinical Informatics more often.

Table 4: Descriptive statistics of healthcare workers' social influence indicators

		Statistics			
		SI1.1	**SI1.2**	**SI1.3**	**SI1.4**
N	**Valid**	57	56	57	55
	Missing	10	11	10	12
Mean		4.12	3.20	3.51	3.47
Mode		4	4	4	4
Std. Deviation		.867	1.271	1.197	1.200
Skewness		-.755	-.108	-.636	-.334
Std. Error of Skewness		.316	.319	.316	.322
Kurtosis		-.070	-1.153	-.587	-.857
Std. Error of Kurtosis		.623	.628	.623	.634

The mean scores for the social influence indicators range from 3.20 to 4.12, with SI1.1 having the highest mean, indicating that healthcare workers generally agree that social influence affects their use of clinical informatics tools and resources. These findings are consistent with the broader literature that generally agree that social influence affects their use of clinical informatics tools and resources [16]. All four indicators have a mode of 4, showing that most healthcare workers agree that social influences play a significant role in their behavioral intentions to use clinical informatics tools.

The standard deviations range from 0.867 to 1.271, indicating some variability in responses. SI1.2 has the highest variability, suggesting differing opinions on this specific aspect of social influence. The skewness values range from -0.755 to -0.108, with all indicators being negatively skewed. This indicates a tendency for healthcare workers to agree more strongly with the social influence statements. The kurtosis values are negative, ranging from -0.070 to -1.153, indicating a flatter distribution than a normal curve. This suggests a wider spread of responses, with fewer clustering around the mean.

The analysis of the social influence indicators reveals that healthcare workers at the public clinics generally agree that social influences affect their behavioral intentions to use clinical informatics tools and resources. The mean scores indicate a moderate to high level of agreement, particularly for SI1.1, which had the highest mean value of 4.12. The mode of 4 across all indicators suggests that a significant number of healthcare workers perceive social influence as an important factor in their decision to use clinical informatics tools. This is consistent with the negative skewness values, which show a tendency towards stronger agreement. However, the variability in responses, particularly for SI1.2, indicates that not all healthcare workers are equally influenced by social factors. The negative kurtosis values suggest a broader range of opinions, highlighting that while social influence is generally agreed upon, the degree to which it impacts individual healthcare workers can vary.

Understanding the role of social influence can help in designing interventions and training programs that leverage positive social dynamics to promote the use of clinical informatics tools. Encouraging influential healthcare workers to advocate for the use of these tools could enhance their acceptance and integration, ultimately improving clinical practices and patient outcomes in the Municipality. By recognizing and addressing the variability in social influence perceptions, healthcare administrators can tailor strategies to better support healthcare workers, ensuring that positive social influences are maximized and barriers to adoption are minimized.

Facilitating conditions

In the current study, facilitating condition is defined as the degree to which healthcare workers believe that organizational and technical infrastructure will support the use of clinical informatics tools and resources. The descriptive statistics of healthcare workers' responses to the facilitating conditions indicators are detailed in Table 3. The descriptive statistics of the five (5) individual indicator statements are shown on the table, which are as follows:

1) Indicator statement one (FC1.1): The Clinic provides the necessary tools to use Clinical Informatics resources.
2) Indicator statement two (FC1.2): I have the necessary knowledge to use Clinical Informatics resources.
3) Indicator statement three (FC1.3): I have the necessary support to use Clinical Informatics resources.
4) Indicator statement four (FC1.4): Using Clinical Informatics fits my working pedagogy.
5) Indicator statement five (FC1.5): I can get help from others when I have difficulties using Clinical Informatics resources.

Table 5: Descriptive statistics of healthcare workers' facilitating conditions indicators

Statistics						
		FC1.1	**FC1.2**	**FC1.3**	**FC1.4**	**FC1.5**
N	**Valid**	57	57	56	52	57
	Missing	10	10	11	15	10
Mean		3.09	3.47	2.98	2.58	3.02
Mode		3	4	4	3	4
Std. Deviation		1.090	1.002	1.342	1.073	1.445
Skewness		-.094	-.533	-.154	-.059	-.032
Std. Error of Skewness		.316	.316	.319	.330	.316
Kurtosis		-.379	-.617	-1.209	-.832	-1.432
Std. Error of Kurtosis		.623	.623	.628	.650	.623

The mean scores for the facilitating condition indicators range from 2.58 to 3.47, indicating a moderate level of agreement among healthcare workers regarding the support provided by organizational and technical infrastructure. Three out of the five facilitating condition indicators (FC1.2, FC1.3, and FC1.5) have a mode of 4, suggesting that a significant number of healthcare workers agree that the conditions at the public clinics facilitate the use of clinical informatics tools. The mode of 3 for FC1.1 and FC1.4 reflects a more neutral stance on these specific indicators.

The standard deviations range from 1.002 to 1.445, indicating some variability in responses. The highest variability is observed in FC1.5 (SD = 1.445), suggesting differing opinions on the extent of organizational and technical support. The skewness values are close to zero, ranging from -0.533 to -0.032, indicating that the distribution of responses is relatively symmetrical. This suggests that there is no significant skewness in healthcare workers' perceptions of facilitating conditions. The kurtosis values are negative, ranging from -0.379 to -1.432, indicating a flatter distribution than a normal curve. This suggests a wider spread of responses, with fewer healthcare workers clustering around the mean.

The analysis of the facilitating condition indicators reveals that healthcare workers at the public clinics generally agree that the organizational and technical infrastructure supports the use of clinical informatics tools, particularly in the aspects covered by FC1.2, FC1.3, and FC1.5. This agreement is consistent with other research studies [6], [38]. However, there is a more neutral perception towards FC1.1 and FC1.4, indicating that not all aspects of facilitating conditions are uniformly perceived as supportive.

The relatively high standard deviations and negative kurtosis values suggest variability in perceptions, pointing to potential areas for improvement in ensuring consistent support across all indicators. Addressing these areas could enhance the overall facilitating conditions, making it easier for healthcare workers to adopt and effectively use clinical informatics tools. By identifying and addressing the specific aspects where perceptions are more neutral or varied, healthcare administrators can implement targeted strategies to strengthen the organizational and technical infrastructure, thereby fostering a more supportive environment for the use of clinical informatics tools. This, in turn, could lead to improved healthcare delivery and patient outcomes in the public clinics in the Municipality.

Behavioral intention (BI)

Behavioral intention in this study is defined as the extent to which healthcare workers intend to use clinical informatics tools and resources, which directly affects actual usage. The descriptive statistics of the five indicator statements used to measure behavioral intention are detailed in Table 4. The descriptive statistics of the five (5) individual indicator statements are shown on the table, which are as follows:

1) Indicator statement one (BI1.1): Whenever possible, I intend to use Clinical Informatics.
2) Indicator statement two (BI1.2): I perceive using Clinical Informatics as natural for me.
3) Indicator statement three (BI1.3): I plan to continue to use Clinical Informatics.
4) Indicator statement four (BI1.4): To the extent possible, I would use Clinical Informatics to teach.
5) Indicator statement five (BI1.5): To the extent possible, I would frequently use Clinical Informatics.

Table 6: Descriptive Statistics of healthcare workers' behavioral intention indicators

Statistics						
		BI1.1	**BI1.2**	**BI1.3**	**BI1.4**	**BI1.5**
N	**Valid**	55	54	55	52	52
	Missing	12	13	12	15	15
Mean		3.67	3.39	4.04	2.65	2.75
Mode		4	4	5	3	3
Std. Deviation		1.248	1.220	1.088	1.186	1.250
Skewness		-.825	-.412	-1.059	.131	.059
Std. Error of Skewness		.322	.325	.322	.330	.330
Kurtosis		-.427	-.870	.574	-.596	-.817
Std. Error of Kurtosis		.634	.639	.634	.650	.650

The mean scores for the behavioral intention indicators range from 2.65 to 4.04, with BI1.3 having the highest mean, indicating strong agreement among healthcare workers on their intention to continue using clinical informatics tools and resources. The modes vary, with values of 4, 4, 5, 3, and 3. This indicates that while healthcare workers generally agree on their intention to use clinical informatics tools (modes of 4 and 5), there is neutrality or less agreement on specific uses such as teaching (modes of 3). The standard deviations range from 1.088 to 1.250, suggesting some variability in responses, particularly for BI1.1 and BI1.5. The skewness values range from -1.059 to 0.131, with most indicators being negatively skewed, indicating a tendency towards agreement. The positive skewness for BI1.4 and BI1.5 suggests a more neutral stance or slight disagreement on these indicators. The kurtosis values range from -0.870 to 0.574, indicating generally flatter distributions, which suggest a wider spread of responses around the mean.

The analysis of the behavioral intention indicators reveals mixed results among healthcare workers. The high mean and mode values for BI1.3 (mean = 4.04, mode = 5) suggest a strong intention to continue using clinical informatics tools and resources, indicating that healthcare workers see value in these tools and are committed to their continued use. However, the lower mean and mode values for BI1.4 (mean = 2.65, mode = 3) and BI1.5 (mean = 2.75, mode = 3) indicate a more neutral stance. This suggests that while there is general agreement on the usefulness and intention to use clinical informatics tools, specific applications like teaching and frequent usage might not be as strongly endorsed by the majority of respondents.

The varied responses, as indicated by the standard deviations and kurtosis values, highlights differing levels of acceptance and behavioral intention to use clinical informatics tools among healthcare professionals in the various clinics. The negative skewness for most indicators reflects a tendency towards positive intentions, but the positive skewness for BI1.4 and BI1.5 indicates some resistance or neutrality in their behavioral intentions.

These findings suggest that while healthcare workers recognize the benefits of clinical informatics tools, there could be barriers or challenges specific to using certain applications. These benefits have buttressed by the work of [39]. To enhance the overall adoption and usage of these tools, it is important to address the specific concerns and needs of healthcare workers related to their behavioral intentions to use. By understanding these nuances, healthcare administrators can develop targeted strategies to promote the comprehensive use of clinical informatics tools, ensuring that they are not only adopted but also fully integrated into various aspects of clinical practice.

Determinants of usage behavior
Understanding the relationship between the determinants of behavioral intention and actual usage behavior of clinical informatics tools provides valuable insights into how these factors influence healthcare workers' adoption and utilization of these tools.

The relationship between behavioral intention and actual usage behavior of clinical informatics tools is complex and interdependent as agreed by other studies [6], [16], [40]. Facilitating conditions directly influences usage behaviour by providing a supportive working environment and necessary resources or not.

Thus, to improve the adoption and usage of clinical informatics tools in local municipality clinics, it is essential to support all the determinants of behavioral intention and usage behaviour comprehensively. This holistic approach can drive the successful adoption and sustained use of these clinical informatics tools and contributing to the overall improvement of healthcare delivery in the municipality.

Challenges in the adoption of clinical informatics
Despite the potential benefits of clinical informatics tools, several challenges were reported to hinder their adoption and effective use in the local municipal clinics. From the semi-structured interviews with clinic managers the main challenges identified in this study include technical barriers, organizational issues, and human factors. Understanding these challenges is crucial for developing strategies to overcome them and enhance the implementation of these tools.

Technical barriers
From the qualitative dataset it arose that one of the primary challenges in adopting clinical informatics tools is the technical barrier associated with inadequate ICT infrastructure. Many clinic managers in the municipality reported issues such as outdated hardware, insufficient internet connectivity, and lack of reliable technical support. These technical deficiencies can make it difficult for healthcare professionals when using clinical informatics tools, leading to frustration and reduced enthusiastic adoption rates. Another specific example given was the integration of new clinical informatics systems with existing electronic health records (EHR) and other healthcare management systems, which was reported to be complex and problematic. This included incompatibility issues and data migration challenges which often discouraged healthcare workers from fully utilizing these tools.

Organizational issues
It was reported by some of the interviewed respondents that organizational challenges also hindered the adoption of clinical informatics tools in many clinics. Specific examples included a lack of adequate training and ongoing support for healthcare workers, leading to resistance and lower adoption rates. In addition, the reported organizational culture within some clinics may not be conducive to promote the adoption of new technologies. Examples of organizational themes reported on included resistance to change, hierarchical structures, and a lack of leadership support which made healthcare professionals more reluctant to adopt and integrate some clinical informatics tools into their daily working practice.

Human factors
This theme included attitudes, perceptions, and behaviors of healthcare professionals, which is known to significantly impact the adoption of clinical informatics tools. It was reported that some healthcare professionals may have negative attitudes towards new technologies due to previous bad experiences or technophobia, or being influenced by one of the barriers discussed above. These negative perceptions would lead to resistance and reluctance to use clinical informatics tools, even when they are available and potentially beneficial. Apart from the behavioral intentions of healthcare professionals, their workload and time constraints can also impede the adoption of new clinical informatics tools.

Strategies to overcome challenges
The following discussion lists four strategy themes to overcome the identified challenges revealed through both qualitative interviews and quantitative questionnaire results.

1) Technical improvements in most clinics, should include the upgrading of old hardware, enhancing poor internet connectivity and data restrictions, and most importantly ensuring reliable technical support who can alleviate the frustrations technical barriers. Additionally, by ensuring compatibility and smooth integration of the EHR system with all clinical informatics tools can improve their adoption.

2) Ongoing training and support can improve healthcare professionals' confidence and competence in using clinical informatics tools. Continuous professional development is the best practice recommended for all healthcare professionals who work with new technologies and systems. The study's findings also revealed the need for training on data capturing to ensure the increased use of electronic filing and database management. Regular training courses related to ICT tools, systems, concepts, and theories should be developed to accommodate staff members with minimal experience and knowledge of clinical informatics tools. This recommendation aligns with findings by [41], [42], emphasizing the value of hands-on, locally relevant training in low-resource settings
3) Promoting a positive organizational culture that values innovation and technological advancement is crucial for the clinic managers and leaders. Its is essential that leadership support and encouragement can motivate healthcare professionals to go the extra mile to embrace new tools and integrate them into their working practice.
4) It is recommended that education and awareness campaigns can help mitigate resistance and negative attitudes and perceptions of healthcare professionals to the adoption of clinical informatics tools. Additionally, by demonstrating the practical benefits of clinical informatics tools in reducing healthcare professionals workload, making the work easier and improving patient care can motivate their adoption.

It is recommended that by addressing the identified challenges through the above targeted strategies, the adoption and effective use of clinical informatics tools by healthcare professionals in the local Municipality clinics can be improved, leading to enhanced healthcare delivery and better patient outcomes.

Significance of key determinants of the theoretical framework

The study focused on understanding both the broad contextual barriers to the adoption of clinical informatics tools and individual perceptions of healthcare professionals to their behavioral intentions and usage behavior of the specific clinical informatics tools in their public municlinics. The findings from sampled healthcare professionals (n=67) revealed the significance of key determinants of UTAUT having a positive influence towards the adoption of clinical informatics tools, these included the constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions, which now will be discussed.

Findings showed that performance expectancy was the most significant construct to positively influence healthcare professionals' intention to adopt and use clinical informatics tools. Healthcare workers thus perceived that these tools will enhance their job performance and thus reported that they were more likely to embrace and utilize them. This shows that clinical informatics tools have a positive impact on task efficiency, work performance, and quality of care, all of which influence higher adoption rates.

Effort expectancy was also found to be a significant construct and showed that sampled healthcare professionals found it relatively easy to use the clinical informatics tools in their local clinics. The perception that these tools require minimal effort to use positively affected their adoption and use. However, further simplifying user interfaces and offering user-friendly training programs can further enhance the positive influence of the effort expectancy construct.

As was expected social influence was also found to be a powerful determinant that influenced healthcare professionals' attitudes towards adopting clinical informatics tools. The encouragement from colleagues and supervisors significantly impact the decision to use these tools in the sampled municipal clinics. Creating a culture where experienced users advocate for the benefits of clinical informatics tools, can thus strengthen the behavioral intentions and use behavior of healthcare professionals.

Facilitating conditions, which directly impacts use behavior was shown to have a small positive affect in the adoption of clinical informatics tools by healthcare professionals. It would seems that there is the availability of limited resources, such as hardware, software, internet connectivity, and technical support, however the findings reveal that by improving these conditions clinics can significantly enhance healthcare professionals usage behavior. Thus, it is recommended that the Department of Health invests in upgrading aging infrastructure, improving technical support, and ensuring reliable access to necessary resources to strengthen the positive affect of this construct.

The significance of supporting these key UTAUT constructs by the Department of Health in the municipal clinics cannot be overstated. The study has shown that performance expectancy drives the motivation to adopt clinical informatics tools by highlighting their benefits. Effort expectancy demonstrates that these tools are easy to use. Social influence from peer and supervisory support has been shown to encourage adoption. The facilitating conditions of clinics do provide the essential infrastructure and resources needed to use the tools but can also improve to further increase the usage behavior of healthcare professionals. By supporting these determinants comprehensively, healthcare administrators can create an environment that fosters the successful adoption and integration of clinical informatics tools, leading to improved clinical workflows, enhanced patient care, and more efficient healthcare delivery in the Municipality clinics.

Practical implications

The practical implications for healthcare administrators, policymakers, and technology developers are to firstly overcome the barriers to the adoption of their clinical informatics tools by following the recommended strategies and secondly to support the individual perceptions and attitudes of healthcare professionals towards using these tools. By addressing these practical aspects, local healthcare facilities can improve the adoption and effective use of clinical informatics tools, ultimately enhancing healthcare delivery and patient outcomes in the Municipality.

CONCLUSION

In conclusion, this study contributes to the understanding of the adoption of clinical informatics tools by healthcare professionals in public clinics in South Africa. By identifying key UTAUT determinants of adoption by healthcare professionals as well as additional challenges, the research offers valuable insights and practical recommendations for improving the integration of technological tools into local clinics and paving the way for more efficient and effective healthcare delivery in the municipality. By utilizing UTAUT as theoretical framework, the paper identified positive relationships between performance expectancy, effort expectancy, social influence and facilitating conditions and healthcare professionals intention to use, and use of clinical informatics tools. The paper also highlighted the critical role of infrastructure support, training, and organizational culture in facilitating effective adoption.

Building on the findings of this research, several avenues for future studies are recommended:

- Conduct longitudinal research over time to examine changes in behavioral intentions and usage behavior of healthcare professionals, thus providing insights into intervention strategies on the long-term adoption and integration of clinical informatics tools.
- Extend the study to include multiple municipalities or regions with varying urban, peri-urban and rural populations to compare and contrast how the technological infrastructure and healthcare resources influence adoption of clinical informatics tools.
- Implement and evaluate targeted interventions, such as enhanced training programs or infrastructure upgrades, to assess their effectiveness in improving the adoption and utilization of clinical informatics tools.
- Explore the user experience and satisfaction of specific clinical informatics tools in depth, using methods such as usability testing and focus groups, to identify specific areas for improvement in tool design and functionality.
- Investigate the impact of healthcare policies on the adoption of clinical informatics tools, providing evidence-based recommendations for policymakers to support technological integration in healthcare settings.

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